Health Consultation

Analysis of Cancer Incidence Near the Middlesex Sampling Plant

MIDDLESEX SAMPLING PLANT (USDOE)

MIDDLESEX BOROUGH, MIDDLESEX COUNTY, NEW JERSEY

EPA FACILITY ID: NJ0890090012

JANUARY 31, 2001

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:

New Jersey Department of Health and Senior Services
Division of Epidemiology, Environmental and Occupational Health
Consumer and Environmental Health Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry
with the Division of Public Health

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Summary

The Middlesex Sampling Plant in Middlesex Boro (MSP) processed radioactive ores from 1943 to 1955. The facility's property and some off-site locations became contaminated with radioactive materials. In January 1999, the MSP was added to the National Priorities List of Superfund sites. Subsequently, the federal Agency for Toxic Substances and Disease Registry (ATSDR) requested the New Jersey Department of Health and Senior Services (DHSS) to conduct a cancer incidence analysis for this site.

The study area consisted of four census tracts, the census tract where the MSP facility resided and three surrounding census tracts where off-site contamination occurred. Standardized incidence ratios (SIRs) were calculated for all cancers combined and eleven site-specific cancers. The site-specific cancers were selected jointly by research staff from ATSDR and DHSS for an earlier radiological study conducted by DHSS of cancer incidence in other New Jersey communities with radiologically contaminated Superfund sites because of medical evidence that these cancers may be more sensitive to the effects of radiation exposure. Two evaluation time periods were selected. The first evaluation time period, 1979-1991, corresponds to the earlier study. The second evaluation time period, 1992-1998, represents the remaining years of available data. The four census tracts were evaluated together and each separately. Expected numbers were calculated using average state incidence rates and U.S. census data to estimate the population.

For the time period 1979-1991, total cancer incidence and many site-specific cancer groups were lower than expected for the entire study area and each census tract. The only SIR significantly elevated was in census tract 1 (Middlesex Boro) for leukemia in males (SIR=1.92; 95% C.I.=1.02, 3.28). During the later time period (1992-1998), cancer incidence was higher than in the earlier period, particularly in the two Piscataway census tracts. Leukemia incidence in males from census tract 1 was not elevated (SIR=0.27) from 1992-1998.

In conclusion, cancer incidence for the entire study area during the period 1979-1991 was not significantly higher than expected when compared to average state incidence rates. The higher SIRs detected for the period 1992-1998 could be due to the aging of the population and/or population growth. Significant population growth occurred in Piscataway Township's study area as evidenced by the increased number of census tracts designated for that area from 1980 to 1990. Since there was little agreement in the results across the four census tracts or between time periods, it is not likely that the few elevations detected are related to site contamination. Consequently, no further follow-up of cancer incidence appears warranted for this site at this time.

Purpose

At the request of the federal Agency for Toxic Substances and Disease Registry (ATSDR), cancer incidence was evaluated for the population living near the Middlesex Sampling Plant, Middlesex Municipal Landfill, and other off-site contaminated locations. The strategy for this

investigation was to conduct a parallel analysis of a recent New Jersey Department of Health and Senior Services's (DHSS) study of other Superfund sites with similar contamination, *Cancer Incidence in Populations Living near Radiologically Contaminated Superfund Sites in New Jersey*. In this evaluation, as in the earlier study of cancer in communities with radiation contaminated Superfund sites, total cancer incidence and eleven site-specific cancer groupings were evaluated. The site-specific cancers were selected by ATSDR and DHSS staff because they represent groupings that may be more sensitive to the effects of radiation exposure.

Background and Statement of Issues

The Middlesex Sampling Plant (MSP) in Middlesex Boro was originally operated from 1943 to 1955 by the Manhattan Project and later by the Atomic Energy Commission. Primary activities at the facility included sampling, storage and/or shipment of uranium, thorium and beryllium ores. During the facility's operation, buildings, grounds and nearby properties became contaminated with uranium primarily from spillage and off-site runoff. Contaminated soil from the site was also disposed of in the Middlesex Municipal Landfill, about 0.5 miles from the facility. In January 1999 the MSP site was listed on the United States Environmental Protection Agency's National Priorities List (NPL).

Methods

Study Area and Population: The Middlesex Sampling Plant study area for the evaluation of cancer incidence consisted of four census tracts (Figure 1). Two of the census tracts are located in Middlesex Boro (census tracts 1 and 2) and comprise the entire municipality. Two of the census tracts are in Piscataway Township (census tracts 4.01 and 4.03) and are located in the western section of the municipality.

The study population consists of all residents living in the specified census tracts. The U.S. Census Bureau designates the boundaries for census tracts by the size of the population rather than the area of land encompassed by the census tract. As the population within a census tract grows from one census enumeration to the next (as tallied every ten years), census tracts are subdivided into two or more new census tracts. The total population for Middlesex Boro declined slightly from 1980 to 1990 with a shift towards the older age groups (Table 1). The western section of Piscataway Township grew in population through the 1980s. The evidence for the growth in population on the westside of Piscataway is that the single census tract for that section in 1980 was split into three census tracts in 1990. Consequently, for the purpose of calculating statistics in this investigation, the 1990 U.S. Census Bureau population estimates (Table 2) were utilized for the four study census tracts.

Cancer Case Ascertainment and Study Period: The New Jersey State Cancer Registry was used for the ascertainment of cancer cases. The Cancer Registry is a population-based cancer incidence registry covering the entire state of New Jersey. By law, all cases of newly diagnosed cancers are reportable to the Registry. In addition, the Registry has reporting agreements with the

states of New York, Pennsylvania, Delaware and Florida. Information on New Jersey residents who are diagnosed in those states is supplied to the New Jersey State Cancer Registry. The Registry has been in operation since October 1, 1978.

The study period for this investigation was January 1, 1979, through December 31, 1998 and consisted of two evaluation time periods. The first evaluation time period, 1979-1991, corresponds to an earlier study conducted by the DHSS of cancer incidence in other communities with radiologically contaminated NPL sites. The second evaluation time period, 1992-1998, represents the remaining years of available data. A "case" was defined as an individual who was diagnosed with a new primary malignant cancer during the study period while residing in one of the selected census tracts. Information on risk factors such as personal lifestyle habits are not available from the Cancer Registry.

Data Analysis: Analyses were completed for all malignant cancer types combined and for select cancer types for the four census tracts combined and each census tract separately. The select cancer types analyzed include: bladder, brain and central nervous system, pancreas, lung and pleura, leukemia, non-Hodgkin's lymphoma, liver, bone, kidney, thyroid, and breast. These cancer types were evaluated because they were previously selected jointly by research staff from ATSDR and DHSS for the earlier radiological study since they represent groupings that may be more sensitive to the effects of radiation exposure. Males and females were evaluated separately. All races were combined for the analyses.

Standardized incidence ratios (SIR) were used for the quantitative analysis of cancer incidence in the study areas. The SIR is calculated by dividing the observed number of cases (from the Registry) by an expected number for the surveyed population over the time period reviewed.

The expected number was derived by multiplying a comparison population's age-sex-specific incidence rates and the study area age-sex-specific population figures. The comparison rates used to derive the expected number of cases were the New Jersey average annual incidence rates for 1986 to1988. This time period provides a sufficient number of cases statewide for stable age-sex-specific rates and is representative of statewide cancer incidence over the entire study time period. Use of the 1986 to1988 average annual State rates also provides consistency and comparability with the results of an earlier study of cancer in populations living near other radiologically contaminated Superfund sites in New Jersey. The study area age-sex-specific population was determined from the 1990 U.S. Census Bureau data. Eighteen age-specific population groups were used in the analysis.

Evaluation of the observed and expected numbers is accomplished by interpreting the ratio of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal one (1.0). When the SIR is less than one, we conclude that fewer cases were observed than expected. Should the SIR be greater than one, then more cases than expected were observed.

Random fluctuations may account for some SIR deviations from 1.0. Statistical significance of deviations from SIR equal to 1.0 was evaluated using a 95% confidence interval (C.I.). The 95% C.I. was used to evaluate the probability that the SIR may be greater or less than 1.0 due to chance alone, and was based on the Poisson distribution. If the confidence interval includes 1.0, then the estimated SIR is not considered to be significantly different than 1.0.

Results

Table 3 presents the number of malignant incident cases by race, age group, year of diagnosis, and sex for the four census tracts. A total of 904 cancers (473 males and 431 females) were diagnosed in residents living in the four census tracts during the years 1979-1991. The majority of the cases were from census tracts 1 and 2 (77.3%) primarily because nearly 70% of the study population lived in those two census tracts. Nearly all the cases were identified as white (97.2%). Only five of the cases were in children diagnosed under the age of 20 and included two with leukemia and one case each of soft tissue sarcoma, brain/central nervous system, and kidney cancer.

Table 4 presents a description of the cases by cancer type and sex for the four census tracts. For males, the most frequent cancer type was lung and pleura (92) followed by colorectal (74) and prostate (62). For females, the most frequent cancer type was breast (133) followed by colorectal (67) and lung and pleura (42). The three most common cancer types were consistent with New Jersey statewide cancer incidence data.

Tables 5a through 5e present standardized incidence ratio (SIR) results for the four census tracts combined and each census tract separately by sex. Total malignant cancer incidence in all four census tracts combined was significantly low for both males and female (Table 5a). Additionally, five other cancer groupings were significantly low: bladder, breast and lung/pleura cancer in female; and lung/pleura and non-Hodgkin's lymphoma in males.

Four SIRs were significantly low for census tract 1 in Middlesex Boro (Table 5b): all cancers, bladder and breast cancer in females; and non-Hodgkin's lymphoma in males. Leukemia in males was significantly elevated (SIR=1.92; 95% CI=1.02, 3.28) with 13 cases diagnosed and 6.8 expected over the 13 years.

Census tract 2 in Middlesex Boro had two significantly low SIRs (Table 5c): all cancer and lung/pleura cancer in females. Census tract 4.01 in Piscataway Township (Table 5d) had one significantly low SIR: all cancer in males. One SIR in census tract 4.03 (Table 5e) was significantly low, all cancer in males.

Table 6 presents the number of malignant incident cases by race, age group, year of diagnosis, and sex for the four census tracts from 1992-1998. A total of 635 cancers (337 males and 298 females) were diagnosed in residents living in the four census tracts. As in the earlier time period, the majority of the cases were from census tracts 1 and 2 (68.7%) and nearly all the cases

were identified as white (92.6%). Eight of the cases were in children diagnosed under the age of 20 and included two cancers each of brain/central nervous system and testicular cancer, and one case each of leukemia, non-Hodgkin's lymphoma, adrenal cancer and oral/pharyngeal cancer.

Table 7 presents a description of the cases by cancer type and sex for the four census tracts from 1992-1998. For males, the most frequent cancer type was prostate (97) followed by lung and pleura (75) and colorectal (48). The proportion of prostate cancers to total malignant cancers in males more than doubled from the earlier time period to the later time period (13.1% versus 28.8%) and may reflect increased screening for this cancer type or an aging population. For females, the most frequent cancer type was breast (87) followed by colorectal (35) and lung and pleura (33).

Tables 8a through 8e present standardized incidence ratio (SIR) results for the four census tracts combined and each census tract separately by sex from 1992 through 1998. Total malignant cancer incidence in all four census tracts combined was significantly elevated for males (Table 8a). SIRs were significantly low for bladder and pancreatic cancers in males in all four census tracts combined.

None of the SIRs for the Middlesex Boro census tracts were significantly high or low (Tables 8b and 8c). While census tract 1 had significantly elevated incidence of leukemia in males for the earlier time period, the later time period had only one case with 3.7 expected. The Piscataway census tracts had four significantly elevated SIRs: all cancers in males for census tract 4.01; and all cancers in males and females and lung and pleura cancers in males for census tract 4.03.

Discussion

The purpose of this investigation was to evaluate cancer incidence in populations living relatively near to areas contaminated with radioactive waste. Based on average State rates, the number of newly diagnosed cancers in the four census tracts combined was significantly lower than expected for all cancers combined and a number of the type-specific groupings during the period 1979-1991. Overall cancer incidence was lower than expected for each census tract separately. However, SIRs for the period 1992-1998 was higher than the earlier period (1979-1991), particularly in the Piscataway census tracts. The low SIRs for the Middlesex census tracts in the earlier time period could reflect an overestimate of the expected number due to the use of 1990 census data. Since the 1990 census data has a greater percentage of older people than the 1980 data and cancer incidence is significantly higher in older populations, an inflated expected number of cases would result during the earlier time period. The higher SIRs found in the two Piscataway census tracts could reflect population growth in the Township throughout the study time period. Those census tracts were part of a single census tract in 1980, which by 1990 was split into multiple census tracts.

The one unusual finding for the period 1979-1991 was the significantly elevated (SIR=1.92) leukemia incidence in males from census tract 1. However, for the period 1992-1998, leukemia incidence in males from census tract 1 was not elevated (SIR=0.27).

A serious limitation of cancer studies of this type is the inability to assess 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. Since personal exposure information does not exist, residential distance from the contaminated site was used as a surrogate measure for potential past exposure. This was accomplished by grouping the population living in the selected census tracts into a more potentially exposed study area. Although distance from the site may have been the best way to estimate past potential exposures at the time the study was designed, it is also unlikely that all of the residents in these areas were exposed to the contamination. Additionally, the length of residence of each case is unknown, thereby potentially adding to exposure misclassification. The consequence of exposure misclassification would be to bias the results toward the null hypothesis of no effect.

Another interpretation problem is that cancer is a chronic disease that takes many years after exposure to manifest as clinical disease. The information supplied by the New Jersey State Cancer Registry provides only an address at time of diagnosis for each case. No information is available on 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 the sites. 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 each other.

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, due to the large number of comparisons conducted. While it is possible to statistically correct for this concern, it is controversial whether such corrections are needed. Confidence intervals are presented without adjustment for multiple comparison.

The approach utilized in this study was "census" based, where the entire population of the study area and the State of New Jersey were reviewed in order to calculate sex-and age-standardized incidence ratios (SIRs). This "census" approach (ecologic design) is a practical surveillance or screening method for estimating cancer incidence. However, information on important individual risk factors, such as occupational exposures or personal lifestyle habits (e.g., smoking history), were not available for this evaluation and, therefore, cannot be accounted for in this study design and analysis.

Conclusions and Recommendations

In conclusion, total cancer incidence and all eleven specific cancer groupings for the entire study area during the period 1979-1991 were not significantly higher than expected when compared to average state incidence rates. The higher SIRs detected for the period 1992-1998 could be due to the aging of the population and/or population growth. Since there was little agreement in the results across the four census tracts or between time periods, it is not likely that the few elevations detected are related to site contamination. Consequently, no further follow-up of cancer incidence appears warranted for this site at this time.

Authors

Patricia Haltmeier and Michael Berry

New Jersey Department of Health and Senior Services
Division of Epidemiology, Environmental and Occupational Health
Consumer and Environmental Health Services

Certification

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

Gregory V. Ulirsch
Technical Project Officer
Superfund Site Assessment Branch (SSAB)
Division of Health Assessment and Consultation (DHAC)
ATSDR

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

for RG

Richard E. Gillig
Chief, SSAB, DHAC
ATSDR

Figure and Tables

Figure 1. Middlesex Sampling Plant (MSP) and Census Tracts 1 and 2 in Middlesex Boro and 4.01 and 4.03 in Piscataway Township

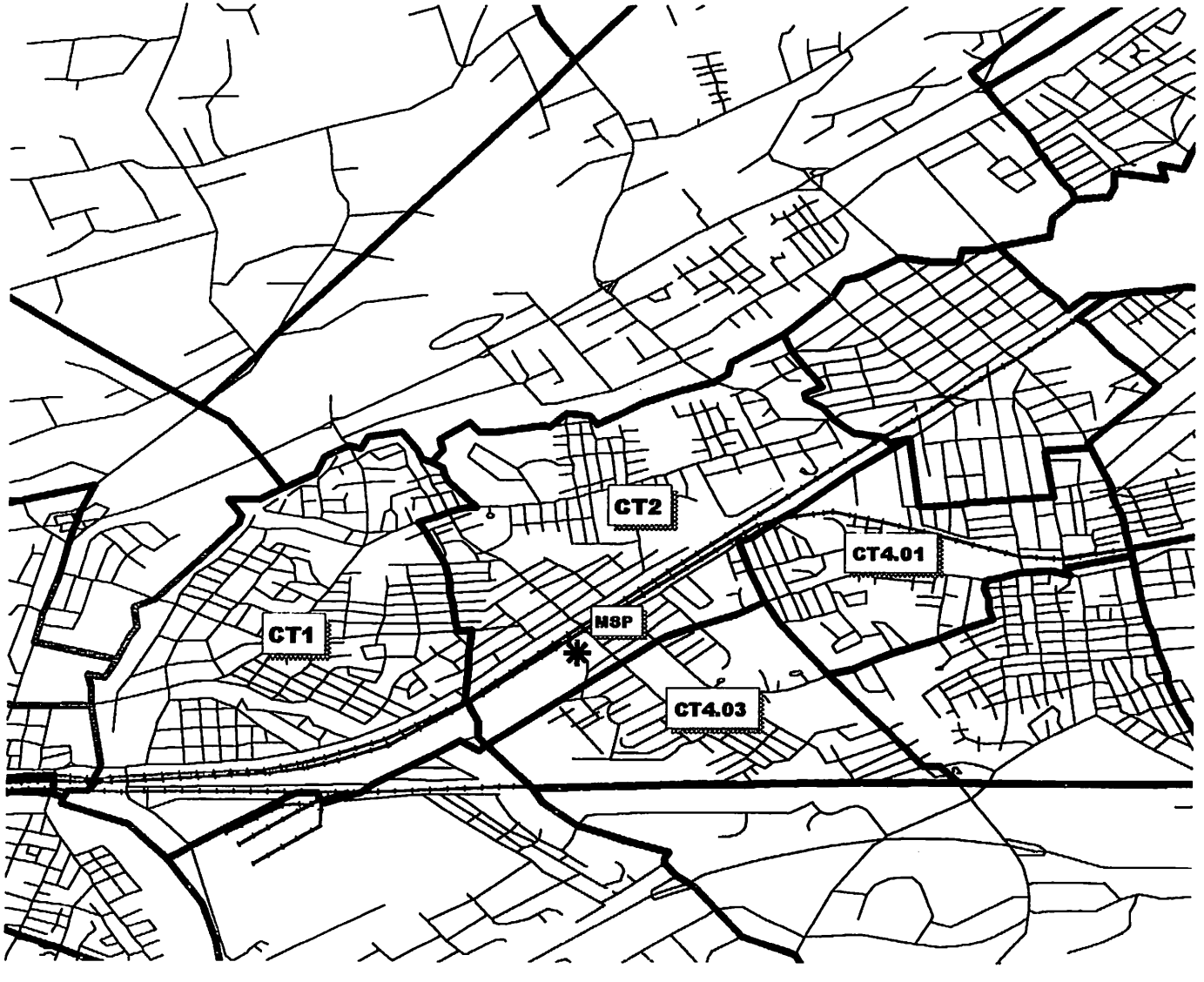

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Table 1. Middlesex Boro: Total Population, 1980 and 1990.

Age Group	1980	1990	% change
0-4	817	864	5.8%
5-9	851	822	-3.4%
10-14	1,094	739	-32.4%
15-19	1,229	755	-38.6%
20-24	1,207	953	-21.0%
25-29	1,145	1,135	-0.9%
30-34	1,034	1,264	22.2%
35-39	880	1,016	15.5%
40-44	691	1,043	50.9%
45-49	767	828	8.0%
50-55	892	538	-39.7%
56-59	961	550	-42.8%
60-64	722	764	5.8%
65-69	528	698	32.2%
70-74	299	487	62.9%
75-79	180	311	72.8%
80-84	107	135	26.2%
85+	76	153	101.3%
Total	13,480	13,055	-3.2%

Table 2. 1990 Population: Middlesex Boro (census tracts 1 and 2) and Piscataway Township (census tracts 4.01 and 4.03).

Age Group	Male					Female				
	CT 1	CT 2	CT 4.01	CT 4.03	Total	CT 1	CT 2	CT 4.01	CT 4.03	Total
0-4	249	196	131	115	691	257	180	126	72	635
5-9	270	167	106	77	620	217	145	104	78	544
10-14	245	150	117	63	575	223	136	94	84	537
15-19	211	170	144	80	605	206	172	145	75	598
20-24	276	188	150	83	697	231	207	156	78	672
25-29	264	281	165	94	804	301	304	140	73	818
30-34	356	317	168	105	946	336	259	156	130	881
35-39	305	228	140	114	787	323	212	138	120	793
40-44	290	193	135	133	751	270	203	150	108	731
45-49	226	151	118	78	573	254	151	146	87	638
50-54	180	116	132	54	482	185	129	117	53	484
55-59	188	110	107	44	449	211	141	106	32	490
60-64	191	135	93	28	447	219	159	73	30	481
65-69	190	117	44	17	368	238	159	73	15	485
70-74	133	89	31	13	266	172	87	59	21	339
75-79	81	42	32	10	165	127	75	44	16	262
80-84	40	17	15	1	73	84	37	18	2	141
85+	15	7	10	3	35	37	25	11	3	76
Total	3,710	2,674	1,838	1,112	9,334	3,891	2,781	1,856	1,077	9,605

Table 3. Characteristics of malignant cancer incidence by year of diagnosis, age group, race, and sex: Middlesex Boro (census tracts 1 and 2) and Piscataway Township (census tracts 4.01 and 4.03), 1979 - 1991.

	Male					Female				
	CT 1	CT 2	CT 4.01	CT 4.03	Total	CT 1	CT 2	CT 4.01	CT 4.03	Total
Diagnosis Year:										
1979	17	7	9	0	33	19	4	8	3	34
1980	22	8	3	2	35	8	6	3	1	18
1981	21	9	9	0	39	12	9	7	2	30
1982	16	10	5	1	32	21	12	2	2	37
1983	20	10	6	0	36	21	8	11	0	40
1984	21	7	5	2	35	13	7	8	1	29
1985	15	12	7	2	36	13	2	4	5	24
1986	12	9	6	5	32	15	13	6	3	37
1987	27	19	2	1	49	21	9	12	0	42
1988	15	17	8	3	43	20	16	5	3	44
1989	21	8	5	2	36	27	3	3	4	37
1990	19	15	4	2	40	11	9	7	1	28
1991	12	8	7	0	27	13	10	6	2	31
Total	238	139	76	20	473	214	108	82	27	431
Age Group:										
0 - 9	1	1	0	0	2	2	0	0	0	2
10 - 19	0	0	0	0	0	1	0	0	0	1
20 - 34	7	6	2	1	16	7	5	6	1	19
35 - 49	15	11	7	2	35	30	12	22	7	71
50 - 64	78	52	24	8	162	70	43	22	10	145
65 - 79	113	63	37	8	221	90	39	21	9	159
80 +	24	6	6	1	37	14	9	11	0	34
Race:										
White	237	133	75	17	462	209	106	79	23	417
All others	0	4	0	1	5	1	2	3	4	10
Unknown	1	2	1	2	6	4	0	0	0	4

Table 4. Malignant cancer incidence by type: Middlesex Boro (census tracts 1 and 2) and Piscataway Township (census tracts 4.01 and 4.03), 1979 - 1991.

	Male					Female				
	CT 1	CT 2	CT 4.01	CT 4.03	Total	CT 1	CT 2	CT 4.01	CT 4.03	Total
Bladder	22	15	5	0	42	1	3	1	0	5
Bone and Joint	0	0	0	0	0	1	0	0	0	1
Brain/CNS	3	0	1	0	4	4	3	0	0	7
Breast	1	0	0	0	1	54	40	31	8	133
Cervix	-	-	-	-	-	5	1	1	0	7
Colorectal	37	25	9	3	74	34	20	10	3	67
Corpus Uteri	-	-	-	-	-	16	4	7	3	30
Esophagus	5	5	0	1	11	2	0	0	1	3
Eye	1	1	0	0	2	1	0	0	0	1
Gallbladder	3	0	0	0	3	3	2	0	1	6
Hodgkin's Disease	1	1	0	1	3	0	2	0	0	2
Kidney	7	6	3	0	16	6	3	0	1	10
Larynx	4	1	1	0	6	2	0	0	0	2
Leukemia	13	5	3	2	23	4	0	4	0	8
Liver	2	2	0	0	4	1	1	0	0	2
Lung/Pleura	41	30	17	4	92	22	9	6	5	42
Myeloma	6	0	0	1	7	2	0	0	0	2
Oral/Pharynx	10	7	4	0	21	3	2	0	0	5
Other Digestive	0	1	0	0	1	0	0	0	0	0
Other Respiratory	5	2	1	0	8	0	1	0	0	1
Other Female Genital	-	-	-	-	-	2	0	1	0	3
Other Male Genital	1	0	0	0	1	-	-	-	-	-
Ovary	-	-	-	-	-	9	1	4	2	16
Non-Hodgkin's Lymphoma	3	4	2	0	9	8	7	3	1	19
Pancreas	6	2	4	0	12	3	2	2	0	7
Prostate	36	13	10	3	62	-	-	-	-	-
Skin	12	7	9	2	30	8	0	5	1	14
Small Intestine	1	0	0	0	1	0	0	1	0	1
Soft Tissue	2	3	0	0	5	4	2	3	0	9
Stomach	8	4	3	0	15	7	1	0	0	8
Testis	3	2	1	1	7	-	-	-	-	-
Thyroid	0	0	1	0	1	4	2	1	1	8
Other or Unkown Site	5	3	2	2	12	8	2	2	0	12
Total	238	139	76	20	473	214	108	82	27	431

Table 5a

Standardized Incidence Ratios
Middlesex Boro and Piscataway Township
Census Tracts 1, 2, 4.01, 4.03
1979-1991

Cancer Type	Expected	Observed	SIR		95% CI Lower	Upper
Female						
All cancer	552.42	431	0.78	*	0.71	0.86
Bladder	14.31	5	0.35	*	0.11	0.82
Bone and Joint	1.73	1	0.58		0.01	3.23
Brain/Central Nervous System	7.23	7	0.97		0.39	2.00
Breast	172.82	133	0.77	*	0.64	0.91
Kidney	10.34	10	0.97		0.46	1.78
Leukemia	11.26	8	0.71		0.31	1.40
Liver	2.12	2	0.95		0.11	3.41
Lung/Pleura	63.96	42	0.66	*	0.47	0.89
Non-Hodgkin's Lymphoma	17.07	19	1.11		0.67	1.74
Pancreas	14.01	7	0.50		0.20	1.03
Thyroid	8.42	8	0.95		0.41	1.87
Male						
All cancer	552.89	473	0.86	*	0.78	0.94
Bladder	43.21	42	0.97		0.70	1.31
Bone and Joint	1.16	0	0		-	-
Brain/Central Nervous System	9.32	4	0.43		0.12	1.10
Breast	1.20	1	0.83		0.01	4.63
Kidney	16.79	16	0.95		0.54	1.55
Leukemia	15.13	23	1.52		0.96	2.28
Liver	4.55	4	0.88		0.24	2.25
Lung/Pleura	114.99	92	0.80	*	0.64	0.98
Non-Hodgkin's Lymphoma	20.04	9	0.45	*	0.20	0.85
Pancreas	14.21	12	0.84		0.44	1.48
Thyroid	3.26	1	0.31		0.00	1.71

Note. Statistically significant ($p < 0.05$): * = low, ** = high.

Table 5b

Standardized Incidence Ratios
Middlesex Boro
Census Tract 1
1979-1991

Cancer Type	Expected	Observed	SIR	95% CI Lower	95% CI Upper
Female					
All cancer	255.60	214	0.84 *	0.73	0.96
Bladder	6.88	1	0.15 *	0.00	0.81
Bone and Joint	0.70	1	1.43	0.02	7.95
Brain/Central Nervous System	3.21	4	1.24	0.33	3.19
Breast	78.37	54	0.69 *	0.52	0.90
Kidney	4.83	6	1.24	0.45	2.71
Leukemia	5.23	4	0.76	0.21	1.96
Liver	1.01	1	0.99	0.01	5.50
Lung/Pleura	30.04	22	0.73	0.46	1.11
Non-Hodgkin's Lymphoma	7.98	8	1.00	0.43	1.98
Pancreas	6.77	3	0.44	0.09	1.29
Thyroid	3.49	4	1.15	0.31	2.93
Male					
All cancer	256.12	238	0.93	0.81	1.06
Bladder	20.34	22	1.08	0.68	1.64
Bone and Joint	0.49	0	0	-	-
Brain/Central Nervous System	4.00	3	0.75	0.15	2.19
Breast	0.56	1	1.79	0.02	9.96
Kidney	7.64	7	0.92	0.37	1.89
Leukemia	6.78	13	1.92 **	1.02	3.28
Liver	2.10	2	0.95	0.11	3.45
Lung/Pleura	53.49	41	0.77	0.55	1.04
Non-Hodgkin's Lymphoma	8.88	3	0.34 *	0.07	0.99
Pancreas	6.64	6	0.90	0.33	1.97
Thyroid	1.37	0	0	-	-

Note. Statistically significant ($p < 0.05$): * = low, ** = high.

Table 5c

Standardized Incidence Ratios
Middlesex Boro
Census Tract 2
1979-1991

Cancer Type	Expected	Observed	SIR	95% CI Lower	95% CI Upper
Female					
All cancer	160.45	108	0.67 *	0.55	0.81
Bladder	4.21	3	0.71	0.14	2.08
Bone and Joint	0.49	0	0	-	-
Brain/Central Nervous System	2.10	3	1.43	0.29	4.17
Breast	49.76	40	0.80	0.57	1.09
Kidney	3.01	3	1.00	0.20	2.91
Leukemia	3.28	0	0	-	-
Liver	0.62	1	1.61	0.02	8.93
Lung/Pleura	18.69	9	0.48 *	0.22	0.91
Non-Hodgkin's Lymphoma	4.95	7	1.41	0.57	2.91
Pancreas	4.10	2	0.49	0.05	1.76
Thyroid	2.44	2	0.82	0.09	2.96
Male					
All cancer	157.38	139	0.88	0.74	1.04
Bladder	12.26	15	1.22	0.68	2.02
Bone and Joint	0.33	0	0	-	-
Brain/Central Nervous System	2.68	0	0	-	-
Breast	0.34	0	0	-	-
Kidney	4.75	6	1.26	0.46	2.75
Leukemia	4.26	5	1.17	0.38	2.74
Liver	1.30	2	1.54	0.17	5.58
Lung/Pleura	32.86	30	0.91	0.62	1.30
Non-Hodgkin's Lymphoma	5.71	4	0.70	0.19	1.79
Pancreas	4.03	2	0.50	0.06	1.79
Thyroid	0.92	0	0	-	-

Note. Statistically significant ($p < 0.05$): * = low, ** = high.

Table 5d

Standardized Incidence Ratios
Piscataway Township
Census Tract 4.01
1979-1991

Cancer Type	Expected	Observed	SIR	95% CI Lower	95% CI Upper
Female					
All cancer	97.48	82	0.84	0.67	1.04
Bladder	2.40	1	0.42	0.01	2.32
Bone and Joint	0.36	0	0	-	-
Brain/Central Nervous System	1.31	0	0	-	-
Breast	31.36	31	0.99	0.67	1.40
Kidney	1.81	0	0	-	-
Leukemia	1.95	4	2.05	0.55	5.25
Liver	0.36	0	0	-	-
Lung/Pleura	11.19	6	0.54	0.20	1.17
Non-Hodgkin's Lymphoma	2.96	3	1.01	0.20	2.96
Pancreas	2.35	2	0.85	0.10	3.07
Thyroid	1.61	1	0.62	0.01	3.46
Male					
All cancer	100.62	76	0.76 *	0.60	0.95
Bladder	7.79	5	0.64	0.21	1.50
Bone and Joint	0.23	0	0	-	-
Brain/Central Nervous System	1.77	1	0.57	0.01	3.15
Breast	0.22	0	0	-	-
Kidney	3.11	3	0.96	0.19	2.82
Leukemia	2.85	3	1.05	0.21	3.07
Liver	0.83	0	0	-	-
Lung/Pleura	20.87	17	0.81	0.47	1.30
Non-Hodgkin's Lymphoma	3.74	2	0.54	0.06	1.93
Pancreas	2.59	4	1.55	0.42	3.96
Thyroid	0.63	1	1.59	0.02	8.82

Note. Statistically significant ($p < 0.05$): * = low, ** = high.

Table 5e

Standardized Incidence Ratios
Piscataway Township
Census Tract 4.03
1979-1991

Cancer Type	Expected	Observed	SIR	95% CI Lower	95% CI Upper
Female					
All cancer	38.89	27	0.69	0.46	1.01
Bladder	0.82	0	0.00	-	-
Bone and Joint	0.18	0	0.00	-	-
Brain/Central Nervous System	0.61	0	0.00	-	-
Breast	13.33	8	0.60	0.26	1.18
Kidney	0.69	1	1.44	0.02	8.02
Leukemia	0.79	0	0.00	-	-
Liver	0.12	0	0.00	-	-
Lung/Pleura	4.04	5	1.24	0.40	2.89
Non-Hodgkin's Lymphoma	1.18	1	0.85	0.01	4.72
Pancreas	0.78	0	0.00	-	-
Thyroid	0.88	1	1.14	0.01	6.35
Male					
All cancer	38.77	20	0.52 *	0.32	0.80
Bladder	2.82	0	0.00	-	-
Bone and Joint	0.11	0	0.00	-	-
Brain/Central Nervous System	0.88	0	0.00	-	-
Breast	0.09	0	0.00	-	-
Kidney	1.29	0	0.00	-	-
Leukemia	1.24	2	1.61	0.18	5.80
Liver	0.32	0	0	-	-
Lung/Pleura	7.77	4	0.51	0.14	1.32
Non-Hodgkin's Lymphoma	1.72	0	0.00	-	-
Pancreas	0.94	0	0.00	-	-
Thyroid	0.33	0	0.00	-	-

Note. Statistically significant ($p < 0.05$): * = low, ** = high.

Table 6. Characteristics of malignant cancer incidence by year of diagnosis, age group, race, and sex: Middlesex Boro (census tracts 1 and 2) and Piscataway Township (census tracts 4.01 and 4.03), 1992 - 1998.

	Male					Female				
	CT 1	CT 2	CT 4.01	CT 4.03	Total	CT 1	CT 2	CT 4.01	CT 4.03	Total
Diagnosis Year:										
1992	30	12	8	1	51	15	10	6	1	32
1993	20	15	11	3	49	24	19	9	4	56
1994	14	11	8	4	37	12	11	7	7	37
1995	12	12	15	3	42	8	13	6	6	33
1996	20	14	10	3	47	16	15	8	4	43
1997	24	9	13	5	51	19	12	7	12	50
1998	18	16	14	12	60	24	11	8	4	47
Total	138	89	79	31	337	118	91	51	38	298
Age Group:										
0 - 9	1	0	0	1	2	0	0	1	0	1
10 - 19	1	1	1	1	4	1	0	0	0	1
20 - 34	2	2	1	0	5	3	2	0	2	7
35 - 49	10	7	4	5	26	14	11	7	8	40
50 - 64	33	19	19	14	85	28	25	23	16	92
65 - 79	73	50	42	9	174	53	42	18	8	121
80 +	18	10	12	1	41	19	11	2	4	36
Race:										
White	134	82	70	25	311	113	87	45	32	277
All others	4	5	9	5	23	3	4	6	6	19
Unknown	0	2	0	1	3	2	0	0	0	2

Table 7. Malignant cancer incidence by type: Middlesex Boro (census tracts 1 and 2) and Piscataway Township (census tracts 4.01 and 4.03), 1992 - 1998.

	Male					Female				
	CT 1	CT 2	CT 4.01	CT 4.03	Total	CT 1	CT 2	CT 4.01	CT 4.03	Total
Bladder	5	3	2	1	11	3	4	2	2	11
Bone and Joint	0	0	0	0	0	0	1	0	0	1
Brain/CNS	3	0	1	0	4	3	1	1	1	6
Breast	0	0	1	0	1	37	27	10	13	87
Cervix	-	-	-	-	-	1	2	1	0	4
Colorectal	17	14	13	4	48	16	11	5	3	35
Corpus Uteri	-	-	-	-	-	4	5	11	5	25
Esophagus	2	1	0	1	4	0	1	0	0	1
Eye	0	1	0	0	1	0	0	0	0	0
Gallbladder	1	0	1	0	2	1	0	0	0	1
Hodgkin's Disease	3	0	0	0	3	0	0	0	0	0
Kidney	3	5	1	2	11	0	2	0	1	3
Larynx	2	0	2	0	4	2	0	0	0	2
Leukemia	1	1	1	1	4	3	1	2	0	6
Liver	3	1	0	0	4	2	0	0	0	2
Lung/Pleura	28	18	18	11	75	16	8	5	4	33
Myeloma	3	1	1	1	6	2	0	0	0	2
Oral/Pharynx	3	3	3	0	9	1	1	0	1	3
Other Digestive	2	0	0	0	2	0	0	0	0	0
Other Endocrine	0	1	0	0	1	0	0	1	0	1
Other Respiratory	2	1	1	1	5	1	1	0	0	2
Other Female Genital	-	-	-	-	-	1	1	0	0	2
Other Male Genital	0	0	0	0	0	-	-	-	-	-
Ovary	-	-	-	-	-	3	4	3	2	12
Non-Hodgkin's Lymphoma	2	5	2	2	11	6	3	3	0	12
Pancreas	0	0	2	0	2	4	2	2	2	10
Prostate	43	24	24	6	97	-	-	-	-	-
Skin	3	2	2	0	7	2	2	1	2	7
Small Intestine	2	0	0	0	2	1	2	1	0	4
Soft Tissue	1	0	0	0	1	0	2	0	0	2
Stomach	2	1	3	0	6	3	4	1	0	8
Testis	2	0	1	1	4	-	-	-	-	-
Thyroid	0	1	0	0	1	3	1	0	1	5
Other or Unkown Site	5	6	0	0	11	3	5	2	1	11
Total	138	89	79	31	337	118	91	51	38	298

Table 8a

Standardized Incidence Ratios
Middlesex Boro and Piscataway Township
Census Tracts 1, 2, 4.01, 4.03
1992-1998

Cancer Type	Expected	Observed	SIR	95% CI Lower	Upper
Female					
All cancer	297.46	298	1.00	0.89	1.12
Bladder	7.71	11	1.43	0.71	2.55
Bone and Joint	0.93	1	1.08	0.01	5.99
Brain/Central Nervous System	3.89	6	1.54	0.56	3.36
Breast	93.05	87	0.93	0.75	1.15
Kidney	5.57	3	0.54	0.11	1.57
Leukemia	6.06	6	0.99	0.36	2.15
Liver	1.14	2	1.76	0.20	6.34
Lung/Pleura	34.44	33	0.96	0.66	1.35
Non-Hodgkin's Lymphoma	9.19	12	1.31	0.67	2.28
Pancreas	7.54	10	1.33	0.63	2.44
Thyroid	4.53	5	1.10	0.36	2.57
Male					
All cancer	297.71	337	1.13 **	1.01	1.26
Bladder	23.27	11	0.47 *	0.24	0.85
Bone and Joint	0.62	0	0	-	-
Brain/Central Nervous System	5.02	4	0.80	0.21	2.04
Breast	0.65	1	1.54	0.02	8.59
Kidney	9.04	11	1.22	0.61	2.18
Leukemia	8.15	4	0.49	0.13	1.26
Liver	2.45	4	1.63	0.44	4.18
Lung/Pleura	61.92	75	1.21	0.95	1.52
Non-Hodgkin's Lymphoma	10.79	11	1.02	0.51	1.82
Pancreas	7.65	2	0.26 *	0.03	0.94
Thyroid	1.75	1	0.57	0.01	3.17

Note. Statistically significant ($p < 0.05$): * = low, ** = high.

Table 8b

Standardized Incidence Ratios
Middlesex Boro
Census Tract 1
1992-1998

Cancer Type	Expected	Observed	SIR	95% CI Lower	95% CI Upper
Female					
All cancer	137.63	118	0.86	0.71	1.03
Bladder	3.71	3	0.81	0.16	2.36
Bone and Joint	0.38	0	0.00	-	-
Brain/Central Nervous System	1.73	3	1.73	0.35	5.07
Breast	42.20	37	0.88	0.62	1.21
Kidney	2.60	0	0.00	-	-
Leukemia	2.82	3	1.06	0.21	3.11
Liver	0.54	2	3.67	0.41	13.25
Lung/Pleura	16.18	16	0.99	0.56	1.61
Non-Hodgkin's Lymphoma	4.30	6	1.40	0.51	3.04
Pancreas	3.65	4	1.10	0.30	2.81
Thyroid	1.88	3	1.60	0.32	4.66
Male					
All cancer	137.91	138	1.00	0.84	1.18
Bladder	10.95	5	0.46	0.15	1.07
Bone and Joint	0.26	0	0	-	-
Brain/Central Nervous System	2.15	3	1.39	0.28	4.07
Breast	0.30	0	0.00	-	-
Kidney	4.11	3	0.73	0.15	2.13
Leukemia	3.65	1	0.27	0.00	1.52
Liver	1.13	3	2.66	0.53	7.77
Lung/Pleura	28.80	28	0.97	0.65	1.41
Non-Hodgkin's Lymphoma	4.78	2	0.42	0.05	1.51
Pancreas	3.58	0	0.00	-	-
Thyroid	0.74	0	0	-	-

Note. Statistically significant ($p < 0.05$): * = low, ** = high.

Table 8e

Standardized Incidence Ratios
Piscataway Township
Census Tract 4.03
1992-1998

Cancer Type	Expected	Observed	SIR	95% CI Lower	95% CI Upper
Female					
All cancer	20.94	38	1.81 **	1.28	2.49
Bladder	0.44	2	4.54	0.51	16.4
Bone and Joint	0.10	0	0	-	-
Brain/Central Nervous System	0.33	1	3.06	0.04	17.0
Breast	7.18	13	1.81	0.96	3.10
Kidney	0.37	1	2.68	0.03	14.9
Leukemia	0.43	0	0	-	-
Liver	0.07	0	0	-	-
Lung/Pleura	2.18	4	1.84	0.49	4.70
Non-Hodgkin's Lymphoma	0.63	0	0	-	-
Pancreas	0.42	2	4.74	0.53	17.1
Thyroid	0.47	1	2.12	0.03	11.80
Male					
All cancer	20.87	31	1.49 **	1.01	2.11
Bladder	1.52	1	0.66	0.01	3.66
Bone and Joint	0.06	0	0	-	-
Brain/Central Nervous System	0.47	0	0	-	-
Breast	0.05	0	0	-	-
Kidney	0.69	2	2.88	0.32	10.4
Leukemia	0.67	1	1.49	0.02	8.30
Liver	0.17	0	0	-	-
Lung/Pleura	4.19	11	2.63 **	1.31	4.70
Non-Hodgkin's Lymphoma	0.92	2	2.16	0.24	7.81
Pancreas	0.51	0	0	-	-
Thyroid	0.18	0	0	-	-

Note. Statistically significant ($p < 0.05$): * = low, ** = high.