Health Consultation

Analysis of Cancer Incidence in
Moorestown, Burlington County, New Jersey

May 17, 2019

Prepared by:

New Jersey Department of Health
Environmental and Occupational Health Surveillance Program

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Summary

Introduction	The New Jersey Department of Health (NJDOH) prepared this health consultation to evaluate the cancer incidence in Moorestown Township under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).
Conclusion	The overall cancer incidence (all cancers combined) was not elevated in Moorestown Township in the time period 1990 through 2015. Among females (all ages), stomach, lung, and bladder cancers were statistically significantly lower compared to the state, with the exception of breast cancer which was statistically significantly higher than expected. Among males (all ages), oral cavity and pharynx, colorectal, lung, bladder, and all cancers combined were statistically significantly lower than expected.
	Among children, cancer incidence for leukemia, lymphoma, and brain and central nervous system, and all cancers combined were not elevated compared to the state.
	This analysis, including 26 years of cancer incidence data in Moorestown Township, does not suggest that potential exposures to contaminants present in the drinking water supply have affected cancer rates in the community.
Basis for Conclusion	The incidence rates of several cancers were lower in Moorestown compared to the state. However, the incidence rate for breast cancer was higher in Moorestown compared to the state. The known risk factors for breast cancer include delayed childbirth, never having children, early onset of menstruation, late menopause, and a family history of breast cancer. Since the prevalence of these established risk factors is not available for these cases, it is unknown what influence these factors may have had on breast cancer incidence in this community.
Next Steps	The NJDOH has no further recommendations regarding cancer incidence investigation in relation to the Moorestown.
For More Information	Copies of this Health Consultation will be provided to concerned residents via the township libraries and the Internet. NJDOH will notify area residents that this report is available for their review and provide a copy upon request.
	Questions about this Health Consultation should be directed to the NJDOH at (609) 826-4984.

Purpose

Cancer incidence was evaluated for Moorestown, Burlington County, New Jersey at the request of the Moorestown Water Group, which represents community members concerned about the presence of drinking water contaminants in the community water supply. This cancer incidence Health Consultation and the companion Health Consultation evaluating the public health implications of drinking water contaminants are being completed in response to concerns raised by the Moorestown Water community group.

Total cancer incidence and 12 specific cancer types were analyzed among all ages. The specific cancer types were selected because they represent cancer groupings that may be more sensitive to the effects of environmental exposure, though not necessarily related to the drinking water contaminants. Additionally, cancer incidence was analyzed in a subset of the population, including children less than age 19. In this evaluation, total cancer incidence and the three most commonly diagnosed types of childhood cancer were evaluated.

Background and Statement of Issues

In 2016, the Moorestown Water Group expressed concerns to the NJDOH over potential health impacts from exposures to unregulated and unregulated drinking water contaminants. The unregulated contaminants were found during the U.S. Environment Protection Agency's sampling between 2013 and 2015. The exceedances of regulated drinking water contaminants were reported in the Township's 2015 Annual Water Quality Report [NJDOH 2018].

The unregulated contaminants which the community expressed concerns about include 1,2,3-trichloropropane, or TCP (which is now regulated), 1,4-dioxane, and hexavalent chromium. Since some of the contaminants, particularly TCP (which impacted one treatment plant) are carcinogenic, the Moorestown Water Group requested a cancer analysis in the township.

It is unknown how long the unregulated contaminants were present in the community water supply ([NJDOH 2018]). The source of these chemicals is unknown and therefore, we are unable to estimate when the drinking water may have been impacted by these contaminants. Further, the Moorestown water supply is a mixed distribution system, so it is not known which residences received the impacted drinking water [NJDOH 2018]. For example, homes closest to the impacted treatment plant were more likely to receive water from this source, while homes farther away were less likely to receive water from this treatment plant.

This Health Consultation describes the methods used to examine cancer incidence in Moorestown and the results of these analyses.

Methods

Survey Area and Population

The survey area for this analysis consisted of the entire township of Moorestown. Population counts for Moorestown were determined from the 1990, 2000 and 2010 U.S. Censuses [U.S. Census Bureau 2011].

Cancer Case Ascertainment and Survey Period

The New Jersey State Cancer Registry (NJSCR) was used to determine cancer cases. The NJSCR is a population-based cancer incidence registry covering the entire state of New Jersey. By law, all cases of newly diagnosed cancer are reportable to the NJSCR, except for certain carcinomas of the skin. In addition, the NJSCR has reporting agreements with the states of New York, Pennsylvania, Delaware, Maryland, North Carolina, and Florida. Information on New Jersey residents who are diagnosed in those states is supplied to the NJSCR. The NJSCR has been in operation since October 1, 1978 and maintains complete years of cancer data in New Jersey beginning in 1979. At the time the analysis for this Health Consultation was conducted, incidence data were considered complete for all years up to 2015.

The survey period for this investigation was January 1, 1990 through December 31, 2015. This time period was chosen due to the uncertainty of how long exposures may have occurred. A "case" was defined as an individual who was diagnosed with a new primary malignant cancer during the survey period while residing in the township of Moorestown. All cancer cases from the NJSCR identified as Moorestown residents were reviewed to determine the geographic location of residence at the time of diagnosis within the Township. NJSCR cases identified only through search of death or autopsy records were excluded from this evaluation.

Cancer Classification
The International Classification of Diseases for Oncology, 3rd edition (ICD-O-3) was used to classify cancers for the analysis that includes all ages combined. The International Classification of Childhood Cancer (ICCC) was used to classify cancers for the analysis that was limited to children age 0-19. The ICCC is based on tumor histology rather than the site of the tumor, as it is for adults, since histology is more relevant than site for childhood cancers.

Information on important cancer risk factors, such as genetics, personal behaviors (e.g., diet and smoking), or occupational history, is not available from the NJSCR.

Data Analysis

In response to the contaminants found in the Moorestown township water supply, the NJDOH conducted standardized incidence ratio (SIR) cancer analyses separately for 1) all ages combined and 2) children, ages 0-19, who resided in Moorestown Township at the time of their diagnosis from 1990-2015.

Analyses were completed for all malignant cancer types combined and for select cancer types. The select cancer types for all ages examined include: bladder, brain and central nervous system (CNS), female breast, colorectal, oral cavity and pharynx, pancreas, lung, leukemia, non-Hodgkin lymphoma, liver, stomach, and kidney. These cancer types were evaluated because they represent cancer groupings that may be more sensitive to the effects of environmental exposures. For all ages combined, males and females were evaluated separately.

The childhood analysis included all cancers combined as well as the most common subgroups of leukemia, lymphoma, and brain and central nervous system (CNS). Due to smaller case counts and less variation of cancer type by gender for childhood cancers, males and females were evaluated together.

SIRs were used for the quantitative analysis of cancer incidence in the study areas [Kelsey, Thompson, and Evans 1986; Breslow and Day 1987]. The SIR was calculated by dividing the observed number of cases (from the NJSCR) by an expected number of cases for the surveyed population over the time period reviewed.

The expected number was derived by multiplying age and sex-specific incidence rates to the age-sex-specific population estimates for Moorestown. The incidence rates used to derive the expected number of cases were the New Jersey average annual incidence rates for 1979 to 2015. Age group- and sex-specific population data for Moorestown were determined from the 1980, 1990, 2000 and 2010 U.S. Censuses [U.S. Census Bureau 2011].

The observed and expected numbers are evaluated by interpreting the ratio of these numbers. If the observed number of cases equals the expected number of cases, the SIR will equal 1.0. An SIR less than 1.0 indicates that fewer cases are observed than expected. An SIR greater than 1.0 indicates that more cases are observed than expected.

Random fluctuations may account for some SIRs being higher or lower than 1.0. The statistical significance of deviations from an SIR equal to 1.0 was evaluated using a 95% confidence interval (CI). The 95% CI 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 [Breslow and Day 1987; Checkoway et al. 1989]. If the confidence interval includes 1.0, then the estimated SIR is not considered to be statistically significantly different than 1.0.

Results

Cancer among All Ages Combined

For the period 1990 through 2015, a total of 2,978 malignant incident cancer cases were diagnosed in Moorestown residents. Table 1 presents the age distribution for incident malignant cancer cases among Moorestown Township and New Jersey residents by gender. The proportion of Moorestown male residents diagnosed in each of the four age categories is similar to New Jersey, as shown in Table 1.

A majority of cases were diagnosed at age 50 or older, which is consistent with the state. Among females, the proportion of Moorestown residents diagnosed in each category is somewhat similar compared to New Jersey, with the exception of a lower percentage of women diagnosed in the 50 to 69 age category (37% versus 40%) and a higher percentage in the 70 years and older category (47% versus 43%).

Table 1. Age Distribution of Malignant Cancers by Gender, Moorestown and New Jersey, 1990-2015

Age	Moorestown				New Jersey			
	Male		Female		Male		Female	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
0-29	21	1%	27	2%	17,694	2%	17,999	2%
30-49	111	8%	222	15%	65,807	8%	117,144	15%
50-69	678	46%	558	37%	361,522	45%	320,365	40%
70+	660	45%	701	47%	363,616	45%	340,158	43%
Total	1,470	100%	1,508	100%	808,639	100%	795,666	100%

Table 2 presents the SIR results for Moorestown Township by sex and cancer type for the 26-year survey period. The most frequently diagnosed cancer types include breast, colorectal, and lung, representing slightly over 40% of all cancers in Moorestown. The proportion of these cancer types is consistent with New Jersey statewide cancer incidence data.

Among males, the overall cancer incidence (all sites combined) was found to be statistically significantly lower in Moorestown compared to the state rates (SIR=0.91; 95% CI= 0.87, 0.96) for the period 1990-2015. The incidence of colorectal (SIR= 0.80), lung (SIR= 0.72), bladder (SIR= 0.44), and oral cavity and pharynx (SIR= 0.60) cancers were also statistically significantly lower than expected among males.

The incidence of cancer for all sites combined among females in Moorestown over the 26-year period was similar to the expected based on state rates. Breast cancer incidence among females was statistically significantly higher than expected (SIR=1.11; 95% CI= 1.02, 1.21). The incidence of lung (SIR= 0.77), bladder (SIR= 0.64), and stomach (SIR= 0.44) cancers were found to be statistically significantly lower than expected among Moorestown females for the period 1990-2015.

Table 2. SIR Analysis by Cancer Type and Sex, Moorestown, 1990-2015

Cancer Type	Sex	Observed	Expected	SIR		95% Confidence Interval		
All Sites	Male	1,470	1,613.6	0.91	(Low)	0.87	-	0.96
	Female	1,508	1,578.6	0.96		0.91	-	1.005
Breast	Female	504	453.5	1.11	(High)	1.02	-	1.21
Colorectal	Male	137	171.0	0.80	(Low)	0.67	-	0.95
	Female	165	188.1	0.88		0.75	-	1.02
Lung	Male	156	215.3	0.72	(Low)	0.62	-	0.85
	Female	146	190.3	0.77	(Low)	0.65	-	0.90
Bladder	Male	53	119.9	0.44	(Low)	0.33	-	0.58
	Female	29	45.2	0.64	(Low)	0.43	-	0.92
Non-Hodgkin Lymphoma	Male	67	67.2	1.00		0.77	-	1.27
	Female	67	63.1	1.06		0.82	-	1.35
Leukemia	Male	42	47.3	0.89		0.64	-	1.20
	Female	32	38.4	0.83		0.57	-	1.18
Oral Cavity & Pharynx	Male	26	43.4	0.60	(Low)	0.39	-	0.88
	Female	25	21.9	1.14		0.74	-	1.68
Stomach	Male	30	35.0	0.86		0.58	-	1.22
	Female	11	25.0	0.44	(Low)	0.22	-	0.79
Pancreas	Male	31	38.2	0.81		0.55	-	1.15
	Female	32	43.1	0.74		0.51	-	1.05
Kidney	Male	42	54.6	0.77		0.55	-	1.04
	Female	25	33.8	0.74		0.48	-	1.09
Brain & CNS	Male	31	21.6	1.44		0.98	-	2.04
	Female	18	18.4	0.98		0.58	-	1.55
Liver	Male	17	25.1	0.68		0.39	-	1.09
	Female	7	11.2	0.62		0.25	-	1.29

Data source: New Jersey State Cancer Registry December 2017, New Jersey Department of Health.
All cancers include all ICD-O-3 invasive reportable cancers and *in situ* urinary bladder cancers

Cancer among Children (Ages 0-19)

Table 3 presents the SIR results among children (ages 0-19) for Moorestown Township by cancer type. Childhood cancers are analyzed for males and females together since small numbers yield statistically unreliable results. Statistical reliability is improved by combining cases from both genders. This analysis evaluated the most common childhood cancer types (leukemia, lymphoma and cancers of the central nervous system) and all cancers combined. There were no statistically significant differences between the observed and expected for all sites, leukemia, lymphoma, or central nervous system cancers.

Table 3. Moorestown SIR, Childhood Cancers (Ages 0-19), 1990-2015

Cancer Type	Observed	Expected	SIR**	95% Confidence Interval
All Sites	21	26.3	0.8	0.5 – 1.2
Leukemia	<5*	6.4		
Lymphoma	5	4.5	1.1	0.4 – 2.6
CNS	5	4.7	1.1	0.3 – 2.5

*Data suppressed when fewer than 5 cases to ensure confidentiality and/or to protect the privacy of confidential medical information. **SIRs not performed on fewer than 5 cases to ensure statistical reliability. Data source: New Jersey State Cancer Registry December 2017, New Jersey Department of Health

Discussion

The purpose of this investigation was to evaluate cancer incidence in Moorestown Township. The occurrence of cancer (all sites combined) over the 26-year time period (1990-2015) was similar to the expected rate for females and lower than the expected rate for males (compared to average state rates). Breast cancer incidence among females in Moorestown was statistically significantly higher than expected among females (SIR=1.11). Several other cancers were statistically significantly lower than expected including stomach among females only, oral cavity and pharynx and colorectal in males only, and lung and bladder in males and females.

Cancer is a group of more than 100 different diseases (cancer types and subtypes), each with its own set of risk factors. Consequently, any evaluation of potential risk factors and specific cancer types is complicated since most cancer types have more than one known cause or risk factor.

Breast cancer is the most common cancer among women in New Jersey and the United States, except for skin cancer, and the incidence rises sharply with increasing age. Breast cancer is now

understood to be a collection of divergent diseases that have different biologic, clinical, and prognostic characteristics [Thun 2017]. Only about half of the disease occurrence is explained by well-established risk factors.

Hormonal influences play a role in the increased risk of breast cancer. Known risk factors include delayed childbirth, never having children, early onset of menstruation, and late menopause. Women with a personal or family history of breast cancer are also at a higher risk. Other risk factors for breast cancer include biopsy-confirmed atypical hyperplasia, recent use of oral contraceptives or post-menopausal estrogens and progestin, obesity after menopause, and moderate to heavy alcohol consumption.

Breast cancer incidence has been noted to be higher among women of higher socioeconomic status reflecting at least in part the risk factors noted above in addition to greater access to screening [Thun 2017]. Since the prevalence of these established risk factors is not available for these cases, it is unknown what influence these factors may have had on breast cancer incidence in this community.

The SIR analysis is an ecological design, based on grouped data, and is a practical surveillance or screening method for cancer incidence. However, this type of analysis cannot assess actual past contaminated drinking water consumption in individuals in the population. Important information needed to assess a cause-effect relationship includes data on actual personal exposure to the contamination as well as information on the 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. Further, interpretation is also limited since information on other important risk factors (such as family history, lifestyle factors, hormonal exposures, and behaviors such as tobacco smoking, occupational exposures, etc.) is not known for the individuals in the population.

There are several other limitations to the interpretation of the cancer incidence analysis reported in this Health Consultation. This analysis was completed using the entire town because it is not possible to identify the subset of homes that consistently received drinking water from the contaminated treatment plant. The evaluation of cancer incidence to assess the impact of contaminated water that was mostly served to a subset of the entire township should be interpreted with caution. The uncertainty of when potential exposures may have begun, and which homes actually received the contaminated water is further complicated by the fact that cancer often takes many years to develop following an exposure. The latency period from exposure to a contaminant to clinical recognition of disease may range from a few years to decades, depending on the type of cancer, magnitude of exposure, and individual characteristics.

The information supplied by the cancer registry provides only an address at the 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 were short-term residents with little or no exposure; in contrast, long-time residents who may have been exposed could have moved and would not have been included in this analysis. Population mobility cannot be accounted for in this analysis.

Lastly, when researchers independently examine statistical associations for a large number of comparisons, it is likely that some number of statistically high or low SIRs will occur by chance alone. While it is possible to statistically correct for this concern, opinions differ on whether such corrections are needed. In this analysis, confidence intervals are presented without adjustment for multiple comparisons.

Conclusions and Recommendations

Overall cancer incidence (all cancers combined) among all age groups was lower than expected among males and there were no differences than expected among females in Moorestown Township. Breast cancer incidence among females in Moorestown is higher than expected. Other cancers were lower than expected including stomach among females only, oral cavity and pharynx and colorectal in males only, and lung and bladder in males and females.

This is a descriptive analysis of cancer incidence in a geographic area, and it does not provide evidence of a specific relationship to environmental contamination. Other plausible explanations for the elevated SIR include other unmeasured risk factors in the community or chance alone.

These analyses of both time periods of cancer incidence provide little evidence to suggest that potential exposures to drinking water contamination have affected the cancer rate in the community.

The NJDOH has no further recommendations regarding cancer incidence investigation in relation to the drinking water contamination in Moorestown Township.

References

Breslow NE, Day NE 1987. Statistical Methods in Cancer Research: Vol II-The Design and Analysis of Cohort Studies, E. Heseltine, ed. In IARC Scientific Publication No. 82. Lyon: International Agency for Research on Cancer.

Checkoway H, Pearce NE, Crawford-Brown DJ 1989. Research Methods in Occupational Epidemiology, B. MacMahon, ed. In Monographs in Epidemiology and Biostatistics Vol. 13. Oxford: Oxford University Press.

Kelsey JL, Thompson WD, Evans AS 1986. Methods in Observational Epidemiology, B. MacMahon, ed. In Monographs in Epidemiology and Biostatistics Vol. 10. Oxford: Oxford University Press.

[NJDOH] New Jersey Department of Health 2018. Health Consultation: Evaluating Potential Public Health Implications of Drinking Water Contamination Moorestown, Burlington County, New Jersey.

Thun MJ, Linet MS, Cerhan, JR, Haiman, CA, and Schottenfeld D, eds. 2017: Cancer Epidemiology and Prevention, 4th edition. Oxford University Press, New York, NY.

U.S. Census Bureau 2011. Summary file 1, New Jersey prepared by the U.S. Census Bureau, 2011.

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