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Data-Driven Birth Outcomes Objectives for a Community Health Improvement Plan

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Abstract

Purpose: To identify factors associated with poor birth outcomes in four Montgomery County, Ohio zip codes identified as priority areas for public health intervention.

Methods: A cross-sectional study was conducted using data from zip codes 45415 (*N*=267), 45416 (*N*=158), 45417 (*N*=1,104) & 45426 (*N*=571) in Montgomery County, Ohio from 2013 – 2015. The outcome was birth weight. Predictor variables included maternal demographics and behavioral variables. Multiple linear regression was used to test for associations.

Results: Children of White mothers had greater mean birth weight compared to children of non-White mothers in all four zip codes; it was statistically significant in three of the zip codes (45415, 45416, 45417). A greater mean number of cigarettes smoked during pregnancy was relatively associated with a decrease in mean birth weight across the four zip codes; this association was statistically significant in zip code 45417. Although Apgar scores and breastfeeding status were statistically significantly associated with changes in mean birth weight, they were found to be un-fit predictors of birth weight as they both occur after a child's birth. Maternal age, education level, marital status, WIC participation, payment method for birth of child, month prenatal care began and type of doctor attending to birth were not significantly associated with birth weight.

Conclusion: Maternal race and smoking are significantly associated with changes in birth weight; these significant associations can be used to guide the development of birth outcomes-related Community Health Improvement Plan (CHIP) objectives and funding allocations to improve birth outcomes.

Keywords: public health, birth outcomes, birth weight, CHNA, CHIP

Data-Driven Birth Outcomes Objectives for a Community Health Improvement Plan

The Community Health Needs Assessment (CHNA) and Community Health Improvement Plan (CHIP) process is a new requirement for all non-profit hospital systems as set forth in the Patient Protection and Affordable Care Act (ACA) of 2010 (see https://www.congress.gov/bill/111th-congress/house-bill/3590) (Stall, Anderson, Fadel, & Goodman, 2012). The new mandate to conduct a health assessment of the community was effective as of March 23, 2012 (Stall et al., 2012). The CHNA is an assessment identifying the health needs of the people the particular hospital system serves. The hospitals are then required to prioritize each of the identified needs and determine a plan of action as to how each need will be addressed within their respective community, which is what constitutes the CHIP. Local and state health departments are also required to complete a community health plan, known as the Community Health Assessment (CHA) as well as a CHIP. (See Montgomery County, Ohio's local CHA and CHIP created by Public Health – Dayton & Montgomery at www.phdmc.org.) It is vital that the CHNAs and CHAs within jurisdictions align in their identified priorities and work collaboratively to improve the health of the community.

Premier Health (https://www.premierhealth.com), one of two major health systems in the greater Dayton area and Miami Valley Region,[1] is one of many hospital systems affected by the new federal mandate. The Premier Health system includes five hospitals, six emergency centers, four outpatient surgery centers, and a multitude of primary care and specialty physician offices throughout the region. An opportunity to become involved with the CHNA and CHIP for Premier was presented and is the focus of this culminating experience. One of the identified priority areas in terms of health in the surrounding region was poor birth outcomes.

[1] The other is Kettering Health Network, http://www.ketteringhealth.org.

Statement of Purpose

The purpose of this study was to identify clinical and demographic, socio-demographic factors that affect birth outcomes in specific Montgomery County, Ohio zip codes. Birth weight was used as the indicator for measuring birth outcomes. The results of the data analysis can be used to guide in the development of birth outcomes-oriented, data-driven objectives for Premier Health's CHIP, the second step in the community health planning process following the publishing of the CHNA. Additionally, the results of this data analysis could be used to make data-driven decisions as to where to best allocate health system funds to improve birth outcomes within the four zip codes under study.

Review of Literature

The following literature review addresses the exposures of interest as they relate to birth outcomes. For purposes of this study, we were interested in the relationships between each exposure variable and the outcomes of interest – adverse birth outcomes measured by birth weight as the indicator.

Maternal Race

Racial disparities are well documented among American minorities and these disparities often result in differential outcomes in preventable diseases, death, and disability (Centers for Disease Control and Prevention, 2016). For the purpose of this literature review, racial disparities were examined in regards to maternal and infant race and its relation to birth outcomes. The findings in the review of research were consistent – birth outcomes differed by the mother's race, with African Americans being disproportionately and negatively affected (Lorch, Kroelinger, Ahlberg, & Barfield, 2012; MacDorman, 2011; Wingate & Barfield, 2010; Reddy, Ko, & Willinger, 2006; Kramer & Hogue, 2009). An American study done on preterm birth found that more than 16% of African American infants were born preterm, whereas only 10% of Caucasian infants were preterm (Kramer & Hogue, 2009). Additionally, multiple studies found that fetal mortality rates for non-Hispanic Black or African-American women were roughly twofold of those for non-Hispanic Caucasian women (Lorch et al., 2012; MacDorman, 2011; Wingate & Barfield, 2010; Reddy et al., 2006). A March of Dimes report stated that the infant mortality rate for African Americans was almost two times that of Caucasians, and the rates for American Indians and Puerto Ricans were also higher than that of Caucasians (Mathews & MacDorman, 2013). The consistency in research findings provided evidence that race indeed impacts birth outcomes.

Maternal Age

Over time, the average childbearing age in the United States has increased, as more and more mothers have chosen to delay when they have children (United States Department of Health and Human Services [HHS], Health Resource and Services Administration, Maternal and Child Health Bureau, 2013). Therefore, a greater proportion of pregnancies are now occurring to mothers of increased ages. In contrast, the number of teenagers and adolescents having children in the United States has decreased, although pregnancy rates for this age group are still well above those of other developed countries (HHS, Office of Adolescent Health, 2016). A review of studies that examined maternal age and its effect on birth outcomes found significant associations between the two. Research shows that women at both extremes of the maternal age spectrum (younger than 26 and older than 30 years) were at an increased risk of experiencing adverse birth outcomes such as stillbirth, preterm birth, infant death, congenital anomalies and low birth weight (Weng, Yang, & Chiu, 2014). Another study noted that a greater proportion of young mothers were African American, of low socioeconomic status, and were more likely to use tobacco products, which could possibly act as confounding factors in the relationship, and is an important finding to consider in future research (Warshak et al., 2013). Other studies noted that women of increasing maternal age are also at an increased risk of experiencing negative health outcomes such as hypertension and diabetes, which could in turn affect their pregnancy outcomes and act as confounding factors (Fretts, Schmittdiel, Mclean, Usher, & Goldman, 1995; Reddy et al., 2006).

Maternal Marital Status

An article in *TIME* Magazine explained how studies over time have found that marriage is good for one's health (Luscombe, 2015). Research has shown that the marital status of a mother during pregnancy is associated with birth outcomes, both positively and negatively (Balayla, Azoulay, & Abenhaim, 2011; Raatikainen, Heiskanen, & Heinonen, 2005; Shah, Zao, & Ali, 2010). Multiple studies found that being an unmarried mother was associated with greater chances of poor birth outcomes including low birth weight, preterm birth, and small for gestational age (Raatikainen et al., 2005; Shah et al., 2010).

Maternal Education Level

Socioeconomic status (SES) is defined as the "social standing or class of an individual or group...[and is] often measured as a combination of education, income and occupation" (American Psychological Association, 2017, Socioeconomic Status section, first paragraph). In the field of public health, and as identified by Healthy People 2020 (n.d.a, Understanding Social Determinants of Health), SES is deemed a social determinant of health. SES is just one of many determinants that impact our well-being and daily health; it impacts a person's environment, the affordability and accessibility of needed commodities, and more. Educational attainment is one factor used in determining a person's SES. For purposes of this study, maternal education level will be used as the indicator for mother's SES. Studies have found that maternal educational attainment indeed impacts birth outcomes. Two studies found that mothers with lower levels of educational attainment were more likely to experience adverse birth outcomes (Luo, Wilkins, & Kramer, 2006; Luque-Fernandez, Lone, Gutierrez-Garitano, & Bueno-Cavanillas, 2011). The findings in each of the aforementioned studies were consistent with public health findings that have shown lower levels of education are associated with poorer health outcomes (World Health Organization, 2016).

Prenatal Care

Prenatal care is vital to the health of both mother and baby throughout a pregnancy, as it is an opportunity for the mother to become better educated and equipped for both pregnancy and motherhood, and in turn promotes a healthy pregnancy and reduces risk for potential complications (Eunice Kennedy Shriver National Institute of Child Health and Human Development, n.d.). During prenatal care, a woman is provided consultation on a number of important topics including: proper diet, exercise, abstaining from behaviors that could adversely affect the health of the baby's development, how to and the benefits of breastfeeding, proper weight gain, education on injury and illness prevention, and more (Child Trends, 2015). All of the aforementioned factors contribute to a healthier pregnancy and better birth outcomes (Child Trends, 2015).

Breastfeeding Status

There are many benefits to breastfeeding babies. Breastfeeding provides the child with nutrients that are essential to building immunity and reducing the risk of illness (HHS, Office on Women's Health, 2014). According to the United States' Office on Women's Health, research has shown that babies who were breastfed had lower risk of the following: asthma, Type 2 diabetes, childhood obesity, infection, SIDS and more. Breastfeeding is associated with better health outcomes for both mother and infant (Dieterich, Felice, O'Sullivan, & Rasmussen, 2013). The aforementioned study by Dieterich, Felice, O'Sullivan, and Rasmussen (2015) cited another study that found that "if 90% of US families could comply with the medical recommendations to breastfeed exclusively for 6 months, the United States could save $13 billion per year and prevent an excess 911 deaths annually, 95% of which would be of infants" (Bartick & Reinhold, 2010, e1052).

WIC (Special Supplemental Nutrition Program for Women, Infants, and Children)

WIC is a program through the United States Department of Agriculture (USDA) Food and Nutrition Service. Funding is provided at the state level for local health departments to sponsor the WIC program (United States Department of Agriculture (USDA), Food & Nutrition Service, 2017). WIC provides a number of services including supplemental nutrition items, nutrition education, breastfeeding support, and additional referrals to those women who are pregnant or who have children up to the age of five (USDA, Food & Nutrition Service, 2017). Eligibility is determined by a combination of factors, including: pregnant, postpartum, and breastfeeding women with children up to the age of five years, income level, and whether or not the family is deemed at nutritional risk (USDA, Food & Nutrition Service, 2017). A retrospective cohort study looking at women in Hamilton County, Ohio found that those women who utilized WIC during their pregnancy were less likely to experience an infant death compared to those women who did not utilize WIC, and furthermore, African-American women utilizing WIC were significantly less likely to experience an infant death than those African-American women who were not enrolled (Khanani, Elam, Hearn, Jones, & Maseru, 2010). Therefore WIC appears to act as a protective factor against poor birth outcomes based on the review of existing literature.

Gestational Age

Gestational age is an important predictor of birth outcomes. Gestational age is the measure of the length of a pregnancy, with normal pregnancies being 38 to 42 weeks in length (Kaneshiro, Zieve, & Ogilvie, 2015). Dr. Konald Prem (1976) found that mortality rates decrease with increasing gestational age. Preterm birth is a common term associated with gestational age, as a preterm birth is a baby born before 37 weeks, which is deemed too early (Kaneshiro et al., 2015). Preterm birth is, in turn, often synonymous with poor birth outcomes (New York State Department of Health, Bureau of Women, Infant and Adolescent Health, 2015). However, for purposes of the following study, we chose to use birth weight as the indicator of birth outcomes.

Apgar Scores

The Apgar score was developed in the early 1950s by an anesthesiologist named Virginia Apgar. Dr. Apgar's goal in creating this scoring methodology was a measurement system that could assess the clinical status of infants in the first few minutes of their life (American College of Obstetricians and Gynecologists, 2015). Apgar scores are calculated on a scale of zero through 10, with 10 equating to the highest score (Hirsch, 2014). The Apgar test assesses the following factors on the infant at five minute intervals post-birth: skin color, heart rate, reflexes, muscle tone, and breathing abilities, with each factor being out of a possible two points (Hirsch, 2014). A ten-year retrospective cohort study found that of 13,399 infants born before term who scored an Apgar of zero through three at five minutes had a neonatal death incidence of 315 per 1,000 preterm infants (Casey, McIntire, & Leveno, 2001). However, the study found that infants born before term who scored an Apgar score of seven or greater at the five minute mark experienced a significantly lower incidence of neonatal death: only five per 1,000 preterm infants (Casey et al., 2001). The aforementioned study therefore demonstrated an association between lower Apgar scores and poor birth outcomes. However there is very little other existing research on Apgar scores and their association with other birth outcomes.

Birth Weight

Birth weight is another important predictor of birth outcomes, and will be used as a proxy for birth outcomes in general in this study. A study published in the *International Journal of Epidemiology* depicted the relationship between birth weight and mortality as a J curve: mortality rates are much higher at extremely low birth weights and decrease with increasing weight and then begin to rise again at extremely high birth weights (Wilcox, 2001). Child Health USA 2011 cites low birth weight as a leading contributor to neonatal mortality rates (HHS, Health Resources and Services Administration, Maternal and Child Health Bureau, 2011). Based on this association as identified in many research studies, Healthy People 2020 (n.d.b) has set a goal to decrease infant mortality rates by decreasing the number of low birth weight babies born.

Methods

A cross-sectional study was conducted using data obtained from Public Health – Dayton & Montgomery County's live birth datasets for the years 2013, 2014, and 2015. Personal information was de-identified prior to receiving the data for confidentiality purposes and to ensure compliance with the Health Insurance Portability and Accountability Act (HIPAA) (United States, 2004; see https://www.hhs.gov/hipaa/). The study analyzed de-identified data, which made it exempt from review by the Wright State University Institutional Review Board

(Appendix A). Study participants included infants and their mothers living in four Montgomery County, Ohio zip codes 45415 (*N*=267), 45416 (*N*=158), 45417 (*N*=1,104), and 45426 (*N*=571). Analysis was performed using the Statistical Package for the Social Sciences (SPSS) (IBM SPSS Statistics for Windows, Version 23.0, Armonk, NY: IBM Corp., 2015). Frequencies were computed for categorical variables (*n*, %) and descriptive statistics (mean and standard deviation) were computed for the continuous variables to provide a summary of the data analyzed. Subjects with missing data on any analysis variable were excluded from the study sample for analysis purposes. Multiple linear regression was used to test for associations between the predictor variables and the outcome of interest, *birth weight* (grams). Separate models were fit for each of the four zip codes. Predictor variables included: maternal age (years), race (White, non-White), education level (<high school degree, high school diploma or General Education Diploma (GED), and some college or more), maternal marital status (married, non-married), breastfeeding status at the time of birth (yes/no), WIC use (yes/no), Apgar score at five minutes, average number of cigarettes smoked during pregnancy, attending physician at birth (Doctor of Medicine (MD), Doctor of Osteopathic Medicine (DO), other), payment method (Medicaid, other), and month prenatal care began (1^{st} – 2^{nd} month, 3^{rd} month, 4^{th} month, 5^{th} month or more). Multiple linear regression results were interpreted using the coefficient (β) as a measure of the effect size and the p-value to determine whether the association was statistically significant. When the predictor variable was categorical, a β of greater than zero indicates the mean outcome is greater in that particular category than it is in the referent category. For continuous predictor variables, a β greater than zero means there is a positive association between the predictor variable and outcome. All tests were two-sided and conducted at the α = 0.05 level of significance.

Results

Characteristics of the study sample within the four zip codes are outlined in Table 1. The average age range of mothers in the four zip codes was roughly 25 years to 27 years old. In all zip codes except 45415, over half of mothers had only attained a high school diploma/GED or less. The predominant race category in all four zip codes was non-White. Over half of all mothers in each zip code were breastfeeding at the time of discharge. In regards to month prenatal care began, over half of mothers in each zip code had begun care in the third month or earlier. Across each zip code, a large percentage of mothers had participated in WIC. The primary method of payment for birth in each zip code was Medicaid. Most mothers in each zip code had an MD attending to the birth of their child. The average number of cigarettes smoked by mothers during pregnancy ranged from one to two cigarettes in each zip code. Lastly, the average Apgar score at five minutes in each zip code ranged from 8.59 to 8.75.

Table 1

Characteristics of the Study Sample, by Zip Code

Zip Code (*N*)	**45415** (267)	**45416** (158)	**45417** (1,104)	**45426** (571)
Maternal age, mean ± SD	27.65 ± 5.54	26.07 ± 5.53	25.21 ± 5.42	25.93 ± 5.14
Maternal education, *n*, %				
< High School Degree	29, 10.9	27, 17.1	325, 29.4	92, 16.1
High School Diploma or GED	61, 22.8	63, 39.9	412, 37.3	212, 37.1
Some College or More	177, 66.3	68, 43.0	367, 33.2	267, 46.8
Maternal race, n, %				
White	128, 47.9	31, 19.6	201, 18.2	90, 15.8
Non-White	139, 52.1	127, 80.4	903, 81.8	481, 84.2
Marital status, *n*, %				
Married	132, 49.4	34, 21.5	167, 12.9	117, 20.5
Not Married	135, 50.6	124, 78.5	1123, 87.1	454, 79.5
Breastfeeding at time of discharge, *n*, %				
Yes	204, 76.4	83, 52.5	593, 53.7	361, 63.2
No	63, 23.6	75, 47.5	511, 46.3	210, 36.8
Month prenatal care began, *n*, %				
1^{st} – 2^{nd} month	100, 37.5	52, 32.9	313, 28.4	193, 33.8
3^{rd} month	104, 39.0	50, 31.6	361, 32.7	189, 33.1
4^{th} month	26, 9.7	19, 12.0	167, 15.1	83, 14.5
5^{th} month + / none	37, 13.9	37, 23.4	263, 23.8	106, 18.6
WIC participation, n, %				
Yes	109, 40.8	97, 61.4	778, 70.5	356, 62.3
No	158, 59.2	61, 38.6	326, 29.5	215, 37.7
Payment method for birth, *n*, %				
Medicaid	134, 50.2	122, 77.2	934, 84.6	395, 69.2
Other	133, 49.8	36, 22.8	170, 15.4	176, 30.8
Type of doctor attending to birth, *n*, %				
MD	199, 74.5	123, 77.8	863, 78.2	430, 75.3
DO	41, 15.4	22, 13.9	173, 15.7	91, 15.9
Other	27, 10.1	13, 8.2	68, 6.2	50, 8.8
Mean # cigarettes smoked during pregnancy, mean ± SD	1.02 ± 3.39	1.31 ± 3.66	2.06 ± 4.66	1.21 ± 4.34
Apgar at five minutes, mean ± SD	8.72 ± 1.10	8.59 ± 1.34	8.75 ± 1.04	8.74 ± 0.87

Note: SD = standard deviation; GED = General Education Development; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; MD = Doctor of Medicine; DO = Doctor of Osteopathic Medicine.

Zip Code 45415

The multiple linear regression results for zip code 45415 are presented in Table 2. The difference in mean birth weight between children of White mothers and children of non-White mothers was 283.68g, and this difference was statistically significant (p<.001). The difference in mean birth weight between mothers who were not breastfeeding at time of discharge and those mothers who were breastfeeding was -271.04g. This breastfeeding association was statistically significant (p=.004). For every one-unit increase in Apgar score at five minutes, mean birth weight increased by 199.27g, and this association was statistically significant (p<.001). Maternal level of education, marital status, month prenatal care began, WIC participation, payment method for birth, type of doctor attending to birth, nor mean number of cigarettes smoked during pregnancy were statistically significantly associated with birth weight in zip code 45415.

Table 2

Multiple Linear Regression Results for Zip Code 45415

Independent variable	**Coefficient**	**95% CI**	***p*-value**
Intercept	1639.08	(859.08, 2419.08)	<.001
Maternal age	-6.40	(-21.57, 8.77)	0.407
Maternal education			0.304
< High School Degree	183.28	(-76.61, 443.17)	0.166
High School Diploma or GED	-17.12	(-197.57, 163.32)	0.852
Some College or More	(ref)	---	---
Maternal race			
White	283.68	(127.73, 439.63)	<.001
Non-White	(ref)	---	---
Marital status			
Married	41.36	(-133.96, 216.67)	0.643
Not Married	(ref)	---	---
Breastfeeding at time of discharge			
Yes	(ref)	---	---
No	-271.04	(-455.63, -86.46)	.004
Month prenatal care began			0.889
1st – 2nd month	-81.19	(-310.32, 147.94)	0.486
3rd month	-32.26	(-260.38, 195.85)	0.781
4th month	-40.78	(-333.01, 251.44)	0.784
5th month + / none	(ref)	---	---
WIC participation			
Yes	(ref)	---	---
No	-21.45	(-199.88, 156.99)	0.813
Payment method for birth			
Medicaid	-43.36	(-223.56, 136.84)	0.636
Other	(ref)	---	---
Type of doctor attending to birth			0.240
MD	-23.45	(-256.78, 209.88)	0.843
DO	144.59	(-134.85, 424.03)	0.309
Other	(ref)	---	---
Mean # cigarettes smoked during pregnancy	-19.08	(-41.49, 3.34)	.095
Apgar at five minutes	199.27	(133.32, 265.21)	<.001

Note: SD = standard deviation; CI = confidence interval; ref = reference category; GED = General Education Development; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; MD = Doctor of Medicine; DO = Doctor of Osteopathic Medicine.

Zip Code 45416

Table 3 presents the multiple linear regression results for zip code 45416. While not statistically significant, the mean birth weight of children born to White mothers was 228.36g greater than children of non-White mothers. When looking at the association between month prenatal care began and birth weight, there were statistically significant associations. The difference in mean birth weight between mothers who began care in the third month and mothers who began in the fifth month or later was 275.48g, and this association was statistically significant (p=.039). Additionally, the difference in mean birth weight between mothers who began care in the first or second month compared to those mothers beginning in the fifth month or later was 286.18g, which was also a statistically significant association (p=.031). The difference in mean birth weight between births where the attending was an MD and where the attending was another medical professional was -411.73g and this association was statistically significant (p=.021). Lastly, a one unit increase in Apgar scores at five minutes was associated with a 270.37g increase in mean birth weight, and this association was statistically significant (p<.001). Maternal age, maternal level of education, race, marital status, breastfeeding status, WIC participation, payment method for birth, nor mean cigarettes smoked during pregnancy were statistically significantly associated with birth weight.

Table 3

Multiple Linear Regression Results for Zip Code 45416

Independent variable	Coefficient	95% CI	*p*-value
Intercept	694.38	(-324.74, 1713.51)	0.180
Maternal age	8.90	(-12.43, 30.22)	0.411
Maternal education			0.221
< High School Degree	-37.57	(-367.03, 291.89)	0.822
High School Diploma or GED	159.64	(-76.06, 395.34)	0.183
Some College or More	(ref)	---	---
Maternal race			
White	228.36	(-36.56, 493.29)	.091
Non-White	(ref)	---	---
Marital status			
Married	223.63	(-38.22, 485.49)	.094
Not Married	(ref)	---	---
Breastfeeding at time of discharge			
Yes	(ref)	---	---
No	-74.37	(-271.15, 122.40)	0.456
Month prenatal care began			.060
1st – 2nd month	286.18	(26.44, 545.93)	.031
3rd month	275.48	(13.96, 537.01)	.039
4th month	11.67	(-328.22, 351.56)	0.946
5th month + / none	(ref)	---	---
WIC participation			
Yes	(ref)	---	---
No	-99.09	(-296.61, 98.43)	0.323
Payment method for birth			
Medicaid	-117.11	(-355.44, 121.21)	0.333
Other	(ref)	---	---
Type of doctor attending to birth			.064
MD	-411.73	(-760.02, -63.44)	.021
DO	-314.98	(-729.17, 99.22)	0.135
Other	(ref)	---	---
Mean # cigarettes smoked during pregnancy	2.61	(-24.57, 29.79)	0.850
Apgar at five minutes	270.37	(198.33, 342.42)	<.001

Note: SD = standard deviation; CI = confidence interval; ref = reference category; GED = General Education Development; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; MD = Doctor of Medicine; DO = Doctor of Osteopathic Medicine.

Zip Code 45417

Table 4 describes the associations with birth weight found in zip code 45417. The mean birth weight of children born to White mothers was 197.81g greater than that for children born to non-White mothers, and this association was highly statistically significant ($p<.001$). A one-unit increase in mean number of cigarettes smoked during pregnancy was associated with a 14.09g decrease in mean birth weight, and this association was statistically significant ($p=.004$). A one-unit increase in Apgar scores at five minutes was associated with a 96.64g increase in mean birth weight, and this association was highly statistically significant ($p<.001$). Maternal age, maternal education, marital status, breastfeeding status, WIC participation, month prenatal care began, payment method for birth, nor type of doctor attending to birth were statistically significantly associated with birth weight in zip code 45417.

Table 4

Multiple Linear Regression Results for Zip Code 45417

Independent variable	Coefficient	95% CI	*p*-value
Intercept	2477.77	(2004.82, 2950.72)	<.001
Maternal age	-0.423	(-8.58, 7.73)	0.919
Maternal education			0.368
< High School Degree	0.61	(-113.22, 114.44)	0.992
High School Diploma or GED	-61.21	(-162.79, 40.36)	0.237
Some College or More	(ref)	---	---
Maternal race			
White	197.81	(82.33, 313.28)	.001
Non-White	(ref)	---	---
Marital status			
Married	93.65	(-43.70, 231.01)	0.181
Not Married	(ref)	---	---
Breastfeeding at time of discharge			
Yes	(ref)	---	---
No	9.83	(-77.10, 96.76)	0.824
Month prenatal care began			0.338
1st – 2nd month	4.79	(-111.85, 121.43)	0.936
3rd month	-79.80	(-191.95, 32.35)	0.163
4th month	1.82	(-133.16, 136.79)	0.979
5th month + / none	(ref)	---	---
WIC participation			
Yes	(ref)	---	---
No	-82.13	(-176.48, 12.22)	.088
Payment method for birth			
Medicaid	-58.84	(-180.67, 62.99)	0.344
Other	(ref)	---	---
Type of doctor attending to birth			0.365
MD	-91.92	(-263.70, 79.85)	0.294
DO	-142.18	(-339.93, 55.58)	0.159
Other	(ref)	---	---
Mean # cigarettes smoked during pregnancy	-14.09	(-23.64, -4.53)	.004
Apgar at five minutes	96.64	(57.19, 136.09)	<.001

Note: SD = standard deviation; CI = confidence interval; ref = reference category; GED = General Education Development; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; MD = Doctor of Medicine; DO = Doctor of Osteopathic Medicine.

Zip Code 45426

The multiple linear regression results for zip code 45426 are outlined in Table 5. A one-year increase in mother's age was associated with a decrease in mean birth weight of 11.35g and was just on the cusp of statistical significance (p=.051). In regards to race, the mean birth weight of children born to White mothers was 292.44g greater than children of non-White mothers, and this association was highly statistically significant (p<.001). When looking at the association between month prenatal care began and birth weight, the difference in mean birth weight between mothers who began care in the fourth month of pregnancy and mothers who began in the fifth month or later was -203.18g, a significant association (p=.029). The difference in mean birth weight between mothers who began care in the third month and mothers who began in the fifth month or later was -187.02g, and this association was also statistically significant (p=.015). The difference in mean birth weight between mothers who began care in the first or second month compared to those mothers beginning in the fifth month or later was 116.05g, but was not statistically significant (p=0.132). A one-unit increase in Apgar scores at five minutes was associated with a 222.86g increase in mean birth weight, and this association was highly statistically significant (p<.001). Maternal level of education, marital status, breastfeeding status, participation in WIC, payment method for birth, type of doctor attending to birth, nor mean number of cigarettes smoked during pregnancy were statistically significantly associated with birth weight.

Table 5

Multiple Linear Regression Results for Zip Code 45426

Independent variable	Coefficient	95% CI	*p*-value
Intercept	1780.77	(1137.73, 2423.80)	<.001
Maternal age	-11.35	(-22.74, 0.038)	.051
Maternal education			0.353
< High School Degree	-112.88	(-276.67, 50.91)	0.176
High School Diploma or GED	-7.30	(-126.56, 111.96)	0.904
Some College or More	(ref)	---	---
Maternal race			
White	292.44	(144.34, 440.54)	<.001
Non-White	(ref)	---	---
Marital status			
Married	131.92	(-16.11, 279.95)	.081
Not Married	(ref)	---	---
Breastfeeding at time of discharge			
Yes	(ref)	---	---
No	-51.49	(-164.74, 61.76)	0.372
Month prenatal care began			.066
1st – 2nd month	-116.05	(-267.01, 34.91)	0.132
3rd month	-187.02	(-337.34, -36.70)	.015
4th month	-203.18	(-384.96, -21.41)	.029
5th month + / none	(ref)	---	---
WIC participation			
Yes	(ref)	---	---
No	-60.83	(-172.67, 51.02)	0.286
Payment method for birth			
Medicaid	-24.36	(-147.09, 98.38)	0.697
Other	(ref)	---	---
Type of doctor attending to birth			0.195
MD	-166.59	(-352.91, 19.72)	.080
DO	-181.57	(-400.17, 37.03)	0.103
Other	(ref)	---	---
Mean # cigarettes smoked during pregnancy	-0.55	(-12.94, 11.84)	0.931
Apgar at five minutes	222.86	(163.75, 281.97)	<.001

Note: SD = standard deviation; CI = confidence interval; ref = reference category; GED = General Education Development; WIC = Special Supplemental Nutrition Program for Women, Infants, and Children; MD = Doctor of Medicine; DO = Doctor of Osteopathic Medicine.

Table 6 provides coefficients for each of the predictor variables by zip code. The results of this study show that in all four zip codes, children of White mothers had greater mean birth weight compared to children of non-White mothers. The difference in mean birth weight by race was statistically significant in three of the four zip codes (45415, 45416, 45417). Apgar scores at five minutes were significantly associated with birth weight in all four zip codes. With every one-unit increase in Apgar score, mean birth weight significantly increased by an average of 197.29g across the four zip codes. The month that prenatal care began was found to be significantly associated in only one of the four zip codes (45416); however the associations were in different directions across the four zip codes. For example, in zip code 45416, mean birth weight increased with earlier start of prenatal care, but in 45426, mean birth weight decreased with earlier start of care. In three of the four zip codes, children of mothers who did not breastfeed had lower mean birth weights compared to children of mothers who did breastfeed (see Table 6). Mean number of cigarettes smoked during pregnancy by the mother was associated with birth weight in three of the four zip codes. With every one additional cigarette smoked during pregnancy, mean birth weight decreased. Maternal age, education level, marital status, WIC participation, and payment method for birth were not significantly associated with birth weight, nor were the relationships in the same direction across zip codes.

Table 6

Comparison of Regression Coefficients by Zip Code

Independent variable	**45415** (*N*=267)	**45416** (*N*=158)	**45417** (*N*=1,104)	**45426** (*N*=571)
Intercept	1639.08	694.38	2477.77	1780.77
Maternal age	-6.40	8.90	-0.423	-11.35
Maternal education				
< High School Degree	183.28	-37.57	0.61	-112.88
High School Diploma or GED	-17.12	159.64	-61.21	-7.30
Some College or More	(ref)	(ref)	(ref)	(ref)
Maternal race				
White	**283.68**	228.36	**197.81**	**292.44**
Non-White	(ref)	(ref)	(ref)	(ref)
Marital status				
Married	41.36	223.63	93.65	131.92
Not Married	(ref)	(ref)	(ref)	(ref)
Breastfeeding at time of discharge				
Yes	(ref)	(ref)	(ref)	(ref)
No	**-271.04**	-74.37	9.83	-51.49
Month prenatal care began				
1^{st} – 2^{nd} month	-81.19	**286.18**	4.79	-116.05
3^{rd} month	-32.26	**275.48**	-79.80	-187.02
4^{th} month	-40.78	11.67	1.82	-203.18
5^{th} month + / none	(ref)	(ref)	(ref)	(ref)
WIC participation				
Yes	(ref)	(ref)	(ref)	(ref)
No	-21.45	-99.09	-82.13	-60.83
Payment method for birth				
Medicaid	-43.36	-117.11	-58.84	-24.36
Other	(ref)	(ref)	(ref)	(ref)
Type of doctor attending to birth				
MD	-23.45	-411.73	-91.92	-166.59
DO	144.59	-314.98	-142.18	-181.57
Other	(ref)	(ref)	(ref)	(ref)
Mean # cigarettes smoked during pregnancy	-19.08	2.61	**-14.09**	-0.55
Apgar at five minutes	**199.27**	**270.37**	**96.64**	**222.86**

*Bold coefficients were statistically significant ($p<.05$).

Note: GED stands for General Education Development; WIC stands for Special Supplemental Nutrition Program for Women, Infants, and Children; MD stands for Doctor of Medicine; DO stands for Doctor of Osteopathic Medicine

Discussion

The results of this study show that race was significantly associated with birth weight in three of the four zip codes in that children of White mothers had a mean birth weight greater than the children of non-White mothers (45415, 45417, 45426) (see Table 6). The race association is consistent with the findings in the aforementioned literature review in that previous studies have found those of minority races (constituting the non-White race category) are disproportionately and negatively affected by poor birth outcomes. The significant association between Apgar score and birth weight makes sense, as higher Apgar scores equate to a healthier child, and hence better birth outcomes according to the aforementioned literature review. The month that prenatal care began was found to be significantly associated in one zip code; however the associations were in different directions across the four zip codes. Based on previous literature, the positive association with month of care in zip code 45416 makes sense – the earlier the prenatal care begins, the better the birth outcomes. However, the negative association found in some other zip codes (albeit not statistically significant) between month care began and birth weight does not align with previous research and additional studies would be necessary to better understand why the results were so inconsistent across zip codes. Although not statistically significant, increasing maternal age was associated with a decrease in mean birth weight in three of the four zip codes. This aligns with the literature review in that both extremes of the maternal age spectrum experience poorer birth outcomes; in this case, the older end of the spectrum, as the association shows that with increasing age, mean birth weight decreased. Again, although not statistically significantly associated, mothers who were married had children with mean birth weights greater than those children to unmarried women in all four zip codes. This finding aligned with previous studies that found unmarried women had a greater chance of experiencing poor birth outcomes than married women. Mothers who were not breastfeeding at time of discharge gave birth to children with mean birth weights less than those children born to mothers who did; this aligns with the literature review, as breastfeeding was associated with better health outcomes for both mother and infant. The review of the literature also found that mothers who participated in WIC were less likely to experience poor birth outcomes; this study found that in all four zip codes, women who did not participate in WIC had mean birth weights lower than those children of women who did. However, none of these associations were statistically significant. The associations between maternal level of education and birth weight found in this study did not align with the findings in the literature review; previous studies found that mothers with lower levels of education were more likely to experience adverse birth outcomes and this study found inconsistent patterns in birth weight and educational attainment.

The birth outcomes study in Montgomery County has some clear strengths. The data analyzed were directly obtained from birth certificates data as opposed to self-report which could result in bias. The analysis also looked at three years' worth of data in each zip code to make for a more comprehensive analysis. Another strength of the study was the diversity in study subjects across each of the four zip codes. Each category within each of the categorical predictor variables was well represented (see Table 1). However the study also presented a few limitations. First, three of the four zip codes had relatively small sample sizes (45415 = 267 subjects, 45416 = 158 subjects, 45417= 1,109 subjects, 45426 = 571 subjects). The study design presents a limitation in that it was conducted retrospectively, resulting in missing data for many subjects who were therefore excluded from the analyses, making sample sizes even smaller in each zip code. Additionally, associations found in multiple linear regression do not imply causation. Additional, prospective, studies would need to be conducted to infer causal relationships between predictor variables and birth weight. After the study was conducted, it was realized that two of the predictor variables selected, breastfeeding and Apgar scores, could not be causally related nor directly influence birth weight since they occur after the birth of the child. Although related to birth outcomes, breastfeeding and Apgar scores may not be sound targets for improving birth weight and rather better predictors for infant mortality. Including them in the linear regression model used for the analysis may have attenuated the results for the other predictors. Thus, the data analysis could be redone with breastfeeding and Apgar scores excluded or it could look at birth weight and preterm birth as correlated with or predictive of breastfeeding and Apgar scores. Additional predictor variables associated with both mother and child could be included in future studies and could include: illicit substance use, paternal characteristics, presence of a sexually transmitted disease, gestational age, adequacy of prenatal care, and additional clinical characteristics more specific to the hospital system. Future studies could also look at additional years of data to make for a more comprehensive analysis.

Conclusions

Poor birth outcomes are a significant public health issue, especially within Montgomery County, Ohio. The study results revealed that certain variables are significantly associated with changes in birth weight – the indicator used for birth outcomes. Premier Health can use the significant associations revealed in this study to guide the development of birth outcomes-oriented, data-driven objectives for their CHIP, and to make funding allocation decisions to improve birth outcomes in each of the four Montgomery County zip codes of interest.

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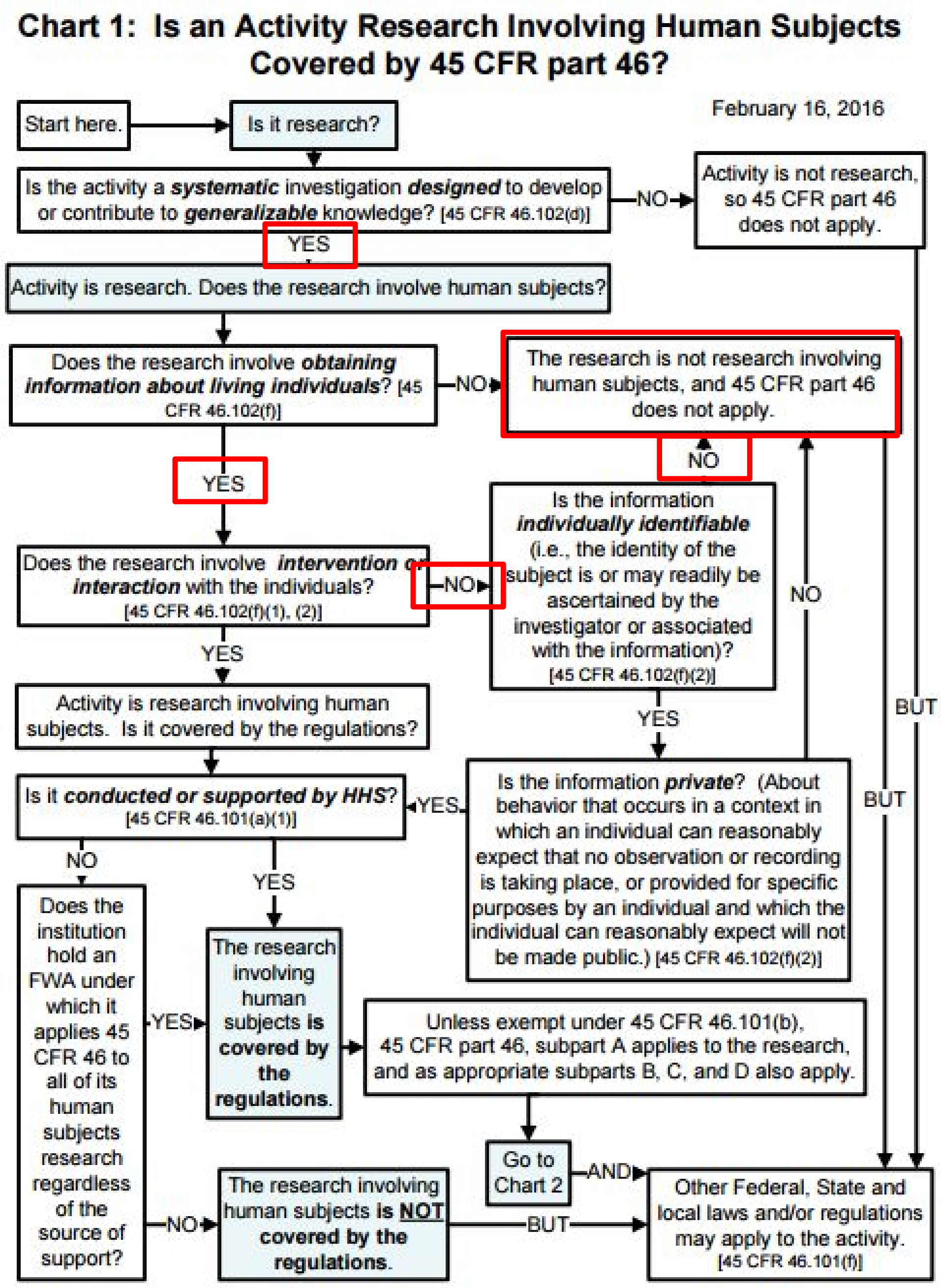
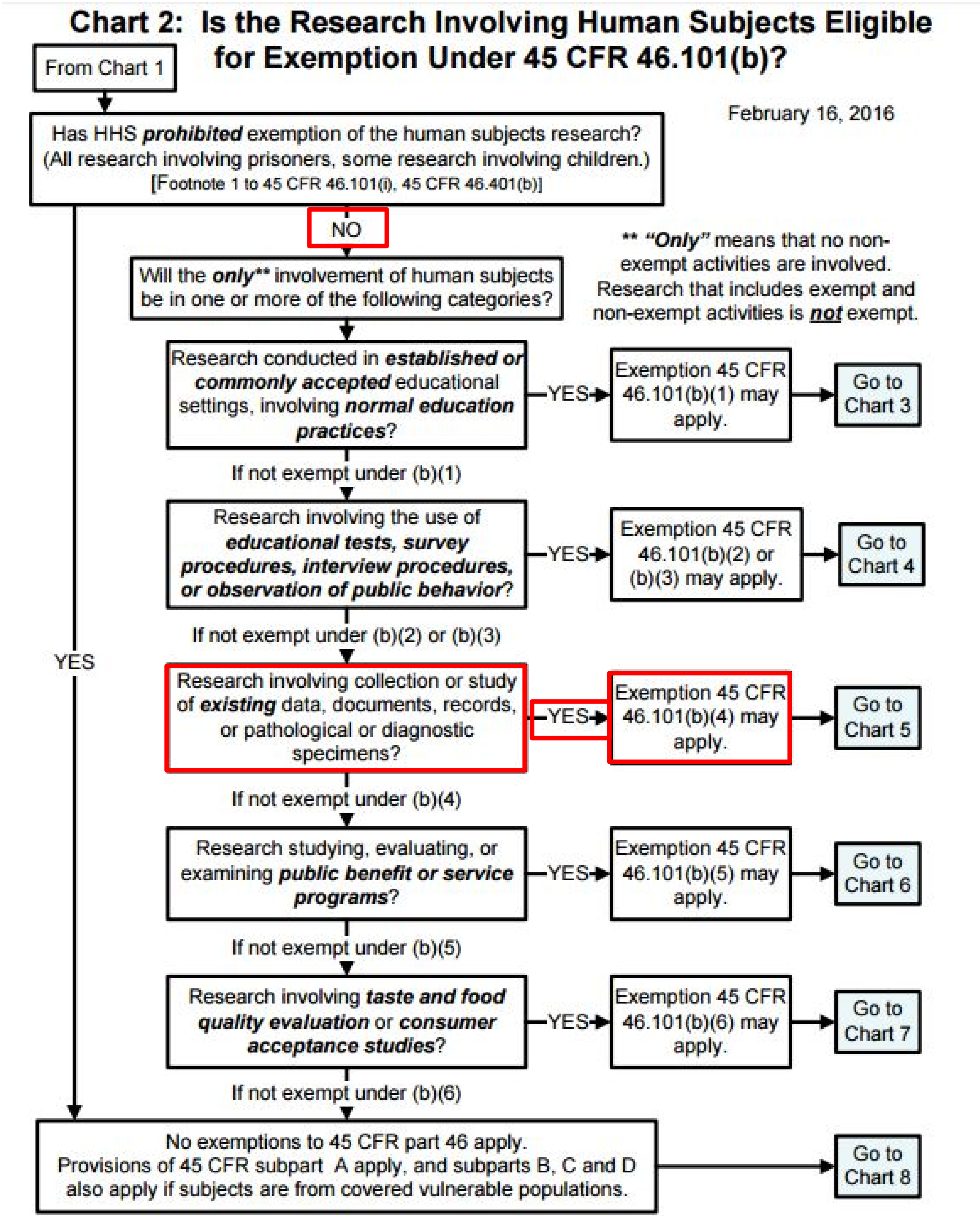
Appendix A: IRB Exemption Status

Decision charts taken from https://www.hhs.gov/ohrp/regulations-and-policy/decision-charts/

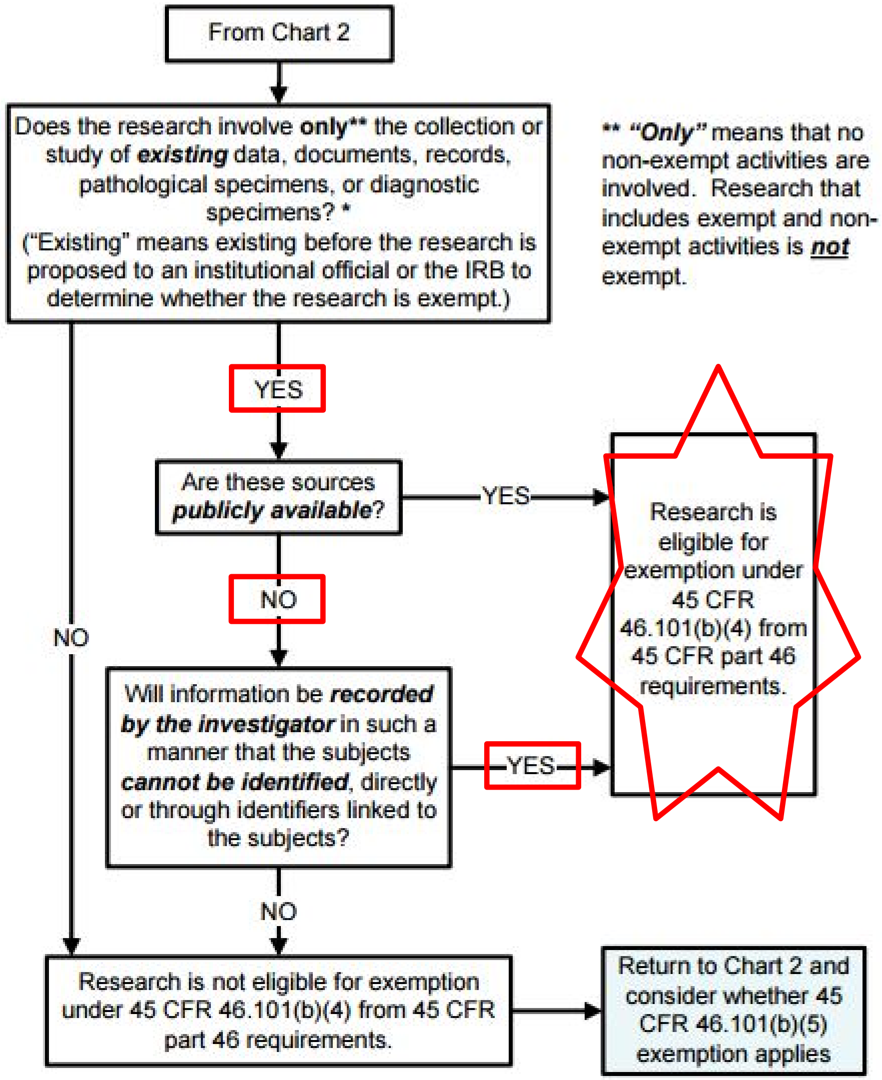


(see Chart 2 on next page)



(see Chart 5 on next page)

Chart 5: Does Exemption 45 CFR 46.101(b)(4) (for Existing Data Documents and Specimens) Apply?



* Note: See OHRP guidance on research use of stored data or tissues and on stem cells at http://www.hhs.gov/ohrp/regulations-and-policy/guidance/guidance-on-research-involving-stem-cells/index.html, and on coded data or specimens at http://www.hhs.gov/ohrp/regulations-and-policy/guidance/research-involving-coded-private-information/index.html for further information on those topics.

February 16, 2016

Appendix B: List of Competencies Met in CE

Wright State Program Public Health Competencies

Identify and describe the 10 Essential Public Health Services that serve as the basis for public health performance.
Assess and utilize quantitative and qualitative data.
Apply analytical reasoning and methods in data analysis to describe the health of a community.
Communicate public health information to lay and/or professional audiences with linguistic and cultural sensitivity.
Engage with community members and stakeholders using individual, team, and organizational opportunities.
Evaluate and interpret evidence, including strengths, limitations, and practical implications.
Demonstrate ethical standards in research, data collection and management, data analysis, and communication.
Explain public health as part of a larger inter-related system of organizations that influence the health of populations at local, national, and global levels.

Concentration Specific Competencies

Health Promotion and Education:	
Area 1: Assess Needs, Assets and Capacity for Health Education	
1.1	Identify stakeholders to participate in the assessment process
1.3	Analyze factors that foster or hinder the learning process
1.4	Identify factors that foster or hinder skill building
1.6	Synthesize assessment findings
Area 4: Conduct Evaluation and Research Related to Health Education	
4.1	Create purpose statement
4.2	Develop evaluation/research questions
4.3	Assess the merits and limitations of qualitative and quantitative data collection for research
4.4	Critique existing data collection instruments for research
4.6	Develop data analysis plan for research
4.7	Write new items to be used in data collection for research
Area 5: Manage Health Education Programs	
5.10	Synthesize data for purposes of reporting
5.11	Promote collaboration among stakeholders
5.12	Employ conflict resolution strategies
5.15	Identify potential partner(s)