



STATE OF MICHIGAN
DEPARTMENT OF HEALTH AND HUMAN SERVICES
LANSING

RICK SNYDER
GOVERNOR

NICK LYON
DIRECTOR

February 28, 2018

Jennifer Kostasich, Project Officer
Centers for Medicare and Medicaid Services
7500 Security Boulevard
Mail Stop S2-01-16
Baltimore, Maryland 21244-1850

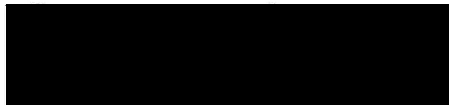
Dear Ms. Kostasich,

Re: Project Number 11-W-00302/5 – Flint Michigan Section 1115 Demonstration

Enclosed is the quarterly report for the Flint Michigan Section 1115 Demonstration. It covers the fourth quarter of calendar year 2017. The report provides operational information, program enrollment, and policy changes related to the waiver as specified in the Special Terms and Conditions.

Should you have any questions related to the information contained in this report, please contact Jacqueline Coleman. She may be reached by phone at (517) 284-1190, or by e-mail at colemanj@michigan.gov.

Sincerely,



Penny Rutledge, Director
Actuarial Division

cc: Ruth Hughes
Angela Garner

Enclosure (9)

Flint Michigan Section 1115 Demonstration
Quarterly Report

Demonstration Year: 1 (03/01/2017 – 02/28/2018)
Calendar Year Quarter: 4 (10/01/2017 – 12/31/2017)

Table of Contents

Introduction	3
Enrollment and Benefits Information	3
Table 1: Flint Demonstration Enrollment by Month	3
Table 2: Flint Demonstration New Enrollment by Month	4
Table 3: Flint Demonstration Re-Enrollment by Month.....	4
Table 4: Flint Demonstration Disenrollment by Month.....	4
Table 5: Cumulative Flint Demonstration PCP Utilization	5
Table 6: Monthly Flint Demonstration PCP Visits.....	5
Table 7: Genesee Health System Targeted Case Management Activity	6
Outreach/Innovation Activities to Assure Access.....	6
Operational and Policy Development	6
Budget Neutrality Monitoring	6
Table 8: Flint Demonstration Budget Neutrality Monitoring	7
Consumer Issues	7
Table 9: Flint Demonstration Customer Service Requests.....	7
Demonstration Evaluation	7
Enclosures/Attachments	8
State Contacts	9
Date Submitted to CMS	9

Introduction

On March 3, 2016 the Centers for Medicare and Medicaid Services (CMS) approved Michigan Department of Health and Human Services' (MDHHS) application to expand Medicaid coverage for individuals impacted by lead exposure in the Flint water system through February 28, 2021. Through the demonstration, entitled "Flint Michigan Section 1115 Demonstration" and the associated state plan amendments, State Medicaid eligibility expanded to low-income children and pregnant women who were served by the Flint water system during a specified period of time and who would not otherwise be eligible for Medicaid. This population consists of children in households with incomes from 212 percent of the federal poverty level (FPL) up to and including 400 percent of the FPL and pregnant women in households with incomes from 195 percent up to and including 400 percent of the FPL.

The demonstration population receives care primarily through Medicaid managed care plans and receives all state plan benefits including, for children, Early and Periodic Screening, Diagnostic and Treatment (EPSDT). Individuals receiving benefits under the demonstration are exempt from cost sharing and premiums. Targeted Case Management and home lead investigation services are available to children and pregnant women served by the Flint water system during the defined period who have been determined eligible for Medicaid. The provision of specialized services are limited to certain providers as allowable under the approved demonstration.

Enrollment and Benefits Information

Enrollment into the Flint Medicaid waiver program began May 9, 2016. Beneficiaries already eligible for Medicaid were contacted by mail with information on expanded services provided by the waiver. Potential enrollees can apply for the program via the MDHHS website, by calling a toll-free number or by visiting any MDHHS County office or an area navigator site. Healthcare coverage and application information for people impacted by the Flint water system can be found on the MDHHS website.¹

Demonstration enrollment activity is detailed in this section of the report. For reporting purposes, the Children enrollment group is defined as demonstration enrollees under the age of 21. Pregnant women are identified using pregnancy indicators in the MDHHS data warehouse. To avoid duplication, pregnant women are excluded from the Children enrollment group.

The following table, Table 1, shows enrollment in the demonstration by month.

Enrollment Group	October 2017	November 2017	December 2017
Pregnant Women	566	512	462
Children	27,850	27,565	27,285
Total	28,416	28,077	27,747

¹ <http://www.michigan.gov/mdhhs/0,5885,7-339-71547-384168--,00.html>

Table 2 displays Flint demonstration new enrollment by month. This includes individuals who may have previously been enrolled in other Medicaid programs but are new to the Flint demonstration.

Table 2: Flint Demonstration New Enrollment by Month				
Enrollment Group	October 2017	November 2017	December 2017	Total
Pregnant Women	63	58	42	163
Children	192	177	169	538
Total	255	235	211	701

Table 3 shows Flint demonstration re-enrollments by month. Re-enrollments include individuals who have disenrolled and re-enrolled in the Flint demonstration. Individuals under the re-enrollment category also include individuals that may have previously been enrolled in other Medicaid programs.

Table 3: Flint Demonstration Re-Enrollment by Month				
Enrollment Group	October 2017	November 2017	December 2017	Total
Pregnant Women	24	23	17	64
Children	379	348	317	1,044
Total	403	371	334	1,108

Table 4 contains Flint demonstration disenrollment by month. Disenrollment for a reporting month contains individuals with program enrollment in the prior reporting month that do not have program enrollment for the current reporting month. For example, individuals defined as disenrolled in October 2017 were enrolled in the demonstration in September 2017 but were not enrolled in October 2017. Demonstration disenrollment is often the result of failure to timely return redetermination paperwork and transferring to another Medicaid program.

Table 4: Flint Demonstration Disenrollment by Month				
Enrollment Group	October 2017	November 2017	December 2017	Total
Pregnant Women	140	135	114	389
Children	760	810	766	2,336
Total	900	945	880	2,725

Additional demonstration disenrollment reports by month have been included as attachments. Enrollment maps depicting the geographic distribution of demonstration enrollees for the quarter have also been included as attachments to this report. The attached reports will not necessarily align numerically with the figures reported in the quarterly report tables due to differences in the timing of data retrieval and specifications.

MDHHS monitors the Flint demonstration population's usage of Medicaid benefits to assure access to care. The following access to care metrics utilize the same enrollment group definitions for children and pregnant women as described for tables 1 – 3. It should be noted that the Children Under 6 category below is a subgroup of the Children category.

The following table lists the cumulative, unduplicated count of Flint demonstration enrollees since the waiver begin date of May 9, 2016 through the end of the reporting quarter, December 31, 2017. The table displays the total number of those enrolled with a visit to a provider with a primary care associated specialty. This includes practitioners with a specialty of family medicine, general medicine, internal medicine or pediatrics. This metric includes any procedure rendered by a primary care provider (PCP).

Table 5: Cumulative Flint Demonstration PCP Utilization			
May 2016 – December 2017			
Enrollment Group	Cumulative Enrollment	Cumulative Count of Enrollees with PCP Visit(s)	Cumulative Percentage of Enrollees with PCP Visit(s)
Children	35,012	29,066	83%
Children Under 6	13,558	12,497	92%
Pregnant Women	2,693	2,426	90%
Total	37,705	31,492	83%

Table 5 indicates the monthly count of PCP visits for the reporting quarter's Flint demonstration population.

Table 6: Monthly Flint Demonstration PCP Visits				
Enrollment Group	October 2017	November 2017	December 2017	Total
Children	9,237	8,291	6,081	23,609
Pregnant Women	228	219	152	599
Total	9,465	8,510	6,233	24,208

Targeted Case Management services are provided by Genesee Health System and include the following assistance:

- Comprehensive assessment and periodic reassessment of individual needs;
- Development of a specific care plan;
- Referrals and related activities to help obtain needed services;
- Monitoring and follow-up activities.

The following table includes Targeted Case Management service activity as provided by Genesee Health System. Individuals counted as those with ongoing services are defined as individuals receiving a Targeted Case Management-related service other than assessment during the month, including unbilled face-to-face and phone contacts.

Month	Count of Assessments	Count of Enrollees with Ongoing Targeted Case Management
October 2017	5	50
November 2017	8	37
December 2017	4	42
Cumulative Total	205	530

Outreach/Innovation Activities to Assure Access

MDHHS and community partners work together to coordinate and implement outreach for those affected by the Flint water system. Activities have included press conferences, public service announcements, community events, advertisements on radio and television, social media posts, and letters to providers and potential enrollees. The public can access waiver specific information, including weekly enrollment reports, on the department’s website.² A variety of resources for Flint families are available on the State’s Flint water website.³ MDHHS has prominently displayed links to both Flint websites on the MDHHS homepage.⁴

Operational and Policy Development

This and future quarterly reports will address policy, administrative or budget issues identified during the demonstration. This quarter, MDHHS did not issue any policy bulletins or provider letters specific to the Flint demonstration. In October 2017, MDHHS published its analysis of City of Flint birth outcomes. MDHHS and its Genesee County health partners analyzed birth outcomes in the City of Flint to determine if there were differences in birth outcomes before the change in water source and after. This analysis did not find significant differences in birth outcomes when comparing these time periods. The methods and results of the MDHHS Flint Perinatal Metrics Analyses can be found in the attached press release and report.

Budget Neutrality Monitoring

According to the demonstration special terms and conditions, MDHHS is required to report demonstration expenditures subject to budget neutrality. In this demonstration, this is limited to all demonstration medical assistance expenditures for lead investigation with dates of services within the demonstration’s approval period. The following budget neutrality table includes expenditures for March 2016 – December 2016.

² <http://www.michigan.gov/mdhhs/0,5885,7-339-71547-376862--,00.html>

³ <http://www.michigan.gov/flintwater>

⁴ <http://www.michigan.gov/mdhhs/>

Table 8: Flint Demonstration Budget Neutrality Monitoring

	DY 1 - PMPM	DY 2 - PMPM	DY 3 - PMPM	DY 4 - PMPM	DY 5 - PMPM
Approved Flint Lead Diagnostics PMPM	\$ 10.49	\$ 10.49	\$ 10.49	\$ 10.49	\$ 10.49
Actual Flint Lead Diagnostics PMPM (YTD)	\$ 0.18	-	-	-	-
Total Flint Lead Diagnostics Expenditures (YTD)	\$ 29,940.00	-	-	-	-
Total Flint Demonstration Member Months (YTD)	168,304	-	-	-	-

As of January 1, 2017, Michigan's approved Children's Health Insurance Program (CHIP) Health Services Initiative (HSI) provides funding for lead abatement in the impacted areas of Flint, Michigan. As a result, expenditures subject to budget neutrality in the Flint Demonstration are limited to calendar year 2016. Lead abatement expenditures after 2016, including those associated with environmental diagnostic testing, are reported per CHIP HSI regulatory requirements.

Consumer Issues

MDHHS utilizes the Beneficiary Helpline as a central point of contact for members to ask questions, report complaints and resolve issues. Information on beneficiary complaints and health plan grievances and appeals are currently collected for other Medicaid programs. In the following table, MDHHS has refined existing reporting mechanisms to measure Flint demonstration member telephone contacts with the department. The Other category below included complaints pertaining to duplicate IDs, enrollment issues, and medical supplies.

**Table 9: Flint Demonstration Customer Service Requests
October 2017 – December 2017**

Category	Number of Contacts
Obtaining Prescriptions	13
Covered Services	5
Duplicate ID	4
Enrollment/Eligibility Not Recognized	3
Other	3
Dental	2
Total	30

Demonstration Evaluation

MDHHS has commissioned the Michigan State University Institute for Health Policy (MSU-IHP) to serve as the Flint demonstration independent evaluator. On August 8, 2017, CMS approved the demonstration evaluation design. The complete Demonstration Evaluation Plan is available as an attachment to the Flint Demonstration's approved Special Terms and Conditions. During the current quarter, MSU-IHP continued to engage in evaluation preparatory activities. This

included the identification of target software, corresponding with the Department of Education on available data, and establishing a data management and analysis team. Future quarterly reports will contain activity specific to the demonstration evaluation domains.

As described in the demonstration Special Terms and Conditions, MSU-IHP will conduct demonstration evaluation activities in four domains over a four year evaluation period. The four domains are as follows:

- I. Access to Services
- II. Access to Targeted Case Management
- III. Improved Health Outcomes
- IV. Lead Hazard Investigation

Domain I: Access to Services

Domain I will examine the hypothesis that demonstration enrollees will access services to identify and address physical or behavioral health issues associated with lead exposure at a rate higher than others with similar levels of lead exposure.

Domain II: Access to Targeted Case Management

Domain II will assess if demonstration enrollees who access Targeted Case Management services will access needed medical, social, educational, and other services at a rate higher than others with similar levels of lead exposure.

Domain III: Improved Health Outcomes

Domain III will evaluate the hypothesis that demonstration enrollees will have improved health outcomes compared to others with similar levels of lead exposure.

Domain IV: Lead Hazard Investigation

Domain IV will examine if the lead hazard investigation program reduces estimated expected ongoing or re-exposure to lead hazards in the absence of this program.

Enclosures/Attachments

1. October 2017 Flint Demonstration Disenrollment Report (CM-100)
2. November 2017 Flint Demonstration Disenrollment Report (CM-100)
3. December 2017 Flint Demonstration Disenrollment Report (CM-100)
4. Quarterly Geographic Distribution Enrollment Map: Pregnant Women
5. Quarterly Geographic Distribution Enrollment Map: Children
6. Quarterly Geographic Distribution Enrollment Map: Children Under 6
7. Press Release: Michigan analysis finds no significant differences in City of Flint birth outcomes
8. Flint Perinatal Metrics Analyses

State Contacts

If there are any questions about the contents of this report, please contact one of the following people listed below.

Jacqueline Coleman, Waiver Specialist

Phone: (517) 284-1190

Carly Todd, Analyst

Phone: (517) 284-1196

Andrew Schalk, Federal Regulation & Hospital Reimbursement Section Manager

Phone: (517) 284-1195

Penny Rutledge, Actuarial Division Director

Phone: (517) 284-1191

Actuarial Division

Bureau of Medicaid Operations and Actuarial Services

MSA, MDHHS, P.O. Box 30479

Lansing, MI 48909-7979

Fax: (517) 241-5112

Date Submitted to CMS

February 28, 2018

State of Michigan
 Department of Health and Human Services
 Medicaid waiver Monthly CMS report

Report ID: CM-100
 Report Period: 10/01/2017

Run Date: 01/16/2018
 Run Time: 7:07:00AM

1. Monthly count of disenrollment because of transfer to another eligibility group:	282
2. Monthly count of disenrollment other than transfer to another Medicaid group:	494
3. Monthly count of beneficiaries due for renewal:	1353
4. Number of beneficiaries due for renewal who did not renew:	1246
5. Number of beneficiaries due for renewal who lost eligibility:	298
6. Enrollment continuity in weeks for all individuals enrolled during the reporting month:	
05/07/2016 Thru 09/30/2017	Count: 51,751
10/01/2017 Thru 10/07/2017	Count: 308
10/08/2017 Thru 10/14/2017	Count: 201
10/15/2017 Thru 10/21/2017	Count: 258
10/22/2017 Thru 10/28/2017	Count: 164
10/29/2017 Thru 10/31/2017	Count: 85

***** END OF THE REPORT *****

State of Michigan
 Department of Health and Human Services
 Medicaid waiver Monthly CMS report

Report ID: CM-100
 Report Period: 11/01/2017

Run Date: 01/16/2018
 Run Time: 7:49:43AM

1. Monthly count of disenrollment because of transfer to another eligibility group:	315
2. Monthly count of disenrollment other than transfer to another Medicaid group:	538
3. Monthly count of beneficiaries due for renewal:	1268
4. Number of beneficiaries due for renewal who did not renew:	1194
5. Number of beneficiaries due for renewal who lost eligibility:	321
6. Enrollment continuity in weeks for all individuals enrolled during the reporting month:	
05/07/2016 Thru 10/31/2017	Count: 52,767
11/01/2017 Thru 11/04/2017	Count: 168
11/05/2017 Thru 11/11/2017	Count: 205
11/12/2017 Thru 11/18/2017	Count: 176
11/19/2017 Thru 11/25/2017	Count: 117
11/26/2017 Thru 11/30/2017	Count: 174

***** END OF THE REPORT *****

State of Michigan
 Department of Health and Human Services
 Medicaid waiver Monthly CMS report

Report ID: CM-100
 Report Period: 12/01/2017

Run Date: 01/16/2018
 Run Time: 7:56:33AM

1. Monthly count of disenrollment because of transfer to another eligibility group:	240
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2. Monthly count of disenrollment other than transfer to another Medicaid group:	556
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3. Monthly count of beneficiaries due for renewal:	1629
4. Number of beneficiaries due for renewal who did not renew:	1540
5. Number of beneficiaries due for renewal who lost eligibility:	336

6. Enrollment continuity in weeks for all individuals enrolled during the reporting month:					
	05/07/2016	Thru	11/30/2017	Count:	53,607
	12/01/2017	Thru	12/02/2017	Count:	107
	12/03/2017	Thru	12/09/2017	Count:	213
	12/10/2017	Thru	12/16/2017	Count:	244
	12/17/2017	Thru	12/23/2017	Count:	168
	12/24/2017	Thru	12/30/2017	Count:	112
	12/31/2017	Thru	12/31/2017	Count:	1

***** END OF THE REPORT *****

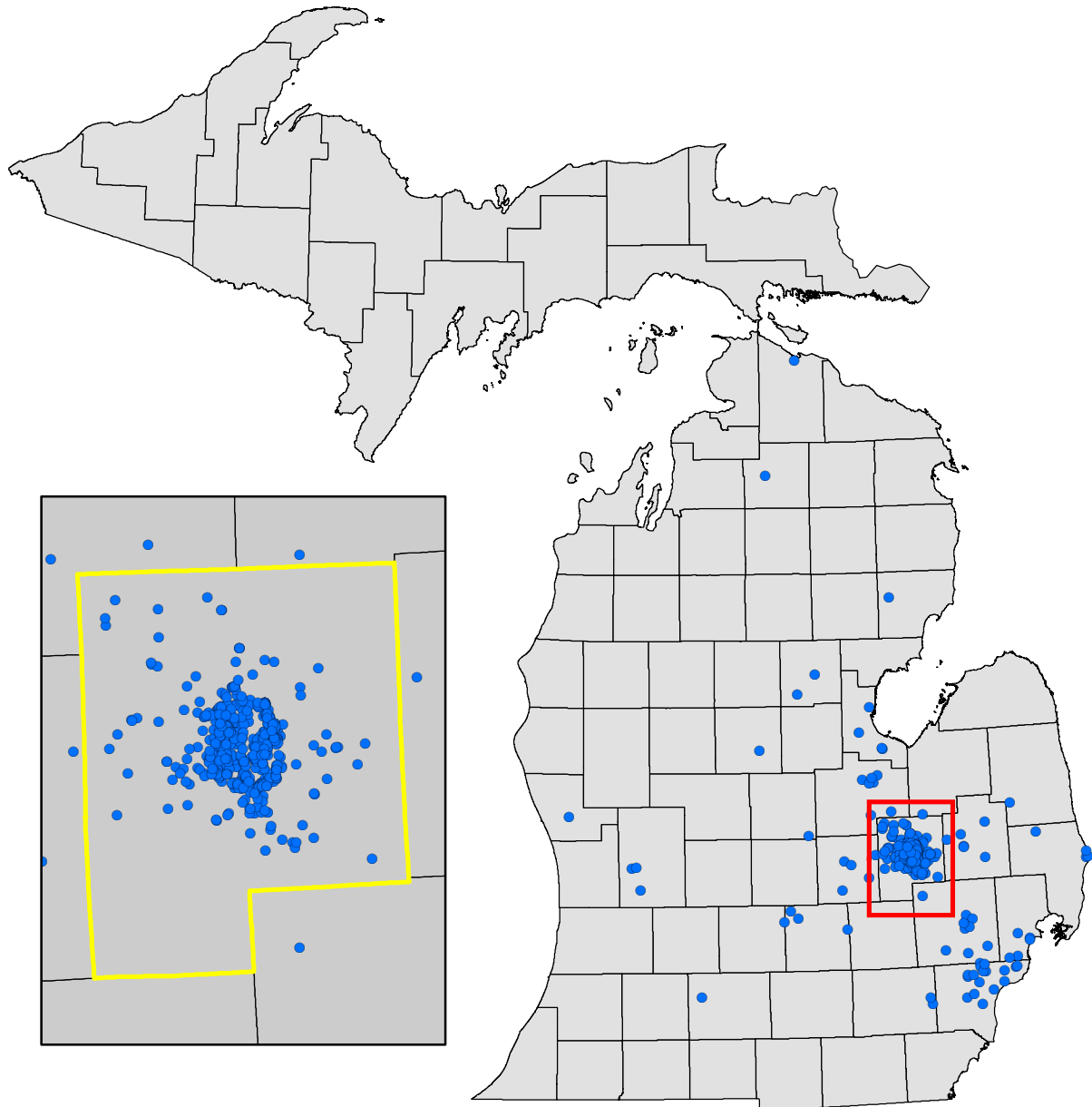
Flint Demonstration Waiver Enrollees

Pregnant

October 2017 - December 2017

Genesee county: 709

All Other Counties: 102



Source: MDHHS Data Warehouse
Retrieved on January 30, 2018

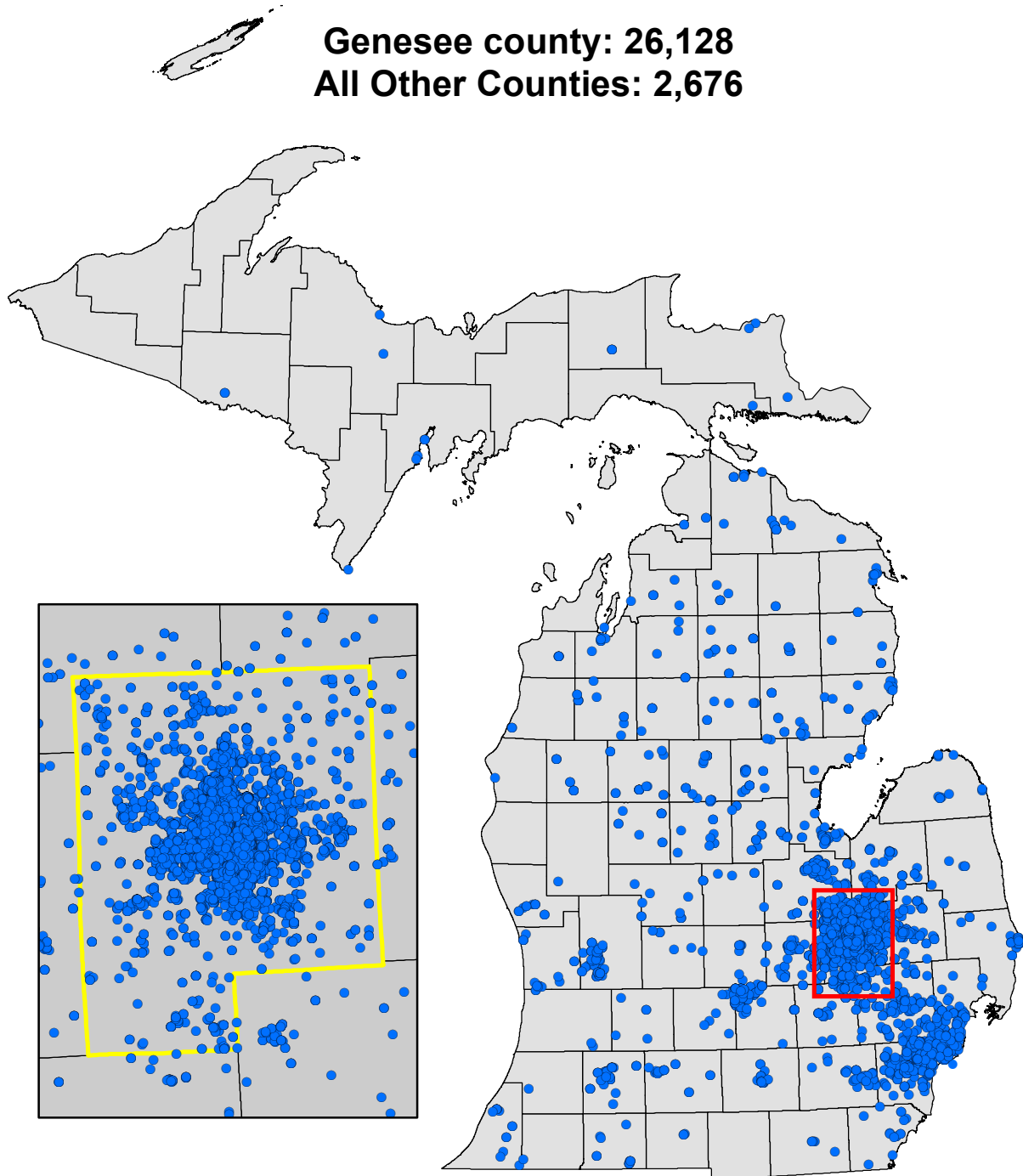
MDHHS - Actuarial Division
January 30, 2018

Flint Demonstration Waiver Enrollees

0-20 Years Old

October 2017 - December 2017

Genesee county: 26,128
All Other Counties: 2,676



Source: MDHHS Data Warehouse
Retrieved on January 30, 2018

MDHHS - Actuarial Division
January 30, 2018

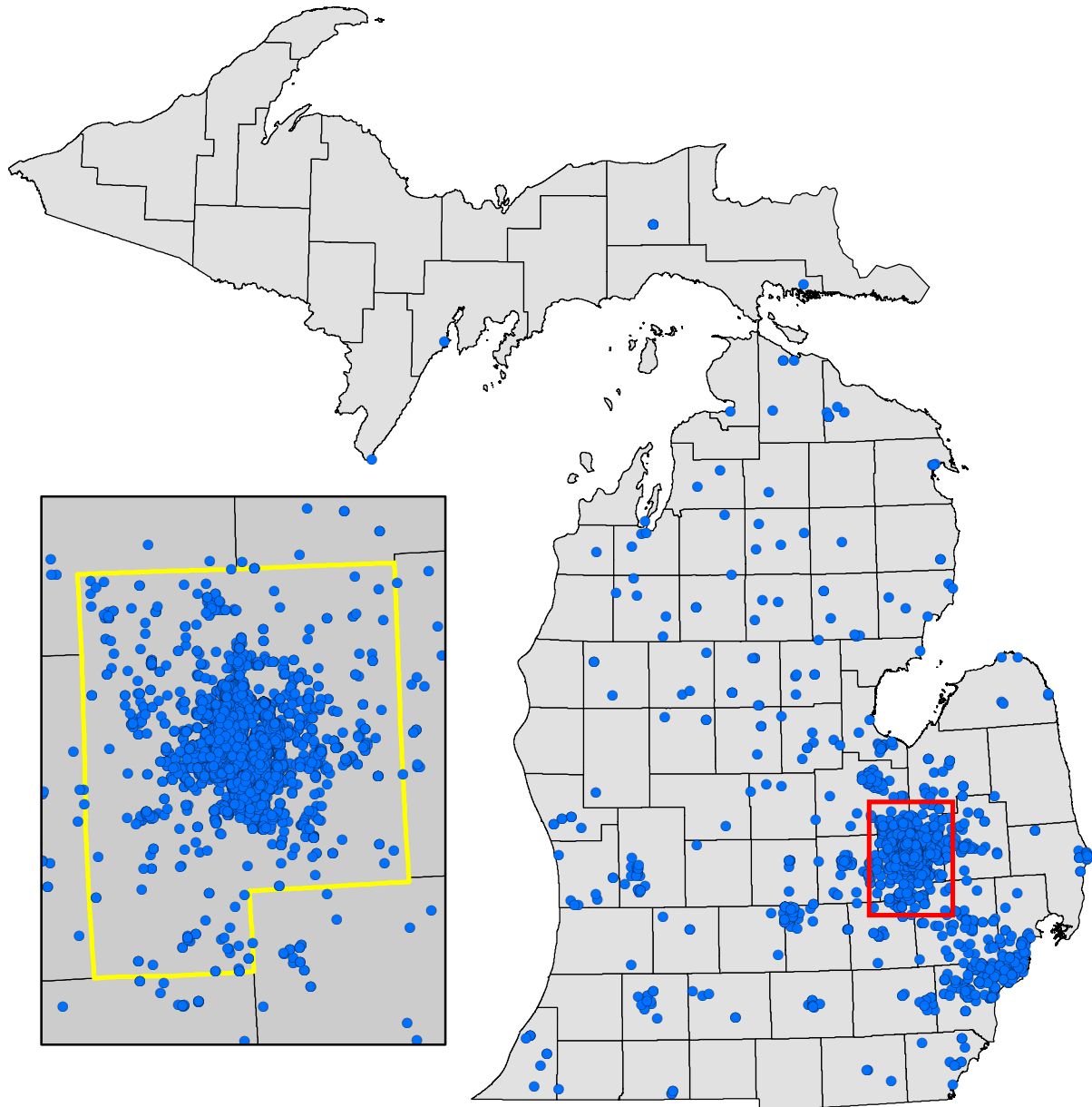
Flint Demonstration Waiver Enrollees

0-5 Years Old

October 2017 - December 2017

Genesee county: 8,892

All Other Counties: 1,039



Source: MDHHS Data Warehouse
Retrieved on January 30, 2018

MDHHS - Actuarial Division
January 30, 2018



RICK SNYDER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF HEALTH AND HUMAN SERVICES
LANSING

NICK LYON
DIRECTOR

FOR IMMEDIATE RELEASE
October 10, 2017

CONTACT: Angela Minicuci
(517) 241-2112

Michigan analysis finds no significant differences in City of Flint birth outcomes

LANSING, Mich. – The Michigan Department of Health and Human Services (MDHHS) analyzed birth outcomes in the City of Flint before and after the change in water source to determine if there were any impacts on pregnancy outcomes. The result of this analysis showed no significant differences in birth outcomes for the City of Flint when comparing the pre and post water change time periods.

“The issue of birth outcomes in the City of Flint before and after the water source change is an important one,” said Sarah Lyon-Callo, Director of the Bureau of Epidemiology within the Population Health Administration, MDHHS. “We’re grateful to our partners in Genesee County for lending their expertise and input as we analyzed these data.”

Provisional results were shared with partners from Genesee County and the City of Flint on various occasions to review the findings and refine the analysis. Working with these partners, MDHHS assessed the rates of stillbirth, infant mortality, preterm birth and low birthweight within the City of Flint both before and after the water source change. The findings of the final analysis include:

- When looking at the City of Flint alone, the analysis shows that there were no significant increases in the rates of infant mortality, stillbirth, preterm birth and low birthweight across the two time periods.
- When comparing Flint to the rest of the State, Flint has consistently had higher rates of stillbirth, preterm birth and low birthweight, including both the pre and post water source change time periods.
- There is evidence of an increase in preterm birth within the City of Flint three months after the water source change (during the third quarter of 2014), but this rate returned to pre water source change levels in subsequent quarters.
- The analysis found a non-statistically significant increase in the incidence ratios for stillbirth, preterm birth and low birthweight overall and among Black, non-Hispanic infants during the post water change period.
- In addition, compared to the cities of Detroit, Grand Rapids, Lansing, and Saginaw, in both periods, the risk of stillbirth, preterm birth and low birthweight in the City of Flint is consistently higher.

To refine this analysis, MDHHS worked with experts and Genesee County healthcare partners, including Dr. Mona Hanna-Attisha, Genesee County Health Department, Dr. Marc Edwards, and Dr. Larry Reynolds. MDHHS is currently collaborating with the Centers for Disease Control and Prevention to prepare and submit these analyses for peer review and will continue to monitor this issue in the coming years as additional data becomes available.

###

Flint Perinatal Metrics Analyses

(Methods 1-3)

Version: 10/4/2017

Prepared by MCH Epidemiology Section, Michigan Department of Health and Human Services (MDHHS)

Data source: Division of Vital Records and Health Statistics, MDHHS

Final geocoded Michigan resident live birth files (received 7/27/17), infant mortality files (received 3/3/17) and fetal death files (received 10/2/17)

Background

- In April, 2014, the city of Flint, Michigan, changed its water supply from Detroit-supplied Lake Huron water to the Flint River water, an aging water system without adequate corrosion control.
- A previous study showed that exposure to lead-contaminated drinking water has been associated with adverse pregnancy outcomes (Edwards, 2014).
- We used three methods to assess the rates of stillbirth, infant mortality, preterm birth and low birthweight in the city of Flint, Michigan before and after the water source change.

Methods

- Data source – Michigan Vital Records
 - Vital Records are legal records of Michigan resident live births, fetal deaths and infant deaths and as such are subject to change as new records are submitted or existing records modified or corrected. The data sets used in this analysis are the most current available.
 - Statistical files were prepared by Vital Records statisticians prior to our analysis, including standard de-duplication and removal of voided records.
- Flint definition
 - Geocode of residence was used to determine the minor civil division
- Statistical methods used
 - Statistical test for comparing two proportions
 - Poisson Regression Model (Proc Genmod in SAS)
 - Bayesian Poisson Regression Model (Openbugs)

Method 1

The test statistic for testing the difference of two proportions in the two periods, that is, for testing the null hypothesis $H_0 : p_1 - p_2 = 0$

$$Z = \frac{(\hat{p}_1 - \hat{p}_2) - 0}{\sqrt{\hat{p}(1 - \hat{p}) \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

Where \hat{p} is the proportion of cases in the two periods combined.

$$\hat{p} = \frac{Y_1 + Y_2}{n_1 + n_2}$$

p_1 = the proportion of the case in the pre period (07/01/2012 – 12/31/2013) ;
 p_2 = the proportion of the case in the post period (07/01/2014 – 12/31/2015).

Method 2

Estimate Standardized Incidence Ratio (SIR) Relative to Expected Counts Based on Michigan Rates

- In this CDC approach, we estimated expected outcome for each quarter of the year (2010-2015) for the city of Flint by using data from the rest of the State of Michigan, after excluding the Flint data.
- The expected outcomes for Flint were estimated for White Non-Hispanic and Black Non-Hispanic populations separately, multiplying the race/ethnicity-specific Michigan rate by the appropriate Flint live birth count.
- The expected total number of outcomes in Flint was then estimated by summing the race/ethnicity-specific expected counts.
- The expected outcome counts in Flint were then used as an offset term in a Poisson regression model to fit these data using SAS Proc Genmod.
- Flint-specific standardized incidence ratios (SIR) relative to the rest of the State both before and after the exposure period were estimated, and the ratio of SIRs was estimated by including a time period variable (07/01/2014 – 12/31/2015 vs. 01/01/2010 – 06/30/2014) in the model.

Method 3

- We used a Bayesian modeling approach to specifically evaluate the likelihood that the SIRs for infant mortality in Flint were elevated after 07/01/2014. The observed infant mortality counts for Flint were assumed to be a random sample from a Poisson distribution such that

$$Infant_Deaths_i^{Flint} \sim Poisson(\mu_i)$$

where

$$\mu_i = Exp_Infant_Deaths_i^{Flint} * e^{\beta_0 + \beta_1 * t_i} \quad [1]$$

- In equation [1], the variable t_i takes the value of 1 if the time variable is greater than or equal to 07/01/2014 and is set to 0 for all time points before 07/01/2014. Using this model, the estimated SIR for time periods before 07/01/2014 is given by e^{β_0} while the SIR after 07/01/2014 is estimated using $e^{\beta_0 + \beta_1}$. Therefore, the estimated change in the infant mortality risk in Flint after July 2014 is given by e^{β_1} .
- The Bayesian modelling approach enabled not only estimation of the SIRs for infant mortality in Flint, but also the probability that the risk of infant mortality increased after 07/01/2014.
- We also compared SIRs between Flint and Saginaw, Detroit, Grand Rapids, and Lansing for both time periods.
- The above method was also applied to estimate the SIRs for preterm birth and low birthweight.

Method 3 (Continued)

- We used a Bayesian modeling approach to specifically evaluate the likelihood that the SIRs for stillbirth in Flint were elevated after 07/01/2014. Due to the numerous quarters in which no stillbirths were reported in Flint, we assumed that the observed stillbirth counts for Flint were observations from a Zero-inflated Poisson (ZIP) distribution with mean given by

$$\text{Stillbirth}_i^{\text{Flint}} \sim p * 0 + (1 - p) * \text{Poisson}(\mu_i)$$

Where p is a Bernoulli random variable representing the probability that the observed stillbirth counts takes a value of 0 and μ_i is the mean value of the non-zero observed stillbirth counts defined as

$$\mu_i = \text{Exp_Stillbirth}_i^{\text{Flint}} * e^{\beta_0 + \beta_1 * t_i} \quad [2]$$

- In equation [2], the variable t_i takes the value of 1 if the time variable is greater to or equal to 07/01/2014 and is set to 0 for all time points before 07/01/2014. Using this model, the estimated SIR for time periods before 07/01/2014 is given by e^{β_0} , while the SIR after 07/01/2014 is estimated using $e^{\beta_0 + \beta_1}$. Therefore, the estimated change in the stillbirth risk in Flint after 07/01/2014 is given by e^{β_1} .
- The Bayesian modelling approach enabled not only estimation of the SIRs for stillbirth in Flint, but also the probability that the risk of stillbirth increased after 07/01/2014.
- We also compare SIRs between Flint and Saginaw, Detroit, Grand Rapids, and Lansing for both time periods.

Method --- Outcomes

- **Infant mortality** is defined as a death of a baby before his or her first birthday.
- **Stillbirth** is defined as a death of a fetus that has completed at least 20 weeks of gestation or weighs at least 400 grams.
- **Preterm birth** is defined as a birth of a baby less than 37 completed weeks of estimated gestation.
- **Low birthweight** is defined as a birthweight of a baby less than 2,500 grams.
- **Small for gestational age** baby is defined as a baby who is smaller in size than normal for the gestational age, most commonly defined as a weight below the 10th percentile for the gestational age.
- **Stillbirth and neonatal death** is defined as a sum of a death of a fetus that has completed at least 20 weeks of gestation or weighs at least 400 grams, and a death during the first 28 days of life (0-27 days).

Results --- Infant Mortality

Method 1: There was not enough evidence to indicate that the estimated infant mortality rates were significantly different over the two time periods.

Table 3: Infant Mortality Rate per 1,000 Live Birth in Flint, 2012-2015

	# Live Births	# Infant Mortality	Infant Mortality Rate per 1,000 Live Births	95% C. I.
07/01/2012 --- 12/31/2013	2348	29	12.35	(7.88, 16.82)
07/01/2014 --- 12/31/2015	2121	25	11.79	(7.19, 16.38)
p-value	0.86			

Results --- Infant Mortality

Method 2: There was not enough evidence to indicate that the estimated standardized incidence ratios for infant mortality were significantly different over the two time periods.

Table 1: Standardized Incidence Ratios of Infant Mortality in Flint, 2010-2015

	Infant Mortality		
	N	SIR	95% C. I.
Overall			
2010 Q1 - 2014 Q2	85	1.17	[0.95, 1.45]
2014 Q3 - 2015 Q4	25	1.18	[0.80, 1.74]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.01	[0.64, 1.57]
White Non-Hispanic			
2010 Q1 - 2014 Q2	19	1.47	[0.94, 2.31]
2014 Q3 - 2015 Q4	3	0.85	[0.27, 2.63]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		0.58	[0.17, 1.95]
Black Non-Hispanic			
2010 Q1 - 2014 Q2	65	1.14	[0.90, 1.46]
2014 Q3 - 2015 Q4	21	1.24	[0.81, 1.91]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.09	[0.67, 1.78]

Results --- Infant Mortality

Method 3: There was not enough evidence to indicate that the estimated standardized incidence ratios for infant mortality were significantly different over the two time periods.

	Infant Mortality	
	SIR	95% C. I.
Flint		
2010 Q1 - 2014 Q2	1.17	[0.94, 1.43]
2014 Q3 - 2015 Q4	1.18	[0.77, 1.68]
Probability (2014 Q3 - 2015 Q4 > 2010 Q1 - 2014 Q2)	0.49	
2010 Q1 - 2014 Q2		
Flint	1.17	[0.94, 1.43]
Saginaw	1.25	[0.92, 1.65]
Probability (SIR Flint > SIR Saginaw)	0.36	
2014 Q3 - 2015 Q4		
Flint	1.17	[0.75, 1.68]
Saginaw	1.61	[0.95, 2.43]
Probability (SIR Flint > SIR Saginaw)	0.16	
2010 Q1 - 2014 Q2		
Flint	1.17	[0.94, 1.43]
Detroit	1.21	[1.12, 1.31]
Probability (SIR Flint > SIR Detroit)	0.37	
2014 Q3 - 2015 Q4		
Flint	1.18	[0.76, 1.68]
Detroit	1.31	[1.14, 1.50]
Probability (SIR Flint > SIR Detroit)	0.28	

Table 2: Standardized Incidence Ratios of Infant Mortality in Flint, 2010-2015

	Infant Mortality	
	SIR	95% C. I.
2010 Q1 - 2014 Q2		
Flint	1.17	[0.94, 1.43]
Grand Rapids	1.10	[0.91, 1.31]
Probability (SIR Flint > SIR Grand Rapids)	0.67	
2014 Q3 - 2015 Q4		
Flint	1.18	[0.76, 1.69]
Grand Rapids	0.90	[0.61, 1.24]
Probability (SIR Flint > SIR Grand Rapids)	0.84	
2010 Q1 - 2014 Q2		
Flint	1.17	[0.94, 1.43]
Lansing	0.99	[0.76, 1.25]
Probability (SIR Flint > SIR Lansing)	0.85	
2014 Q3 - 2015 Q4		
Flint	1.18	[0.76, 1.68]
Lansing	1.09	[0.69, 1.57]
Probability (SIR Flint > SIR Lansing)	0.60	

Results --- Stillbirth

Method 1: There was not enough evidence to indicate that the estimated stillbirth rates were significantly different over the two time periods.

Table 6: Stillbirth Rate per 1,000 Live Birth in Flint, 2012-2015

	# Live Births	# Stillbirth	Stillbirth Rate per 1,000 Live Births	95% C. I.
07/01/2012 --- 12/31/2013	2348	25	10.65	(6.50, 14.80)
07/01/2014 --- 12/31/2015	2121	24	11.32	(6.81, 15.82)
P-value	0.83			

Results --- Stillbirth

Method 2: There was not enough evidence to indicate that the estimated standardized incidence ratios for stillbirth were significantly different over the two time periods.

Table 4: Standardized Incidence Ratios of Stillbirth in Flint, 2010-2015

	Stillbirth		
	N	SIR	95% C. I.
Overall			
2010 Q1 - 2014 Q2	78	1.48	[1.18, 1.84]
2014 Q3 - 2015 Q4	24	1.84	[1.24, 2.75]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.25	[0.79, 1.97]
White Non-Hispanic			
2010 Q1 - 2014 Q2	26	2.46	[1.68, 3.62]
2014 Q3 - 2015 Q4	4	1.32	[0.50, 3.52]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		0.54	[0.19, 1.54]
Black Non-Hispanic			
2010 Q1 - 2014 Q2	44	1.11	[0.82, 1.49]
2014 Q3 - 2015 Q4	15	1.60	[0.96, 2.65]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.44	[0.80, 2.59]

Results --- Stillbirth

Method 3: There was not enough evidence to indicate that the estimated standardized incidence ratios for stillbirth were significantly different over the two time periods.

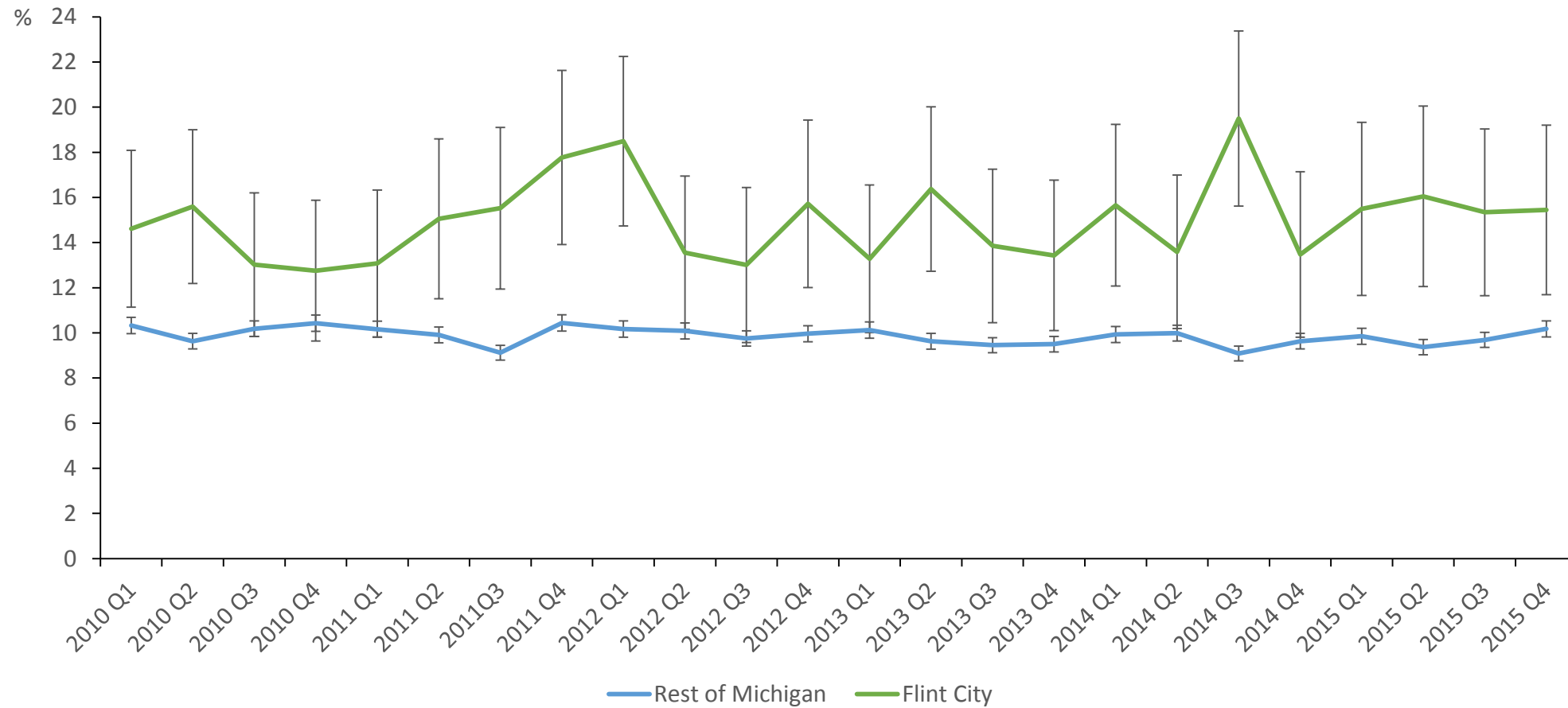
	Stillbirth	
	SIR	95% C. I.
Flint		
2010 Q1 - 2014 Q2	1.47	[1.16, 1.81]
2014 Q3 - 2015 Q4	1.83	[1.18, 2.65]
Probability (2014 Q3 - 2015 Q4 > 2010 Q1 - 2014 Q2)	0.81	
2010 Q1 - 2014 Q2		
Flint	1.47	[1.16, 1.81]
Saginaw	1.13	[0.76, 1.57]
Probability (SIR Flint > SIR Saginaw)	0.90	
2014 Q3 - 2015 Q4		
Flint	1.83	[1.18, 2.65]
Saginaw	1.29	[0.58, 2.25]
Probability (SIR Flint > SIR Saginaw)	0.83	
2010 Q1 - 2014 Q2		
Flint	1.47	[1.16, 1.81]
Detroit	1.03	[0.93, 1.14]
Probability (SIR Flint > SIR Detroit)	0.99	
2014 Q3 - 2015 Q4		
Flint	1.83	[1.18, 2.65]
Detroit	0.70	[0.56, 0.87]
Probability (SIR Flint > SIR Detroit)	1.00	

Table 5: Standardized Incidence Ratios of Stillbirth in Flint, 2010-2015

	Stillbirth	
	SIR	95% C. I.
2010 Q1 - 2014 Q2		
Flint	1.47	[1.16, 1.81]
Grand Rapids	1.19	[0.96, 1.44]
Probability (SIR Flint > SIR Grand Rapids)	0.92	
2014 Q3 - 2015 Q4		
Flint	1.83	[1.18, 2.65]
Grand Rapids	1.17	[0.78, 1.64]
Probability (SIR Flint > SIR Grand Rapids)	0.94	
2010 Q1 - 2014 Q2		
Flint	1.47	[1.16, 1.81]
Lansing	1.04	[0.77, 1.34]
Probability (SIR Flint > SIR Lansing)	0.98	
2014 Q3 - 2015 Q4		
Flint	1.83	[1.18, 2.65]
Lansing	1.54	[0.97, 2.23]
Probability (SIR Flint > SIR Lansing)	0.72	

Results --- Preterm Birth

Incidence of Preterm Birth in Flint City and the Rest of Michigan, 2010-2015



Results --- Preterm Birth

Method 1: There was not enough evidence to indicate that the estimated incidences of preterm birth were significantly different over the two time periods.

Table 9: Incidence of Preterm Birth in Flint, 2012-2015

	# Live Births	# Preterm Birth	Incidence of Preterm Birth (%)	95% C. I.
07/01/2012 --- 12/31/2013	2348	335	14.27	(12.85, 15.68)
07/01/2014 --- 12/31/2015	2121	339	15.98	(14.42, 17.54)
P-value	0.11			

Results --- Preterm Birth

Method 2: There was not enough evidence to indicate that the estimated standardized incidence ratios for preterm birth were significantly different over the two time periods.

Table 7: Standardized Incidence Ratios of Preterm Birth in Flint, 2010-2015

	Preterm Birth		
	N	SIR	95% C. I.
Overall			
2010 Q1 - 2014 Q2	1058	1.21	[1.14, 1.29]
2014 Q3 - 2015 Q4	339	1.35	[1.22, 1.50]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.12	[0.99, 1.26]
White Non-Hispanic			
2010 Q1 - 2014 Q2	314	1.43	[1.28, 1.60]
2014 Q3 - 2015 Q4	106	1.75	[1.45, 2.12]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.23	[0.98, 1.53]
Black Non-Hispanic			
2010 Q1 - 2014 Q2	705	1.15	[1.07, 1.24]
2014 Q3 - 2015 Q4	219	1.22	[1.07, 1.39]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.06	[0.91, 1.24]

Results --- Preterm Birth

Method 3: There was not enough evidence to indicate that the estimated standardized incidence ratios for preterm birth were different over the two time periods.

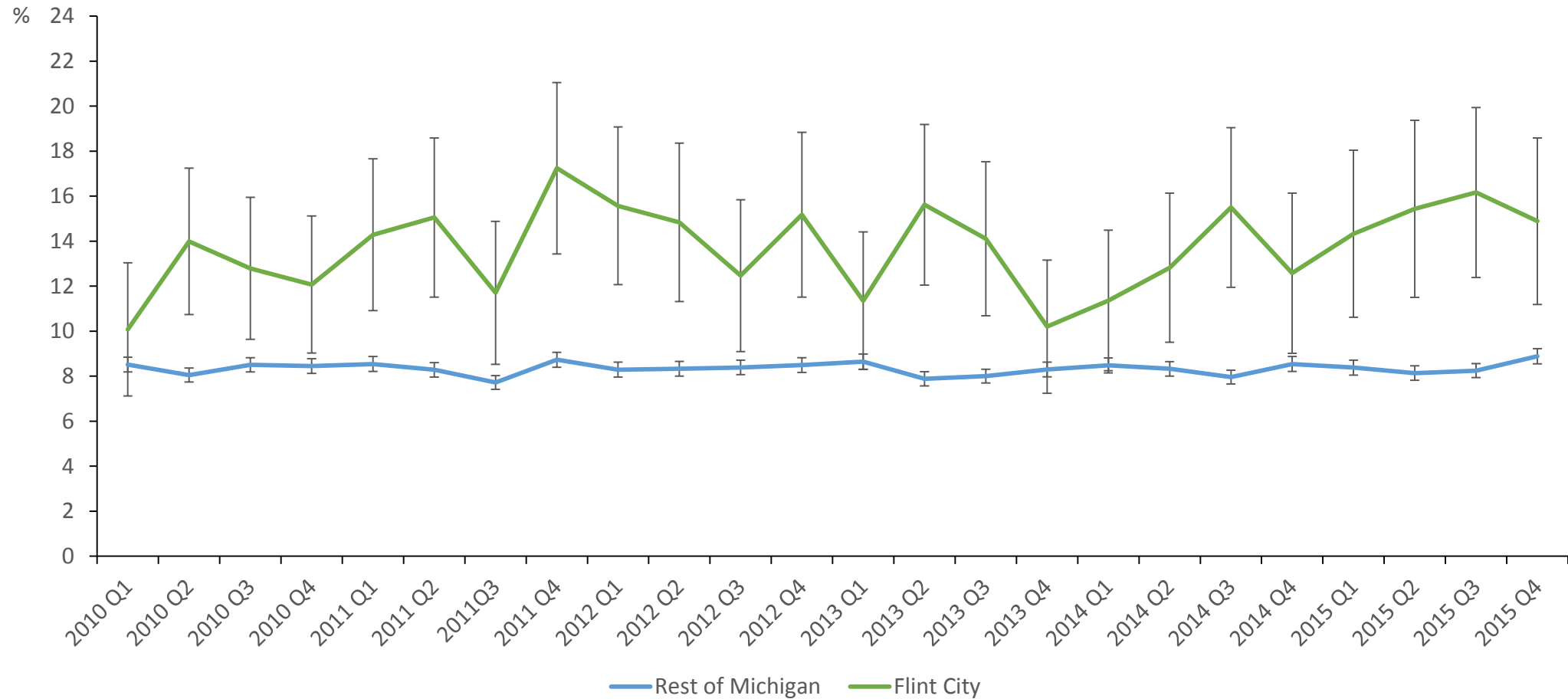
	Preterm Birth	
	SIR	95% C. I.
Flint		
2010 Q1 - 2014 Q2	1.21	[1.14, 1.29]
2014 Q3 - 2015 Q4	1.35	[1.21, 1.50]
Probability (2014 Q3 - 2015 Q4 > 2010 Q1 - 2014 Q2)	0.96	
2010 Q1 - 2014 Q2		
Flint	1.21	[1.14, 1.29]
Saginaw	0.85	[0.77, 0.94]
Probability (SIR Flint > SIR Saginaw)	1.00	
2014 Q3 - 2015 Q4		
Flint	1.35	[1.21, 1.50]
Saginaw	0.91	[0.76, 1.08]
Probability (SIR Flint > SIR Saginaw)	1.00	
2010 Q1 - 2014 Q2		
Flint	1.21	[1.14, 1.29]
Detroit	1.08	[1.06, 1.11]
Probability (SIR Flint > SIR Detroit)	1.00	
2014 Q3 - 2015 Q4		
Flint	1.35	[1.21, 1.50]
Detroit	1.07	[1.02, 1.11]
Probability (SIR Flint > SIR Detroit)	1.00	

Table 8: Standardized Incidence Ratios of Preterm Birth in Flint, 2010-2015

	Preterm Birth	
	SIR	95% C. I.
2010 Q1 - 2014 Q2		
Flint	1.21	[1.14, 1.29]
Grand Rapids	1.01	[0.96, 1.07]
Probability (SIR Flint > SIR Grand Rapids)	1.00	
2014 Q3 - 2015 Q4		
Flint	1.35	[1.21, 1.50]
Grand Rapids	1.01	[0.92, 1.11]
Probability (SIR Flint > SIR Grand Rapids)	1.00	
2010 Q1 - 2014 Q2		
Flint	1.21	[1.14, 1.29]
Lansing	0.98	[0.91, 1.05]
Probability (SIR Flint > SIR Lansing)	1.00	
2014 Q3 - 2015 Q4		
Flint	1.35	[1.21, 1.50]
Lansing	1.04	[0.93, 1.16]
Probability (SIR Flint > SIR Lansing)	0.999	

Results --- Low Birthweight

Incidence of Low Birthweight in Flint City and the Rest of Michigan, 2010-2015



Results --- Low Birthweight

Method 1: There was not enough evidence to indicate that the estimated incidences of low birthweight were significantly different over the two time periods.

Table 12: Incidence of Low Birthweight in Flint, 2012-2015

	# Live Births	# Low Birthweight	Incidence of Low Birthweight (%)	95% C. I.
07/01/2012 --- 12/31/2013	2348	308	13.12	(11.75, 14.48)
07/01/2014 --- 12/31/2015	2121	315	14.85	(13.34, 16.36)
P-value	0.09			

Results --- Low Birthweight

Method 2: There was not enough evidence to indicate that the estimated standardized incidence ratios for preterm birth were significantly different over the two time periods.

Table 10: Standardized Incidence Ratios of Low Birthweight in Flint, 2010-2015

	Low Birthweight		
	N	SIR	95% C. I.
Overall			
2010 Q1 - 2014 Q2	963	1.19	[1.12, 1.27]
2014 Q3 - 2015 Q4	315	1.28	[1.15, 1.43]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.08	[0.95, 1.22]
White Non-Hispanic			
2010 Q1 - 2014 Q2	258	1.52	[1.35, 1.72]
2014 Q3 - 2015 Q4	87	1.82	[1.47, 2.24]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.19	[0.94, 1.52]
Black Non-Hispanic			
2010 Q1 - 2014 Q2	669	1.11	[1.03, 1.19]
2014 Q3 - 2015 Q4	218	1.16	[1.02, 1.32]
2014 Q3 - 2015 Q4 vs 2010 Q1 - 2014 Q2		1.05	[0.90, 1.22]

Results --- Low Birthweight

Method 3: There was not enough evidence to indicate that the estimated standardized incidence ratios for low birthweight were different over the two time periods.

	Low Birthweight	
	SIR	95% C. I.
Flint		
2010 Q1 - 2014 Q2	1.19	[1.12, 1.27]
2014 Q3 - 2015 Q4	1.29	[1.15, 1.43]
Probability (2014 Q3 - 2015 Q4 > 2010 Q1 - 2014 Q2)	0.87	
2010 Q1 - 2014 Q2		
Flint	1.19	[1.12, 1.27]
Saginaw	0.42	[0.38, 0.46]
Probability (SIR Flint > SIR Saginaw)	1.00	
2014 Q3 - 2015 Q4		
Flint	1.28	[1.15, 1.43]
Saginaw	1.15	[0.97, 1.34]
Probability (SIR Flint > SIR Saginaw)	0.87	
2010 Q1 - 2014 Q2		
Flint	1.19	[1.12, 1.27]
Detroit	1.08	[1.05, 1.11]
Probability (SIR Flint > SIR Detroit)	1.00	
2014 Q3 - 2015 Q4		
Flint	1.28	[1.15, 1.43]
Detroit	1.10	[1.10, 1.15]
Probability (SIR Flint > SIR Detroit)	0.99	

Table 11: Standardized Incidence Ratios of Low Birthweight in Flint, 2010-2015

	Low Birthweight	
	SIR	95% C. I.
2010 Q1 - 2014 Q2		
Flint	1.19	[1.12, 1.27]
Grand Rapids	1.05	[1.00, 1.11]
Probability (SIR Flint > SIR Grand Rapids)	1.00	
2014 Q3 - 2015 Q4		
Flint	1.28	[1.15, 1.43]
Grand Rapids	1.06	[0.96, 1.16]
Probability (SIR Flint > SIR Grand Rapids)	0.995	
2010 Q1 - 2014 Q2		
Flint	1.19	[1.12, 1.27]
Lansing	1.02	[0.95, 1.09]
Probability (SIR Flint > SIR Lansing)	1.00	
2014 Q3 - 2015 Q4		
Flint	1.28	[1.15, 1.43]
Lansing	0.99	[0.87, 1.12]
Probability (SIR Flint > SIR Lansing)	0.999	

Conclusions

- Method 1 indicates that there were no significant increases (at $\alpha=0.05$) in the rates of infant mortality, stillbirth, preterm birth and low birthweight across the two time periods.
- When comparing Flint to the rest of the State (method 2), Flint reported higher rates of stillbirth, preterm birth and low birthweight in both the pre and post water source change time periods.
- There is evidence of an increase in preterm birth within the City of Flint three months after the water source change (2014 Q3), but this rate returned to pre water source change levels for the subsequent quarters.
- Quarterly low birthweight incidence in Flint remained high both before and after the water source change.
- Within Flint, method 2 indicates an increase in the standardized incidence ratios overall and among non-Hispanic Black infants for stillbirth, preterm birth and low birthweight during the post water change period, but none of these increases were statistically significant (at $\alpha=0.05$).
- Method 3 shows similar results to that of method 2. In addition, in both periods, the risk of stillbirth, preterm birth and low birthweight in Flint were higher compared to the cities of Detroit, Grand Rapids, Lansing, and Saginaw, respectively.

Next Steps

- Due to study population demographic differences between the pre and post water change time periods, additional analyses that adjust for these differences are needed.
- MDHHS is currently collaborating with the CDC to prepare these analyses for peer review.
- Analyses of additional post water change time periods will be completed as necessary data become available.