Michigan Department of Health and Human Services

Review of Cancer Incidence Data for Selected Areas of Northern Kent County, Michigan

August 14th, 2018

Summary

The Michigan Department of Health and Human Services (MDHHS) has examined the incidence of invasive cancers from 2000 to 2014 in twelve United States (U.S.) census tracts and two ZIP codes (49341 and 49306) in selected areas of northern Kent County, Michigan in response to concerns regarding drinking water contamination by per and polyfluoroalkyl substances (PFAS). The health effects from PFAS exposure are still uncertain, but some associations have been reported in the scientific literature with incidence of kidney, testicular, prostate, and ovarian cancers. Michigan Central Cancer Registry data were reviewed for each cancer type individually and as urogenital groupings. Cancer incidence rates and observed-to-expected standardized incidence ratios (SIRs) were calculated and tested to determine if they are statistically higher than the expected cancer incidence for the selected areas. Ninety-five percent confidence intervals (CIs) were calculated as a measure of how reliable these rate estimates are.

Key Findings:

- The incidence of urogenital cancers from the twelve Kent County census tracts did not differ from expected in any of three five-year time periods (2000-2004, 2005-2009, 2010-2014) when compared to white State of Michigan residents cancer rate. However, four census tracts had significantly higher rates than those for white Kent County residents in the first time period only.
- The yearly incidence of urogenital cancers for the two Kent County ZIP codes indicate no trends across the fifteen-year time period 2000-2014, however some individual years and all years combined have significantly higher than expected rates based on Michigan rates.
- Prostate cancers were significantly higher than expected for the two combined ZIP codes for all three 5-year time periods examined, but declined across time.
- Kidney and renal pelvis cancers were significantly higher than expected for the combined ZIP codes only for the 2000 – 2004 time period, but this difference declined over time.
- Testicular cancers were not significantly higher than expected for the combined ZIP codes during the overall 2000-2014 time period.
- Ovarian cancers were not significantly higher than expected for the combined ZIP codes during the overall 2000-2014 time period.

Limitations:

- This data review cannot determine the linkage of any cancer occurrence with environmental conditions including PFAS exposure nor the cause of observed increases or decreases of any cancer types over time. Michigan Central Cancer Registry records do not include the data necessary to make such an evaluation.
- The ZIP code and U.S. census tract boundaries serve as the geographic scope of this analysis, but do not exactly match the Michigan Department of Environmental Quality (MDEQ) Northern Kent County PFAS Environmental Investigation areas.
- This review cannot determine which individuals (with or without cancer) residing within the geographic area have been exposed to PFAS.

Conclusions:

Except for prostate cancer, this data review found no consistent elevation in cancer incidence for the selected areas of northern Kent County. The prostate cancer results are difficult to interpret as published associations with PFAS exposure are weak and there are other factors known to influence prostate incidence that are beyond the scope of this review to address. Given ongoing concerns in the area, MDHHS is committed to evaluating new data or additional information as it becomes available.

Background

The Michigan Department of Health and Human Services (MDHHS) Division of Environmental Health (DEH) conducted this review of cancer incidence data in support of the MDHHS's and the Kent County Health Department's (KCHD) ongoing efforts to respond to community concerns. These concerns were raised when the Michigan Department of Environmental Quality (MDEQ) discovered per- and polyfluoroalkyl substances (PFAS) in some drinking water samples in certain neighborhoods of northern Kent County in 2017. PFAS are a diverse group of fluorinated organic chemicals resistant to heat, water, and oil that have been used for decades in hundreds of industrial applications and consumer products (U.S. Environmental Protection Agency, 2017). The health risks associated with PFAS exposure are described at the Agency for Toxic Substances and Disease Registry website (https://www.atsdr.cdc.gov/pfas/index.html). A number of cancers have been found to be associated with PFAS according to peer-reviewed literature.

The purpose of this data review is to examine whether incidence of selected cancers is higher than expected in selected ZIP codes and census tracts of northern Kent County from 2000 to 2014. This type of analysis is a first step taken in response to community health concerns.

Methods

For this report, cancer incidence data were analyzed by the MDHHS Division of Vital Records and Health Statistics (DVRHS) Michigan Cancer Surveillance Program (MCSP). MDHHS DEH selected the ZIP codes and census tracts (Figure 1) that are within and around the MDEQ's northern Kent County PFAS environmental investigation area (pictured online: https://www.michigan.gov/documents/pfasresponse/BEL_180601_PFOS_PFOA_HeatMap_MAX_624687_7.pdf). The cancers types evaluated were based on reported associations in published PFAS epidemiology literature.

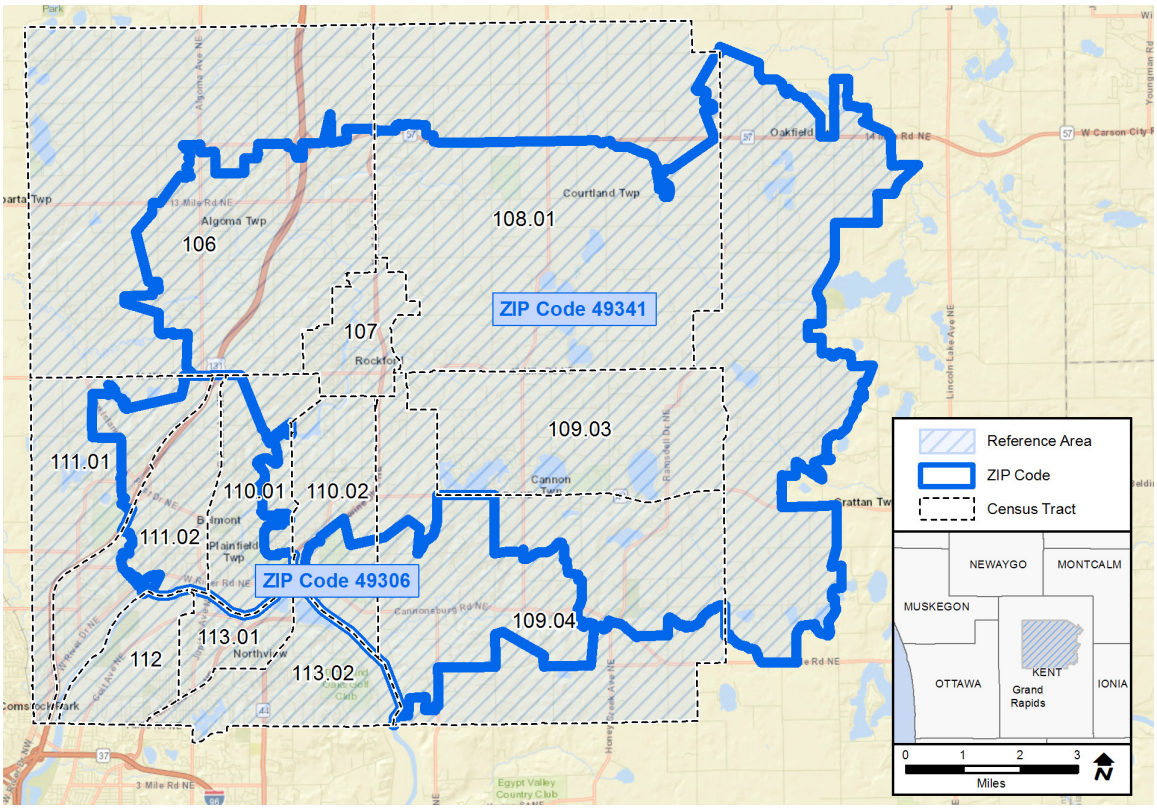


Figure 1. Map of Selected Area in Northern Kent County, Michigan Showing ZIP Codes Numbers and Boundaries in Blue, and Census Tract Numbers and Boundaries in Black

Data Source

The source of the cancer incidence data is the Michigan Central Cancer Registry managed by the MCSP. Information on all newly-diagnosed cases of invasive cancer in Michigan are to be routinely reported to the MCSP by facilities (hospitals and independent laboratories) [required by Michigan law]. This registry collects the patients' age, gender, race, cancer site and type, and residential address upon diagnosis. The registry does not state the cause of an individual's cancer nor does it collect sufficient information to determine the cause. Cancer incidence datasets are submitted annually to the Centers for Disease Control and Prevention (CDC) National Program of Cancer Registries (NPCR) and the North American Association of Central Cancer Registries (NAACCR). The Michigan registry is evaluated annually by both NPCR and NAACR and consistently meets national data quality standards set by these agencies (Hofferkamp, 2008). For this report, MDHHS examined invasive cancer incidence data from 2000 through 2014 in response to citizen concerns over recent cancer cases in the community.

Geographic Area

This review uses geopolitical boundaries available from MCSP to calculate population-based cancer incidence in and around MDEQ's Northern Kent County PFAS Environmental Investigation areas (Figure 1). Initially, the location to be assessed was narrowly focused on the twelve census tracts where private drinking water well contamination was first detected in some drinking water samples. During the course of this statistical analysis, MDEQ expanded their Northern Kent County PFAS Environmental Investigation areas; therefore the area of this analysis was expanded to encompass ZIP codes 49342 and 49306. These ZIP codes include the communities of Rockford, Plainfield Township, Cannonsburg, and Belmont, Michigan (Figure 1). ZIP codes were also used to aggregate the population of these smaller census tracts which would increase the number of cancer cases observed due to a larger population within these ZIP codes as compared most of the census tracts (Table 2 & 8). This methodology of combining geopolitical boundaries into a larger grouping would make the results more stable across time periods (Boston University School of Public Health, n.d.).

Cancer Types

The International Agency for Research on Cancer (IARC) reviewed perfluorooctanoic acid mainly known as PFOA, a type of PFAS, and classified it as "possibly carcinogenic to humans," supported by "credible" epidemiological findings of positive associations with testicular and kidney cancer, but inadequate evidence for associations with cancers of the bladder, thyroid, and prostate (International Agency for Research on Cancer, 2016). Similar conclusions regarding the evidence for kidney and testicular cancers were reached by an expert panel reviewing PFOA risk for the Environmental Protection Agency (Environmental Protection Agency, 2016). These reviews all relied heavily on the C8 Health Project results (Barry et al., 2013; Vieira et al., 2013) and the conclusions of the C8 Science Panel that reviewed their findings in 2012 (http://www.c8sciencepanel.org/index.html). [The C8 Health Project evaluated the health effects of 'C8' (PFOA), which entered community drinking water systems and private water sources in the Mid-Ohio Valley through releases from a local chemical plant (http://www.c8sciencepanel.org/c8health.html).]

For this review, MDHHS evaluated incidence rates and trends for selected census tracts and ZIP codes for all invasive urogenital cancers (cervix uteri, corpus uteri, ovary, prostate gland, other male (including testis) and female genital organs, urinary bladder, kidney and renal pelvis, and other urinary organs), as defined by the International Classification of Diseases for Oncology Third Edition (ICD-O-3). This grouping was used as a first step to assess cancer burden on these communities. Based on the findings of IARC, EPA, and C8 Science Panel, MDHHS refined the cancer type analysis at the ZIP code level to include incident cancers of the testes and the grouping of kidney and renal pelvis. The incidence of prostate and ovarian cancers were also examined, as there is some recent weak evidence they may also be associated with PFOA exposure (Vieira et al., 2013; Hardell et al., 2014; Grandjean and Clapp, 2014).

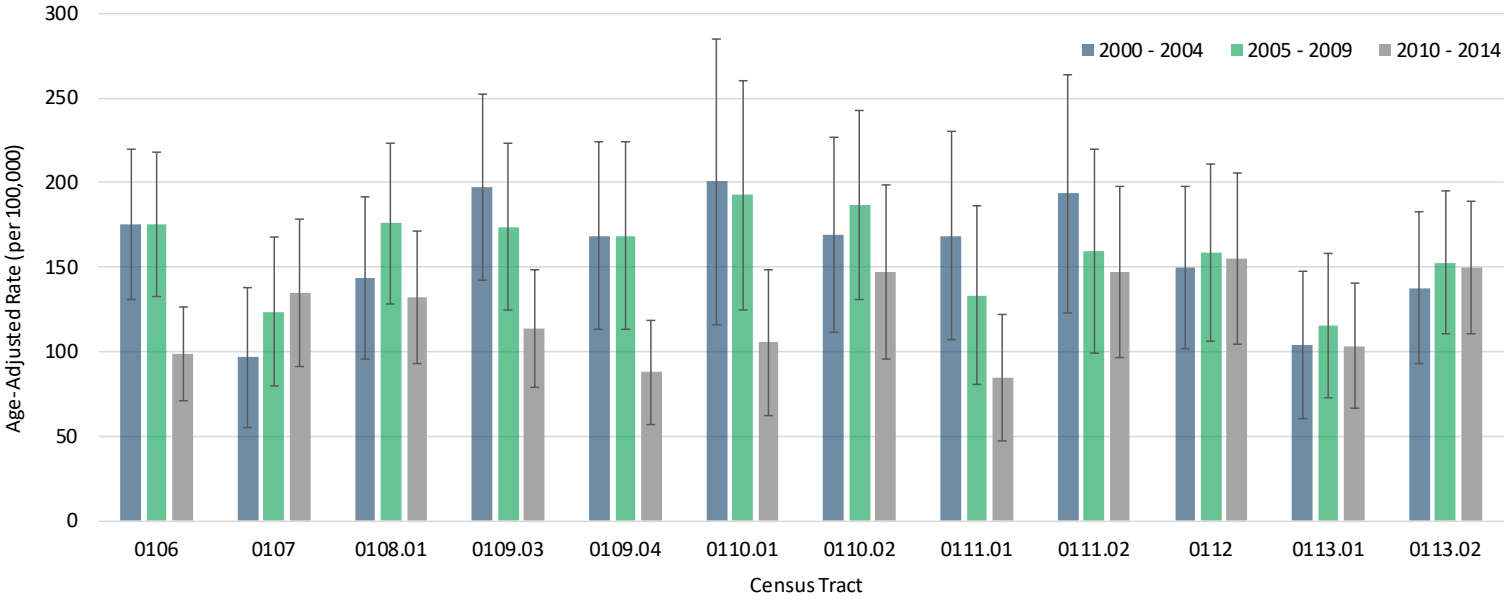
Data Summary and Analysis

The MCSP calculated age-adjusted incidence rates in three five-year periods from 2000 to 2014 for invasive urogenital cancers in the twelve selected census tracts. An age-adjusted incidence rate is a summary rate of new cancer occurrence in a population that allows populations with different age structures to be compared. Age-adjusted rates are cancer rates that would have existed if the geographically selected population had the same age distribution as its comparison population (Kent County). Age-adjustment is routinely done so that comparisons can be made from year to year and across geographic areas. Age-adjustment of the rates was through the indirect method using U.S. 2000 Census population data.

Invasive cancer incidence rates for the comparison populations were calculated in 10 year age intervals except for those age groupings of those under the age of one, from ages one to five and those greater than age 85 from white residents of Kent County or the State of Michigan because using these rates would be of a more comparable population to these twelve census tracts which are predominantly white. When a selected geographic area's population is larger than 90 percent of one single race, MCSP uses race specific rates to calculate an expected value for the SIR and for age-adjustment. This conservative approach for estimating an indicator for comparable populations allows for a more sensitive analysis to find differences. Due to the small number of cancer cases in the census tracts, rates were calculated for five-year periods to increase the number of cases per time period, which should make the results more stable, that is, less likely to be due to chance (New York State Dept. of Health, 2006).

Following MCSP approach for cancer incidence analyses, a one-tailed z-test was used to determine if any of the age-adjusted cancer rates for the census tracts were significantly higher than the white residents of Kent County or State of Michigan age-adjusted rates. The z-test measures the probability that a census tract's cancer incidence rate is no higher than the comparison rates, If this probability (or p-value) is five percent or less, we considered the census tract's rate to be significantly elevated. Ninety-five percent confidence intervals (CIs) were calculated for cancer rates for each of the twelve census tracts for each five-year period. A confidence interval is a range around a measurement that conveys how precise the measurement is; in this case, it estimates how much year-to-year random fluctuation would be expected for that rate. The 'true' rate would fall between the lower and upper CI ninety-five percent of the time. Wide CIs suggest the calculated rate is not very precise,

Figure 2. Graphical Representation of Table 1 Comparing Rate and 95% CI per Time Period for Each Selected Census Tract



while differences between cancer rates with narrow CIs are likely to be true differences rather than the result of random fluctuations (New York State Dept. of Health, 2006). Rates and CIs are presented both numerically and graphically by time period and census tract in Table 1 and Figure 2.

For the ZIP code analysis, DVRHS MCSP calculates Standardized Incidence Ratios (SIRs), which are typically used in cancer cluster investigations to evaluate if a community's cancer burden is similar or different to that of a larger comparator (Centers for Disease Control and Prevention, 2013). The SIR is the number of new cancer cases observed, divided by the expected number of new cancer cases within the selected geographic area. The expected number of cases for the urogenital cancer grouping and specific cancer sites were calculated by applying the age- and sex-specific incidence rates for white Michigan residents to the age- and sex-specific ZIP code population estimates. Incidence rates for white Michigan residents were used to calculate expected number of cases within the SIR because the populations of these ZIP codes are predominately white (Table 8). U.S. Census populations for 2000 were used for 2000-2006 population estimates, and U.S. Census populations for 2010 were used for 2007-2014 population estimates (https://census.gov). SIRs are particularly useful when analyzing cancer rates in a small population. Often age-specific cancer rates are not known or are unstable in a small population but the age distribution is known, so one can multiply the age-specific cancer rates from a larger population (the county or state) by the number of persons in each age group from the smaller population to get an expected number of cases. This expected number will be stable because it is based on the large population, and the resulting SIR will also be relatively stable (Boston University School of Public Health, n.d.). Since cancer rates increase rapidly with age, the SIR method takes into

Table 1. Age-Adjusted[1] Incidence Rates per 100,000 persons, with 95% Confidence Intervals (CIs), of Invasive Urogenital Cancers[2] by Time Period, Selected Kent County 2010 Census Tracts, Kent County and Michigan

Census Tract	2000-2004			2005-2009			2010-2014		
	Age-Adjusted Rate	Lower CI	Upper CI	Age-Adjusted Rate	Lower CI	Upper CI	Age-Adjusted Rate	Lower CI	Upper CI
0106	175.1 *	130.6	219.6	175.3	132.6	218.0	98.7	70.9	126.5
0107	96.8	55.6	138.0	123.7	79.5	167.9	134.8	91.2	178.4
0108.01	143.9	95.8	192.0	176.0	128.4	223.6	132.2	93.0	171.4
0109.03	197.2 *	142.2	252.2	173.7	124.4	223.0	114.0	79.3	148.7
0109.04	168.6	113.1	224.1	168.7	113.1	224.3	87.8	56.6	119.0
0110.01	200.5 *	115.9	285.1	192.7	124.7	260.7	105.5	62.7	148.3
0110.02	168.9	111.2	226.6	186.8	130.5	243.1	147.4	95.7	199.1
0111.01	168.7	106.8	230.6	133.5	80.8	186.2	84.9	47.6	122.2
0111.02	193.5 *	123.1	263.9	159.2	99.0	219.4	147.2	96.3	198.1
0112	149.7	101.6	197.8	158.9	106.7	211.1	154.8	104.3	205.3
0113.01	104.3	60.8	147.8	115.7	73.0	158.4	103.3	66.4	140.2
0113.02	137.6	92.8	182.4	152.8	110.5	195.1	149.8	110.3	189.3
Kent County [2]	134	129.4	138.6	150.1	145.5	154.8	123.3	119.3	127.3
Michigan [2]	153.1	152.0	154.2	142.9	141.8	143.9	124.2	123.3	125.2

1Age-adjusted rates for all time periods are for white residents of Kent County or the State of Michigan calculated through the indirect method using U.S. 2000 Census population data, 10-year age strata except for those groupings of less than one year, those aged one to four and those aged 85 or older.

2 Includes cancers of the cervix, uterus, ovary, prostate, bladder, kidney and other genital and urinary organs (including testis). Source: Michigan Resident Cancer Incidence File. Includes cases diagnosed in 2000-2014 and processed by the MDHHS, Division for Vital Records and Health Statistics by November 30, 2016.

*Age-adjusted census tract rate is significantly greater than the county rate ($p < .05$, one-tailed Z-test).

account whether a community's population is younger or older than the reference population. SIRs greater than 1.0 indicate that the observed number of cases are higher than expected number of cases.

The time periods for each SIR analysis varied based on estimates of the expected number of invasive cancer cases, with incidence of large urogenital grouping examined yearly. The more common cancers were assessed for each of three 5-year time periods while for the more rare cancers a single overall SIR was calculated for the entire 15-year time period. Five-year groupings were used to aggregate data and allow for a large enough number of cases in each subgroup that they can be reported publicly without compromising individual privacy. All SIRs were tested for statistical significance using Byar's approximation for the upper 95 percent or upper 99 percent confidence limit (Rothman and Boice, 1979).

SIRs and statistical tests were calculated for the following cancers and time frames:

- Invasive urogenital cancers separately for Kent County ZIP codes 49341 and 49306 by year from 2000 – 2014 and all years combined (Table 3).
- Prostate cancers (Table 4) and cancers of the kidney and renal pelvis (Table 5) for the combined ZIP codes 49341 and 49306 across three five-year time periods starting in 2000 and ending in 2014.
- Testicular (Table 6) and ovarian (Table 7) cancers for the combined ZIP codes 49341 and 49306 for one 15-year time period (2000-2014).

Table 2. Total Population for selected Census tracts in Kent County, Kent County, and for the State of Michigan for U.S. Census in 2000, and 2010.

U.S. Census tract in Kent County	Total Population in 2000	Total Population in 2010
0106	7,596 [1]	10,270 [4]
0107	4,626 [1]	5,381 [4]
0108.01	5,787 [1]	7,652 [4]
0109.03	6,610 [1]	7,004 [4]
0109.04	5,403 [1]	6,284 [4]
0110.01	3,888 [1]	3,698 [4]
0110.02	3,338 [1]	3,556 [4]
0111.01	4,024 [1]	4,404 [4]
0111.02	4,377 [1]	4,973 [4]
0112	4,270 [1]	3,916 [4]
0113.01	4,897 [1]	4,560 [4]
0113.02	5,563 [1]	6,065 [4]
Geographic Area	**Total Population in 2000**	**Total Population in 2010**
Kent County	574,335 [2]	602,622 [5]
Michigan	9,938,444 [3]	9,883,640 [5]

1 U.S. Census Bureau (2000). 2000 Census Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF1_DP1&prodType=table

2 U.S. Census Bureau (2000). 2000 Census Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_P1&prodType=table

3 U.S Census Bureau (2000). 2000 Census Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

4 U.S. Census Bureau (2010). 2010 Census Retrieved from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_SF1_P1&prodType=table

5 U.S. Census Bureau (2010). 2010 Census Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

Table 3. Observed and Expected[1] Numbers of Invasive Urogenital Cancers[2] by Year, Selected Zip Codes, and Standardized Incidence Ratio (SIR)[3], 2000-2014

	ZIP Code 49306 Residents			ZIP Code 49341 Residents		
Year	Observed	Expected	SIR	Observed	Expected	SIR
2000	12	11.82	1.01	37	35.01	1.06
2001	22	11.65	1.89 **	46	34.58	1.33
2002	12	11.56	1.04	42	34.47	1.22
2003	12	10.83	1.11	40	32.23	1.24
2004	13	10.46	1.24	46	31.28	1.47 **
2005	11	10.41	1.06	32	31.11	1.03
2006	16	10.68	1.50	47	32.05	1.47 **
2007	17	16.31	1.04	56	50.14	1.12
2008	17	15.18	1.12	56	46.76	1.20
2009	15	15.10	0.99	58	46.61	1.24
2010	27	15.13	1.78 **	41	46.80	0.88
2011	13	15.70	0.83	58	48.59	1.19
2012	12	13.28	0.90	52	41.21	1.26
2013	11	12.58	0.87	38	38.99	0.97
2014	10	12.08	0.83	43	37.48	1.15
2000-2014	220	192.78	1.14 *	692	587.32	1.18 *

Data Accessed: October 17, 2017 amended April 23, 2018. Source: Michigan Resident Cancer Incidence File. Includes cases diagnosed in 2000-2014 and processed by the Michigan Department of Health and Human Services, Division for Vital Records and Health Statistics by November 30, 2016.

1 Expected numbers of cases were calculated by applying the age- and sex-specific incidence rates for White Michigan residents to the age- and sex-specific ZIP code population estimates. ZIP code populations for 2000 were used for 2000-2006, and 2010 for 2007-2014.

2 Includes cancers of the cervix, uterus, ovary, prostate, bladder, kidney and other genital and urinary organs (including testis).

3 Standardized Incidence Ratio, or SIR, is the ratio of observed to expected cases.

* SIR was significantly higher than 1.00 ($p < .05$, Byar's approximation of the upper Confidence Interval).

** SIR was significantly higher than 1.00 ($p < .01$, Byar's approximation of the upper Confidence Interval).

Table 4. Observed and Expected[1] Numbers of Invasive Prostate Gland Cases and Standardized Incidence Ratio (SIR)[2] Among Male Residents of ZIP Codes 49306 and 49341 by Time Period, 2000-2014

Years of Diagnosis	Observed	Expected	Standardized Incidence Ratio
2000 – 2004	163	116.02	1.40 **
2005 – 2009	188	135.19	1.39 **
2010 – 2014	163	124.41	1.31 **

Data Accessed: December 19, 2017. Source: Michigan Resident Cancer Incidence File. Includes cases diagnosed in 2000-2014 and processed by the Michigan Department of Health and Human Services, Division for Vital Records and Health Statistics by November 30, 2016.

1 Expected number of cases were calculated by applying the age- and sex-specific incidence rates for white Michigan residents to the age- and sex-specific ZIP code population estimates. ZIP code populations for 2000 were used for 2000-2006, and ZIP code populations for 2010 were used for 2007-2014.

2 Standardized Incidence Ratio, or SIR, is the ratio of observed to expected cases.

** SIR was significantly higher than 1.00 ($p < .01$, Byar's approximation of the upper Confidence Interval).

Table 5. Observed and Expected[1] Numbers of Invasive Cancers of the Kidney and Renal Pelvis and Standardized Incidence Ratio (SIR)[2] Among Residents of ZIP Codes 49306 and 49341 by Time Period, 2000-2014

Years of Diagnosis	Observed	Expected	Standardized Incidence Ratio
2000 – 2004	30	20.58	1.46 *
2005 – 2009	37	30.28	1.22
2010 – 2014	31	35.74	0.87

Data Accessed: December 19, 2017. Source: Michigan Resident Cancer Incidence File. Includes cases diagnosed in 2000-2014 and processed by the Michigan Department of Health and Human Services, Division for Vital Records and Health Statistics by November 30, 2016.

1 Expected number of cases were calculated by applying the age- and sex-specific incidence rates for white Michigan residents to the age and sex-specific ZIP code population estimates. ZIP code populations for 2000 were used for 2000-2006, and ZIP code populations for 2010 were used for 2007-2014.

2 Standard Incidence Ratio, or SIR, is the ratio of observed to expected cases.

* SIR was significantly higher than 1.00 ($p < .05$, Byar's approximation of the upper Confidence Interval)

Table 6. Observed and Expected[1] Numbers of Invasive Cancers of the Testes and Standardized Incidence Ratio (SIR)[2] Among Male Residents of ZIP codes 49306 and 49341, 2000-2014

Years of Diagnosis	Observed	Expected	Standardized Incidence Ratio
2000 – 2014	17	18.49	0.92

Data Accessed: December 19, 2017. Source: Michigan Resident Cancer Incidence File. Includes cases diagnosed in 200-2014 and processed by the Michigan Department of Health and Human Services, Division for Vital Records and Health Statistics by November 30, 2016.

1 Expected number of cases were calculated by applying the age- and sex-specific incidence rates for white Michigan residents to the age- and sex-specific ZIP code population estimates. ZIP code populations for 2000 were used for 2000-2006, and ZIP code populations for 2010 were used for 2007-2014.

2 Standardized Incidence Ratio, or SIR, is the ratio of observed to expected cases.

Table 7. Observed and Expected[1] Numbers of Invasive Ovarian Cancers and Standardized Incidence Ratio (SIR)[2] Among Female Residents of ZIP Codes 49306 and 49341, 2000-2014

Years of Diagnosis	Observed	Expected	Standardized Incidence Ratio
2000-2014	48	40.64	1.18

Data Accessed: December 19, 2017. Source: Michigan Resident Cancer Incidence File. Includes cases diagnosed in 2000-2014 and processed by the Michigan Department of Health and Human Services, Division for Vital Records and Health Statistics by November 30, 2016.

1 Expected number of cases were calculated by applying the age- and sex-specific incidence rates for white Michigan residents to the age- and sex-specific ZIP code population estimates. ZIP code populations for 2000 were used for 2000-2006, and ZIP code populations for 2010 were used for 2007-2014.

2 Standardized Incidence Ratio, or SIR, is the ratio of observed to expected cases.

Table 8. Comparison of Selected Demographics Between ZIP Codes 49306 and 49341, Kent County, and the State of Michigan

Demographics	ZIP Code 49306	ZIP Code 49341	Kent County	State of Michigan
Population in 2010				
Total	9,244 [1]	33,737 [1]	602,622 [1]	9,883,640 [1]
Male	50.0% [1]	49.4% [1]	49.0% [1]	49.1% [1]
Female	50.0% [1]	50.6% [1]	51.0% [1]	50.9% [1]
Population 5-year estimate (2012 – 2016)				
Total	10,083[2]	35,546[2]	629,352[2]	9,909,600[2]
Population growth since 2010	8.32%	5.09%	4.25%	0.33%
Age Distribution in 2010				
Under 5 years	5.8% [1]	6.9% [1]	7.3% [1]	6.0% [1]
5 to 19 years	22.6% [1]	25.6% [1]	21.9% [1]	20.8% [1]
20 to 64 years	59.2% [1]	57.9% [1]	59.7% [1]	59.4% [1]
65 years and over	12.4% [1]	9.6% [1]	11.1% [1]	13.8% [1]
Race and Ethnicity in 2010				
White	94.6% [1]	94.5% [1]	76.0% [1]	76.6% [1]
Hispanic or Latino	2.2% [1]	2.3% [1]	9.7% [1]	4.4% [1]
Black or African American	0.5% [1]	0.6% [1]	9.4% [1]	14.0%[1]
Other Race[3]	2.7% [1]	2.6% [1]	4.9% [1]	5.0%[1]
Socioeconomic Status for 5-year estimate (2012-2016)				
Median household income	$74,571 [2]	$82,029 [2]	$54,673 [2]	$50,803 [2]
Percent of families below poverty level	4.3% [2]	3.9% [2]	10.0% [2]	11.5% [2]
Percent of individuals below poverty level	7.1% [2]	5.7% [2]	14.9% [2]	16.3% [2]
Percent high school graduate or higher of those 18 years and over	95.1% [2]	96.1% [2]	89.5% [2]	89.9% [2]
Some college or associate's degree of those 18 to 24 years	57.6% [2]	43.5% [2]	48.1% [2]	49.0% [2]
Bachelor's degree or higher of those 18 years and over	38.9% [2]	44.6% [2]	33.7% [2]	27.4% [2]
Graduate or professional degree of those 25 years and over	13.8%[2]	15.4%[2]	11.5%[2]	10.7%[2]

1 U.S. Census Bureau (2010). 2010 Census Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

2 U.S. Census Bureau (2016). 2016 American Community Survey. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

3 Other Race was defined as those of American Indian and Alaska Native race alone, Asian race alone, Native Hawaiian and other Pacific Islander alone, some other race alone, or multiracial and all of non-Hispanic or Latino ethnicity.

Results

Invasive Urogenital Cancers

By Census Tract

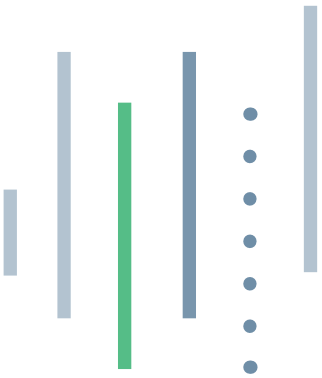
Results of the analysis of invasive urogenital cancer incidence by census tract and time period are presented in Table 1 and the accompanying Figure 2. In the two most recent time periods, 2005 - 2009 and 2010 - 2014, no census tract had age-adjusted rates which differed from those for Kent County or the State (Table 1). Four census tracts, 0106, 0109.03, 0110.01, and 0111.02, had age-adjusted incidence rates significantly higher ($p < 0.05$) than the white Kent County residents rate but only for the 2000 - 2004 time period (Table 1). The 95% CIs for these incidence rates are very wide, (95% CI: 130.6–219.6 for census tract 0106, 95% CI: 142.2–252.2 for census tract 0109.03, 95% CI: 115.9–285.1 for census tract 0110.01, 95% CI: 123.1–263.9 for census tract 0111.02). All confidence intervals overlap the 95% CI for the white Kent County rate except census tract 0109.3 (Table 1). These wide and overlapping CIs indicate that the rates are unstable. In Figure 2, this scenario of wide and overlapping CIs can be seen graphically, for example in census tract 0107 where the rates appear to be rising across time periods but overlapping CIs indicate the rates are unreliable. The total population of these twelve selected census tracts, Kent County, and the State of Michigan from the 2000 and 2010 U.S. censuses are presented in Table 8 for comparison of population size across these geographic areas.

By ZIP code

The SIRs for invasive urogenital cancers by ZIP code and year from 2000-2014, and all years combined are presented in Table 3. SIRs for ZIP code 49306 were significantly elevated for years 2001, 2010 and combined years 2000–2014. In other words, during the total 2000-2014 period 220 cases of invasive urogenital cancers were observed in ZIP code 49306 when 193 cancers were expected, if the ZIP code had same invasive cancer burden as white Michigan residents. SIRs for ZIP code 49341 were significantly elevated for years 2004, 2006 and combined years 2000-2014. The SIRs for invasive urogenital cancers appear to have no consistent elevated incidence significance across years for either ZIP code.

Prostate, Kidney, Testicular, and Ovarian Cancers

The SIRs for prostate, kidney, testicular, and ovarian cancers for ZIP codes 49306 and 49341 combined are presented in Tables 4 - 7. SIRs for prostate cancer in males living within these ZIP codes were significantly elevated above 1.0 ($p < 0.01$) for all three time periods (Table 4). SIRs were also significantly higher than 1.0 ($p < 0.05$) for kidney and renal pelvis cancers only for the 2000 – 2004 period (Table 5). SIRs appear to decrease for both cancer outcomes over the three 5-year time periods. However, both ZIP codes have had higher population growth percentage than Kent County or the State of Michigan in recent years (Table 8). This may be one factor contributing to the decreasing SIR statistic, as the expected number of cases has increased from the initial 5-year time period (2000 -2004) for both cancers (Table 4, 5). The SIRs for testicular (Table 6) and ovarian (Table 7) cancers are not significantly different from 1.0, indicating no difference from the expected number of cases for 2000–2014.



Discussion

The burden of invasive cancer incidence was, in some comparisons, higher than expected when compared to white Kent County or white Michigan residents' age-adjusted rates as seen in the census tracts studied. When the geographic area was expanded to the ZIP codes 49306 and 49341, both areas had higher than expected invasive urogenital cancer incidence during the 2000 - 2014 period. Five hundred fourteen of the 912 (56%) cases in the urogenital site group analyses (Tables 1, 3; Figure 2) were prostate cancer, thus the results of these analyses were heavily impacted by prostate cancer incidence. The American Cancer Society describes prostate cancer as the most common cancer among men, excluding skin cancers, affecting 1 in 9 men during their lifetime (American Cancer Society, 2018). Separate analyses of the incidence of prostate, kidney, testicular, and ovarian cancers (Tables 4 - 7) confirm that only prostate cancer was significantly elevated in these ZIP codes over the entire period from 2000 - 2014.

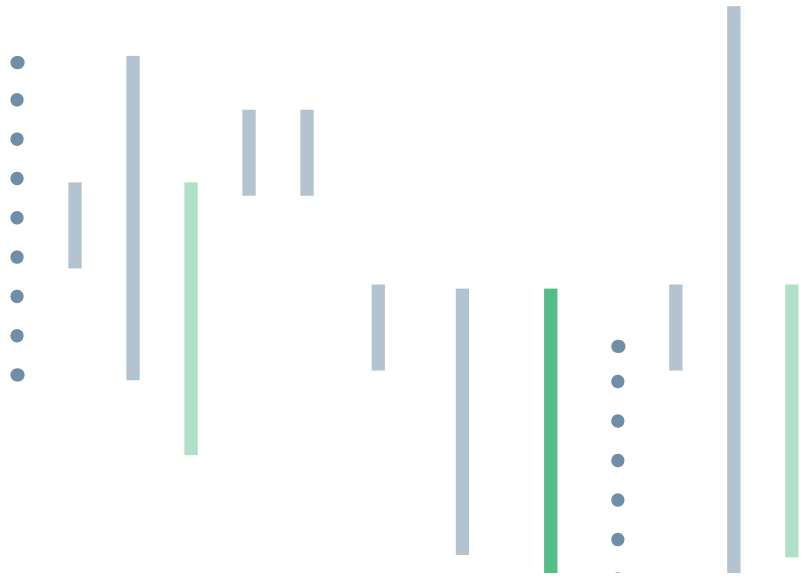
The number of reported incident or newly diagnosed prostate cancers can be influenced by changes in screening practices over time. One screening tool used to identify prostate cancer is the prostate-specific antigen (PSA) test. A major impact of PSA screening is the over-diagnosis of prostate cancers as a result of the rapid dissemination of the PSA test (Etzioni et al., 2002). In this context, over-diagnosis is defined as diagnosing a condition that would never cause symptoms or health problems. The earlier years of significantly elevated SIRs seen in Table 3 could be the result of earlier recommendations for more widespread PSA screenings (Jemal et al., 2015). The declining number of diagnosed invasive urogenital cancers in recent years from 2011 – 2014 (Table 3) in both ZIP codes could be associated with recent recommendations that lowered PSA testing in some groups (U.S. Preventative Services Task Force, 2017). Table 4 shows the same pattern of declining SIRs for prostate cancer over time for residents of ZIP codes 49306 and 49341.

Furthermore, socioeconomic status can impact prostate cancer incidence indirectly as higher socioeconomic status is correlated with more frequent PSA screening and detection (Rundle et al., 2013). ZIP codes 49306 and 49341 have around six percent of residents below the poverty level, less than half the rate of 15 percent for Kent County as a whole (Table 8). Additionally, these ZIP codes have a higher mean household income than Kent County or the State of Michigan (Table 8), the populations used to generate the expected number of prostate cancer cases, as the rate of PSA screening can increase with higher socioeconomic status (Rundle et al., 2013; & Seikkula et al., 2018). Although actual PSA screening rates were not available for this analysis, it is reasonable to infer that the statistically elevated SIRs for prostate cancer in these ZIP codes could be due, in part, to higher PSA screening rates within areas of relatively high socioeconomic status as shown in the scientific literature. Following this logic, these selected areas of higher socioeconomic status in northern Kent County as compared to Kent County and the State of Michigan could have increased screening that can lead to more prostate cancers detected and reported to the Michigan Central Cancer Registry.

Limitations

This review has important limitations, which impact the interpretation of the results.

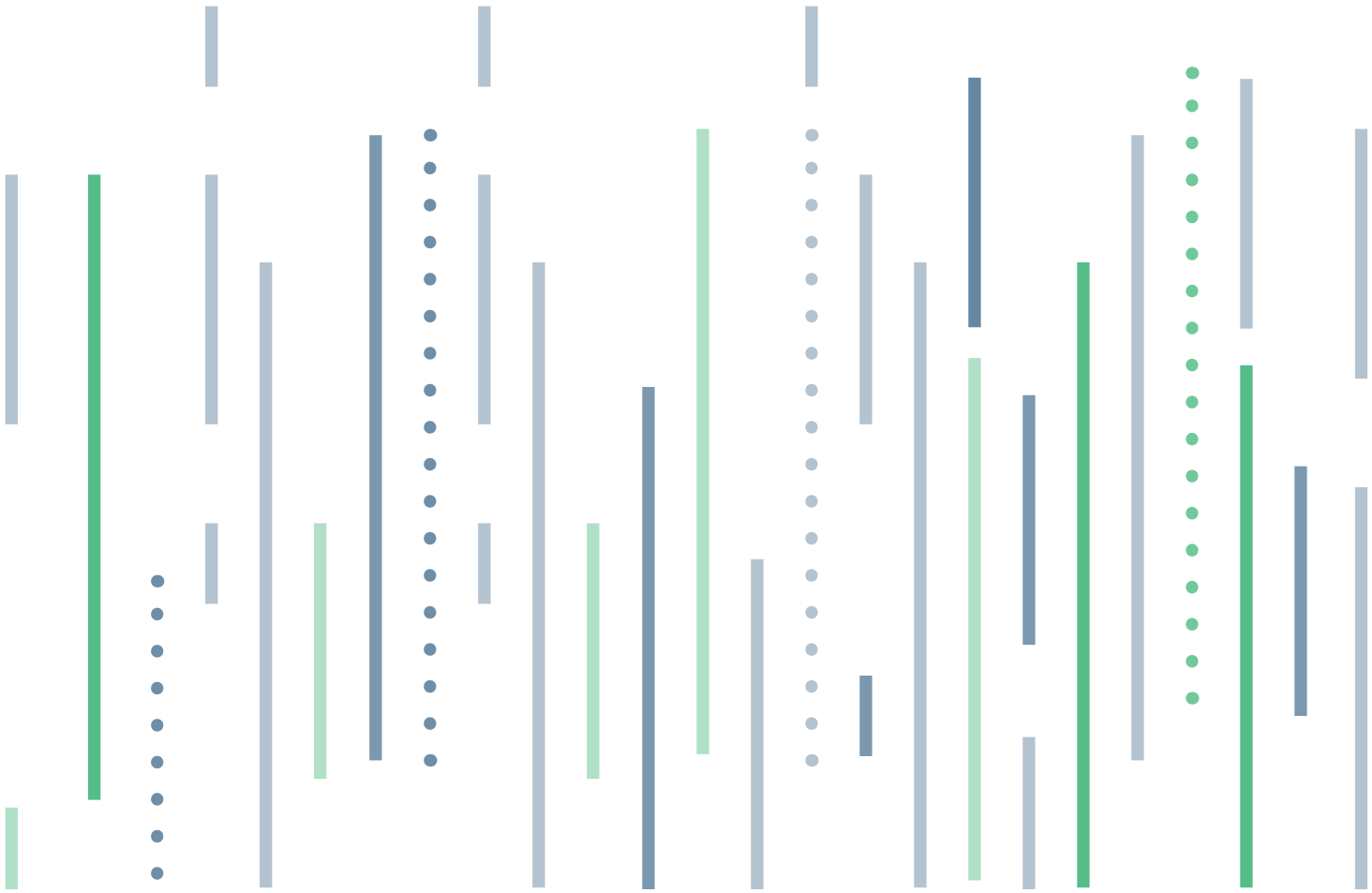
- This review cannot determine the linkage of any cancer occurrence with environmental conditions (including PFAS), nor the cause of observed increases or decreases of any cancer types over time. MDHHS cancer registry records do not include the data necessary to make such an evaluation.
- The ZIP code and U.S. census tract boundaries serve as the geographic scope of this analysis, but they do not exactly match the MDEQ Northern Kent County PFAS Environmental Investigation area.
- This review cannot determine which individuals (with or without cancer) residing within the geographic area have been exposed to PFAS.
- The cancer registry records the patients' address at the time of diagnosis. This information is used to determine the number of incident cancer cases in the census tracts and ZIP codes analyzed in this report, but does not account for amount of time individuals resided in the selected geographic area, nor for the lag time or latency between exposure to a potential cancer causing agent and the diagnosis of cancer. In other words, the address used does not necessarily reflect the location where a person may have encountered environmental factors that caused or contributed to their cancer.
- Latency, the time period for cancer to develop, is typically several decades. This means that many cancers diagnosed today are the result of individual patients' experiences that occurred many years ago. It also means that community cancer rates include individuals who may differ greatly in their time in the community, personal risk factors for cancer, and environmental exposures.
- There are many factors that can impact one's risk of cancer which were not included in the registry by MCSP and thus cannot be included in this review. Such information includes but is not limited to genetics, social and behavioral influences, and occupational or environmental exposures.
- The included rates and expected number of cases calculated rely on the accuracy of population estimates by age and gender that, especially for years between U.S. Censuses, can be imprecise.



Conclusion

The invasive urogenital cancer incidence observed in a subset of census tracts showed no consistent elevations when compared to rates for Kent County or the State of Michigan, while rates in ZIP codes 49306 and 49341 were 14 and 18 percent higher than expected, respectively, compared to State of Michigan rates. The additional sub-set analysis of prostate, kidney, testicular, and ovarian cancer incidence indicate this elevation is being driven by the higher than expected number of prostate cancer cases. This elevation could be attributed to a number of factors such as but not limited to differences in genetics, environmental exposures, PSA screening rates, and socioeconomics between the areas studied and the comparison populations (Vieira et al., 2013; Hardell et al., 2014; Grandjean and Clapp, 2014). Kidney and renal pelvis cancers were significantly higher than expected only for the earliest time period and declined over time, while testicular and ovarian cancers were not significantly elevated.

These results provide a descriptive picture of cancer incidence in the geographic areas where the MDEQ is conducting its PFAS Environmental Investigation in northern Kent County. However, the lack of individual PFAS exposure information, as well as the other limitations outlined in the previous section, constrains our ability to draw any more specific conclusions from this review. This pattern of increases in some years and some cancer types and decreases in others is commonly seen in cancer incidence reviews such as this one (Centers for Disease Control and Prevention, 2013). Given ongoing concerns in the area, MDHHS remains committed to evaluating new data or additional information as it becomes available.



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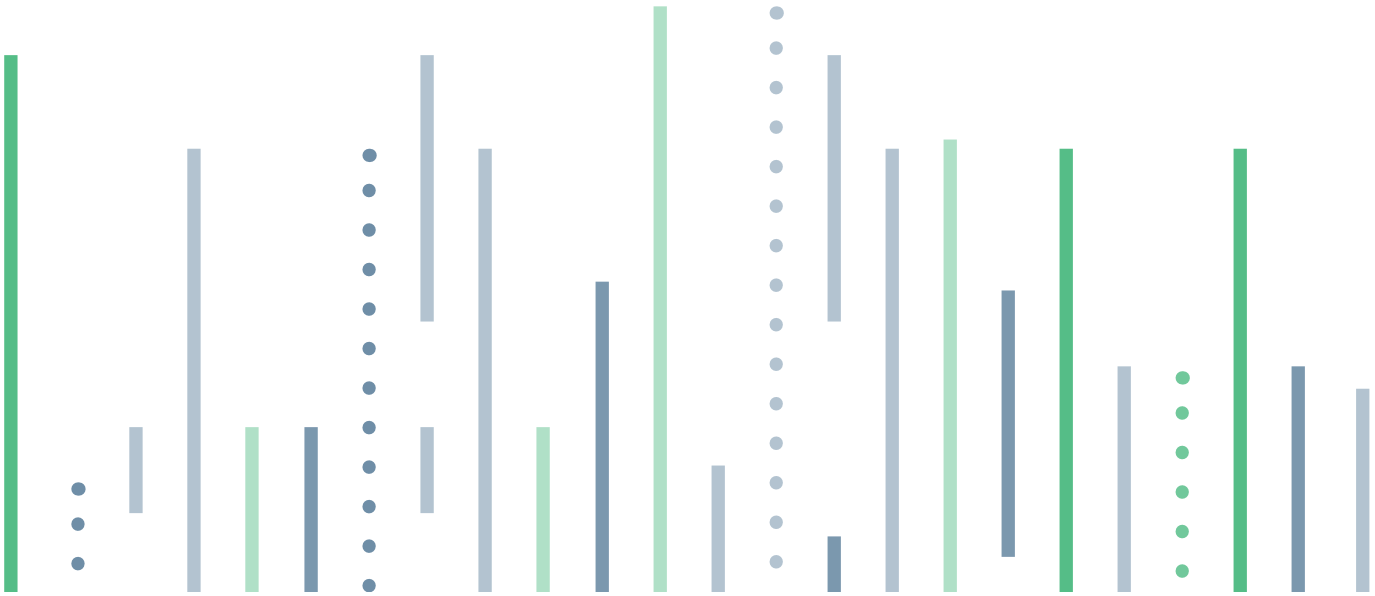

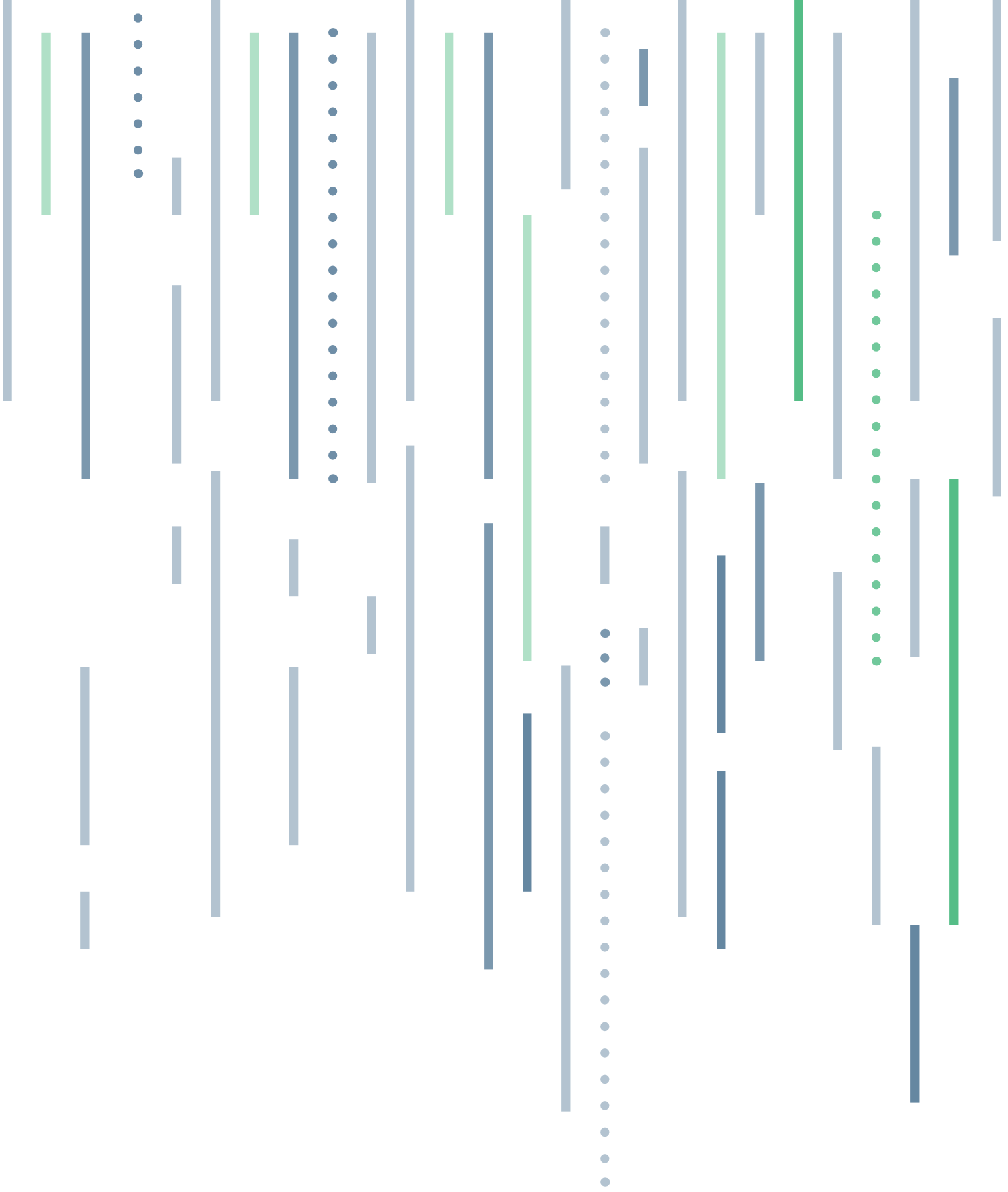

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