Cancer Data Review (1985 – 2013) Selected Zip Codes of Warminster, Warrington, and Horsham, PA

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Purpose

- **Developed by the Agency for Toxic Substances and Disease Registry (ATSDR) and the Pennsylvania Department of Health (PADOH)**
- **Focused on cancer incidence rates**
- **Selected communities living in zip codes surrounding the former Naval Air Warfare Center in Warminster, Bucks County, PA and the Willow Grove Naval Air and Air Reserve Station, Horsham, Montgomery County, PA ("the sites")**
- **Considered a long time period of 1985–2013.**

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Background

- **Residents concerns about environmental contamination and health problems in the Warminster and Willow Grove area**
- **Specific contaminants detected in public and/or private drinking water in the area include:**
  - **Past documentation of volatile chemicals such as tetrachloroethylene (PCE), trichloroethylene (TCE), 1,2-dichloroethene (1,2, DCE), and carbon tetrachloride)**
  - **More recent findings of perfluoroalkyl substances (PFAS) such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA)**

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Background (continued)

- **To address recent community concerns about cancer in the area, PADOH examined the occurrence of cancers in three zip codes surrounding these two sites:**
  - **18974 (Warminster)**
  - **18976 (Warrington)**
  - **19044 (Horsham)**

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Methodology

- **Cancer incidence analysis is the primary tool used by PADOH to investigate the possibility of excess cancer in a community**
- **PADOH calculates incidence rates using information reported to the PA state cancer registry, and compares this information at the zip code level to state wide or county wide rates**
- **Comparisons are done by calculating standardized incidence ratios**
- **Cancer is a reportable disease in PA – all cancers are captured by the current reporting system, no need for individuals to report cancer to the state**

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Methodology (continued)

- **Analysis cannot determine cancer was associated with or caused by environmental or other risk factors**
- **Cancer incidence analysis is specifically intended to address the question, "Is there an excess of cancer in the area or population of concern?"**
- **Analysis considers site specific circumstances**
- **PADOH must also consider that excesses of cancer may occur by chance alone**
- **Analysis looked at the data a few ways:**
  - **PADOH and ATSDR selected the time periods that included 1985 to 1994, 1995 to 2004 and 2005 to 2013**
  - **Also reviewed cancer incidence rates for the combined three zip codes over these time periods**

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Methodology (continued)

- **Number of observed cases in the area was compared to what would be "expected" for that area based on the state cancer rates – this comparison determines whether a statistically significant excess of cancer existed in the community**

- **Seven cancer types selected for inclusion based on associations in the literature for these cancer types and the historical environmental contaminants of concern in this area (PFAS, PCE, and TCE):**
  - **Bladder**
  - **Kidney**
  - **Liver**
  - **Non-Hodgkin's lymphoma**
  - **Multiple myeloma**
  - **Prostate**
  - **Testicular**

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Methodology (continued)

- **In general, if results of the incidence study suggest an increase in implicated cancer types, further study is considered**

- **Very few public health cancer cluster investigations in the United States proceed to this stage of complex epidemiologic studies**

- **Very difficult to show associations between community level exposures over long periods of time and diseases like cancer which take a long time to develop and be diagnosed**

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Methodology (continued)

- **For tables that follow, we did assess whether statistically higher or lower**
- **In light red, statistically significant higher at 95% confidence level**
- **In light green, statistically significant lower at 95% confidence level**

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Results

- **Two of the cancers that are most linked to the contaminants in the community are kidney and liver cancer**

- **For zip codes 18974, 18976, and 19044 and the zip codes combined, kidney and liver cancers were all found to be within expected ranges in both males and females**

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		Time period											
		1985–1994				1995–2004				2005–2013			
	Sex	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI
Kidney		**1985–1994**				**1995–2004**				**2005–2013**			
18974 (Warminster)	Male	19	22	0.87	0.52–1.35	39	36	1.08	0.77–1.48	55	56	0.99	0.75–1.29
	Female	14	13	1.05	0.57–1.76	27	22	1.23	0.81–1.79	41	37	1.12	0.81–1.52
18976 (Warrington)	Male	6	7	0.85	0.31–1.85	15	12	1.26	0.7–2.07	31	22	1.38	0.94–1.97
	Female	5	4	1.16	0.38–2.71	5	7	0.72	0.23–1.69	13	14	0.92	0.49–1.57
19044 (Horsham)	Male	9	6	1.44	0.66–2.74	11	11	1.00	0.5–1.78	15	15	1.00	0.56–1.64
	Female	3	4	0.71	0.15–2.06	7	7	1.07	0.43–2.21	7	9	0.77	0.31–1.59
Combined (3 Zips)	Male	34	35	0.97	0.67–1.35	65	59	1.10	0.85–1.4	101	93	1.09	0.88–1.32
	Female	22	22	1.00	0.63–1.52	39	35	1.10	0.79–1.51	61	60	1.02	0.78–1.31
Liver		**1985–1994**				**1995–2004**				**2005–2013**			
18974 (Warminster)	Male	9	6	1.59	0.73–3.01	11	14	0.79	0.39–1.41	31	27	1.14	0.78–1.62
	Female	2	3	0.70	0.08–2.51	6	6	1.05	0.38–2.28	12	11	1.08	0.56–1.89
18976 (Warrington)	Male	3	2	1.64	0.34–4.78	2	5	0.43	0.05–1.55	12	11	1.08	0.56–1.89
	Female	0	1	0.00		1	2	0.58	0.01–3.23	4	4	0.98	0.27–2.5
19044 (Horsham)	Male	1	2	0.63	0.02–3.51	4	4	0.92	0.25–2.36	9	8	1.16	0.53–2.21
	Female	0	1	0.00		2	2	1.23	0.15–4.46	2	2	0.80	0.1–2.9
Combined (3 Zips)	Male	13	9	1.43	0.76–2.44	17	23	0.74	0.43–1.19	52	46	1.13	0.84–1.48
	Female	2	5	0.42	0.05–1.52	9	9	0.99	0.45–1.88	18	18	1.02	0.6–1.61

Results

Statistically significant increases relative to statewide rates were found for:

Bladder

Males, 2005–2013, increased by approximately 1.3 times statewide rate, zip code 18974 (Warminster)

Males, 2005–2013, increased by approximately 1.2 times statewide rate, combined zip codes

However:

Males, 1985–1994, decreased by approximately 0.3 times statewide rate, zip code 18976 (Warrington)

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		Time period											
		1985–1994				1995–2004				2005–2013			
	Sex	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI
Bladder		**1985–1994**				**1995–2004**				**2005–2013**			
18974 (Warminster)	Male	53	54	0.98	0.73–1.28	94	79	1.19	0.96–1.46	152	119	1.28*	1.08–1.5
	Female	25	18	1.36	0.88–2.01	33	26	1.25	0.86–1.76	44	39	1.13	0.82–1.51
18976 (Warrington)	Male	5	17	0.29**	0.09–0.68	22	24	0.93	0.58–1.41	34	41	0.84	0.58–1.17
	Female	2	6	0.33	0.04–1.19	12	8	1.56	0.81–2.73	9	14	0.66	0.3–1.25
19044 (Horsham)	Male	20	14	1.39	0.85–2.15	22	22	1.01	0.63–1.53	31	24	1.28	0.87–1.81
	Female	6	6	1.07	0.39–2.33	5	7	0.70	0.23–1.63	3	8	0.39	0.08–1.13
Combined (3 Zips)	Male	78	86	0.91	0.72–1.14	138	124	1.11	0.93–1.31	217	184	1.18*	1.03–1.35
	Female	33	30	1.10	0.76–1.54	50	41	1.21	0.9–1.6	56	61	0.92	0.7–1.2

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Results

Statistically significant increases relative to statewide rates were found for:

Myeloma

Males, 1985–1994, increased by approximately 1.9 times statewide rate, zip code 18974 (Warminster)

Males, 1985–1994, increased by approximately 1.6 times statewide rate, combined zip codes

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		Time period											
		1985–1994				1995–2004				2005–2013			
	Sex	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI
Myeloma		**1985–1994**				**1995–2004**				**2005–2013**			
18974 (Warminster)	Male	15	8	1.86*	1.04–3.06	14	12	1.13	0.62–1.89	22	20	1.12	0.7–1.7
	Female	7	7	0.96	0.39–1.97	5	11	0.45	0.15–1.05	12	17	0.71	0.37–1.24
18976 (Warrington)	Male	3	3	1.17	0.24–3.41	7	4	1.83	0.74–3.77	4	7	0.56	0.15–1.43
	Female	2	2	0.84	0.1–3.03	5	3	1.53	0.5–3.58	8	6	1.32	0.57–2.6
19044 (Horsham)	Male	3	2	1.37	0.28–4.01	3	4	0.85	0.17–2.48	6	5	1.33	0.49–2.89
	Female	2	2	0.89	0.11–3.22	2	3	0.66	0.08–2.38	2	4	0.56	0.07–2.02
Combined (3 Zips)	Male	21	13	1.64*	1.01–2.5	24	20	1.21	0.78–1.81	32	31	1.02	0.7–1.44
	Female	11	12	0.92	0.46–1.65	12	17	0.69	0.36–1.2	22	27	0.83	0.52–.26

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Results (continued)

Results were mixed for male cancers

Testis

Males, 1985–1994 and 1995–2004, increased by approximately 2.1 times statewide rate, zip code 19044 (Horsham)

Statistically significant decreases relative to statewide rates were found in the following cancers and zip codes:

Prostate

Males, 1995–2004, decreased by approximately 0.8 times statewide rate, zip code 19044 (Horsham)

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		Time period											
		1985–1994				1995–2004				2005–2013			
	Sex	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI
Prostate		**1985–1994**				**1995–2004**				**2005–2013**			
18974 (Warminster)	Male	176	170	1.03	0.89–1.2	332	333	1.00	0.89–1.11	371	352	1.05	0.95–1.17
18976 (Warrington)	Male	44	53	0.82	0.6–1.1	94	99	0.95	0.77–1.17	143	140	1.02	0.86–1.2
19044 (Horsham)	Male	40	43	0.94	0.67–1.28	69	90	0.77**	0.6–0.97	89	90	0.99	0.8–1.22
Combined (3 Zips)	Male	260	266	0.98	0.86–1.1	495	522	0.95	0.87–1.04	603	582	1.04	0.95–1.12
Testis		**1985–1994**				**1995–2004**				**2005–2013**			
18974 (Warminster)	Male	13	11	1.23	0.66–2.1	11	11	1.02	0.51–1.82	16	10	1.60	0.91–2.6
18976 (Warrington)	Male	3	5	0.66	0.14–1.93	3	5	0.63	0.13–1.83	6	5	1.20	0.44–2.6
19044 (Horsham)	Male	11	5	2.06*	1.03–3.68	12	6	2.05*	1.06–3.59	2	5	0.43	0.05–1.56
Combined (3 Zips)	Male	27	21	1.32	0.87–1.92	26	22	1.21	0.79–1.78	24	20	1.22	0.78–1.82

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Results (continued)

Non-Hodgkin's lymphoma (NHL)

- **Females, 1985–1994, increased by approximately 1.5 times statewide rate, zip code 18974 (Warminster)**
- **Females, 1985–1994, increased by approximately 1.4 times statewide rate, combined zip codes**
- **Males, 2005–2013, increased by approximately 1.3 times statewide rate, zip code 18974 (Warmister)**
- **Males, 2005–2013, increased by approximately 1.2 times statewide rate, combined zip codes**

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		Time period											
		1985–1994				1995–2004				2005–2013			
	Sex	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI	Observed	Expected	SIR	95% CI
NHL		**1985–1994**				**1995–2004**				**2005–2013**			
18974 (Warminster)	Male	39	35	1.12	0.8–1.53	67	55	1.23	0.95–1.56	104	79	1.32*	1.08–1.6
	Female	42	29	1.47*	1.06–1.99	54	46	1.18	0.89–1.54	65	68	0.95	0.73–.21
18976 (Warrington)	Male	13	12	1.11	0.59–1.9	25	18	1.38	0.89–2.04	26	29	0.88	0.58–1.29
	Female	11	9	1.17	0.58–2.09	13	14	0.92	0.49–1.58	18	25	0.72	0.43–1.14
19044 (Horsham)	Male	8	11	0.76	0.33–1.5	13	17	0.75	0.4–1.29	26	19	1.36	0.89–1.99
	Female	11	9	1.21	0.6–2.17	14	13	1.05	0.57–1.76	17	15	1.13	0.66–1.8
Combined (3 Zips)	Male	60	57	1.05	0.8–1.36	105	90	1.17	0.95–1.41	156	127	1.22*	1.04–1.43
	Female	64	47	1.36*	1.05–1.74	81	73	1.11	0.88–1.38	100	109	0.92	0.75–1.12

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Discussion

- **For PFAs, studies in humans have shown that certain PFAs may be associated with prostate, kidney, and testicular cancer – these are the most frequently mentioned – the strongest known associations**

- **Studies are limited - exactly what cancers or other health outcomes are associated with PFAs will take more research and study over a long period of time**

- **For TCE, more studied - strong evidence that TCE can cause kidney cancer in people and some evidence for TCE-induced liver cancer and non-Hodgkin's lymphoma**

- **For PCE, more studied - studies in humans suggest exposure to PCE may lead to higher risk of bladder cancer, multiple myeloma, or non-Hodgkin's lymphoma**

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Discussion (continued)

- **This cancer analysis provides a mixed picture:**
  - **found both increases and decreases for the cancers of potential environmental interest in the Warminster and Willow Grove area, as compared to statewide rates**
  - **most comparisons indicated no difference from state rates**
- **Liver, prostate, and kidney cancer rates were within expected ranges or lower than expected in across all genders, zip codes and time periods.**

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Discussion (continued)

- **For testicular cancer, two time periods showed higher statistical increases from 1985–1994 (2.1 times higher) and 1995–2004 (2.1 times higher) in zip code 19044 (Horsham) only, and then a large decrease in cases observed in the most recent time period from 2005–2013 in the same zip code**

- **Testicular cancer was at expected rates for the other two zip codes and all three zip codes combined**

- **The number of testicular cancer cases involved is relatively small in (e.g., 11–12 in the first two time periods in zip code 19044, and 2 in the most recent time period), adding to the uncertainty of this information**

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Discussion (continued)

- **Bladder cancer rates for males were 1.2–1.3 times higher in zip code 18974 (Warminster) and all three combined zip codes during 2005 to 2013, but were 0.3 times lower for males in zip code 18976 (Warrington) over the time period of 1985–1994, and were at expected rates for males in the 1995–2004 time period and for females in all the time periods.**

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Discussion (continued)

- **Non-Hodgkin's lymphoma was increased in both males (1.3 times higher) and females (1.5 times higher) in the 18974 (Warminster) zip code, but these increases occurred in different time periods.**

- **These results drove the parallel increases observed in males (1.2 times higher) and females (1.4 times higher) in the three zip codes combined for those two same time intervals.**

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Limitations

- **A review of cancer incidence data does not determine the cause of any observed increases or decreases in cancer types**
- **Zip code level boundaries may only approximate potential geographic areas of interest**
- **Cancer registry incidence data are based on residence at the time of diagnosis. Cancers can take years, or even decades to develop following exposure to a cancer-causing agent. Cancers diagnosed in people right now may have been influenced by something that happened somewhere else a long time ago – people move into and out of an area, they arrive with prior exposure history.**

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Limitations (continued)

- **Although cancer overall is a common diagnosis, there may only be a small number of cases of a particular cancer type in a particular zip code. Researchers need larger numbers of persons in order to have a more accurate and representative picture of the cancer burden in a community.**

- **Cancer registry data includes very limited or no information on lifestyle, demographic, or occupational risk factors.**

- **Science does not know the causes of most types of cancer. For each person, cancer is thought to be a caused by a combination of many factors, genetic and environmental.**

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Conclusion

- **This cancer incidence data review provides an inconclusive picture of cancer rates for the cancers of potential interest in the three main zip codes near the Warminster and Willow Grove sites.**
- **This pattern of increases in some cancer types and decreases in others is commonly seen in zip code level analyses.**
- **Even when statistical increases were observed in this preliminary review for the Warminster and Willow Grove area, these results were not consistent across time periods, genders, or zip codes.**
- **This inconsistent pattern makes it difficult to determine if these results are meaningful.**

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Conclusion (continued)

- **This analysis did identify two statistically increased results for the potential cancers of interest (e.g., testicular and non-Hodgkin's lymphoma)**
- **It is important to note the estimates for these cancers were generally based upon small numbers of cases (particularly for testicular cancer)**
- **The reliability of these results is of concern for estimates based on small numbers**
- **Given these findings and the legacy of environmental contamination in this area, as new data or additional information become available, consideration will be given to updating and/or further study of this information**

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Data sources:

- **Pennsylvania Cancer Registry dataset from 1985 to 2013 for cancer incidence.**
- **U.S. Census Bureau, 2010 Census. Summary File 1, Tables P12, P13, and PCT12 were used for population by age group, gender and zip code tabulation areas for 2010 population. These population were used for expected cases and age–adjusted rate calculation for time period 2005–2013.**
- **U.S. Census Bureau, Census 2000 Summary File 1, Matrices P13 and PCT12 were used for population by age group, gender and zip code tabulation areas for 2000 population. These population were used for expected cases and age–adjusted rate calculation for time period 1995–2004.**
- **U.S. Census Bureau's 1990 Census Summary File 3b was used for population by age group, gender and zip code tabulation areas for 1990 population. These population were used for expected cases and age–adjusted rate calculation for time period 1985–1994.**
- **Expected cases were rounded to the nearest integer since cases cannot be fractions. SIRs were calculated using all decimal places in expected cases to provide better precisions in SIR estimation. Exact 95% confidence intervals were calculated using method described by Sahai and Khurshid assuming Poisson distribution.1**
- **Age–adjusted rates were calculated using 2000 U.S. standard population with 18 standard age groups. 95% confidence interval for age-adjusted rate were estimated using method described by Keyfitz.2**
- **Three zip code combined areas comprises zip codes 18974, 18976 and 19044.**

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Questions ?

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