2017

Measurable Predictors of Birth Outcomes: Community Health Needs Assessment Objectives

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Acknowledgements

I would like to thank the Wright State University Master of Public Health Program in aiding my Culminating Experience research project. The research was made possible by Public Health – Dayton & Montgomery County, as they provided the 2013 – 2015 birth data that were analyzed in this study.

Sylvia Ellison, maternal and child health epidemiologist, was the faculty chair on this project. I would like to express my gratitude to Sylvia for her guidance and assistance in developing the culminating experience through her background on birth outcomes.

Dr. Ramzi Nahhas, biostatistician, was faculty co-chair on this project. This work would not have been possible without his guidance on the data analysis. He aided the research through his expertise on SPSS, and by providing continuous feedback on the interpretation of the data.

Shaun Hamilton with Premier Health was the site preceptor on this research project. Thank you to Shaun for guiding me to find my culminating experience topic and giving me the opportunity to work with one of the region's leading healthcare agencies.

Dr. Nikki Rogers was the faculty chair for the Culminating Experience courses that led to this manuscript's development.

This work would not have been possible without the immeasurable love and support from my parents Farrukh and Nasreen Ahmed. I am grateful to my fiancé, Mohsin Sultan for his continuous encouragement, support, and love.

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Abstract

Purpose: The purpose of this study was to identify measurable predictors of birth weight in the four zip codes of Montgomery County, Ohio with the poorest health outcomes. Previous literature has shown that birth weight is strongly correlated with risk of infant mortality.

Methods: Multiple linear regression was used to assess the relationship between multiple predictor variables and the outcome of interest, birth weight. Separate models were fit for each zip code (45402, 45405, 45406, and 45414). Maternal and infant characteristics were analyzed to assess which variables served as the best predictors of birth weight in order to better allocate hospital community health funding to decrease disparities in birth outcomes.

Results: Maternal education was a significant predictor of infant birth weight for all four zip codes. Mothers with higher education on average had children with greater birth weight. Maternal race was significant across three zip codes as a predictor of infant birth weight. White mothers on average had children with greater birth weight.

Conclusion: Maternal education, maternal race, and the mean number of cigarettes smoked during pregnancy were found to be strong predictors of infant birth weight. A higher Apgar score at five minutes was found to be associated with a heavier infant birth weight. However, limited sample sizes in some zip codes may have resulted in certain associations being non-significant and others being significant that were not consistent with previous research

Keywords: CHIP, infant mortality, birth weight, race, ethnicity, maternal education

Measurable Predictors of Birth Outcomes: Community Health Needs Assessment Objectives

A devastating crisis that is prevalent throughout the world is infant mortality. The severity and widespread nature of this crisis has led to a need for increased awareness. More specifically, Martin Kaiser, an editor of the *Milwaukee Journal Sentinel*, stated that “The crisis of infant mortality is not just of public health but of ethics and morality,” calling for an increase in attention to infant mortality, as this crisis is still in existence currently (Center for Urban Population Health, 2011, p.1).

Infant mortality is defined as the death of a child before reaching the age of one, with the rate typically reported as the number of such deaths per 1,000 live births (Centers for Disease Control and Prevention [CDC], 2016a). Previous studies have shown that low infant birth weight is a strong predictor of infant mortality. A study conducted in Myanmar aimed to examine influences of high infant mortality and found birth weight to be a strong indicator of the risk of infant mortality (Deb et al., 2017). Along with tobacco use and chronic diseases, infant mortality is one of Ohio’s most critical health challenges (Reem, Dorn, McGee, Stevens, & Sustersic, 2016). According to the Centers for Disease Control and Prevention (CDC) (2016a), in 2014 over 23,000 infants died in the United States.

Infant mortality is a strong indicator of how well society in an area functions, as socioeconomic factors are reflected by infant mortality rates. The Community Health Needs Assessment (CHNA) is an assessment required of tax-exempt hospitals by the Patient Protection and Affordable Care Act (Association of State and Territorial Health Officials, 2016). A CHNA occurs over a three-year period in which the hospital attempts to identify and prioritize its community’s health needs along with identifying potential measures and resources available that may address these needs (Association of State and Territorial Health Officials, 2016). As part of the CHNA, the implementation strategy (IS) is a plan that identifies how a hospital will address the significant health needs identified by the CHNA (Association of State and Territorial Health Officials, 2016).

According to a study by Callaghan, MacDorman, Shapiro-Mendoza, and Barfield (2016), in the *American Journal of Obstetrics and Gynecology*, both the infant mortality rate and the preterm birth rate in the U.S. have been steadily decreasing, and these decreases are related to changes in the distribution of births by gestational age. Gestational age describes the duration of a pregnancy, which is measured in weeks, starting from the mother's first day of her last menstrual cycle to the infant's date of birth. A normal pregnancy can range from 38 to 42, weeks and infants born before 38 weeks are considered preterm. Improvements in gestational age such as delaying preterm births lead to decreases in infant mortality rates (Valla, Birkeland, Hofoss & Slinning, 2017). Despite the U.S. seeing a decrease in infant mortality rate, Ohio still has a high infant mortality rate which may suggest that health care aimed at preventing or delaying preterm birth may not be reaching all populations. Pregnancy outcomes, according to the CDC, are influenced by the mother's health and can further vary by additional factors such as race, ethnicity, age, location, health care access, education, and income (CDC, 2016a). Hospitals can implement preconception health plans that women can start before becoming pregnant, and between pregnancies, to assure the likelihood of a healthy baby. Important preconception health measures that health practitioners have addressed include consuming an appropriate amount of folic acid, healthy diet and exercise, quitting tobacco use, abstaining from alcohol and any type of recreational drugs, utilizing effective contraception correctly, and family history and the risks it may include (CDC, 2016b).

An individual's income can influence pregnancy outcomes. As reported by the National Infant Mortality Surveillance project, lower economic status groups have infant mortality rates that are two to three times higher than those in top status groups (Stockwell & Goza, 1996). The Community Health Improvement Plan (CHIP) is a systematic effort compiled based on Community Health Assessments (CHA) to develop a shared process to enhance the health of a community (Public Health Accreditation Board, 2016).

Analysis of birth weight in the specified Montgomery county zip codes and factors that are associated with disparities in birth weight in those areas will be utilized to identify measurable predictors that can be targeted, influencing future resource allocation. Various resources and aid provided by Premier's health care system will then be used to address birth weight, with the goal of decreasing infant mortality in the identified areas. The goal of this study was to examine four poorest zip codes in Montgomery County, Ohio (45402, 45405, 45406, and 45414) (Public Health – Dayton & Montgomery County [PHDMC], 2016b). The zip codes identified are those identified by Public Health - Dayton and Montgomery County Department's CHIP. These priority target zip codes have the greatest poverty levels based on economic characteristics and the lowest average household income compared to other zip codes.

The target zip codes have infant mortality rates during 2011 to 2013 according to the CHIP as follows for all races: 45402 - 9.3 per 1,000 live births; 45405 - 21.3; 45406 - 15.1; and 45414 - 18.4 (PHDMC, 2016b). Black infant mortality rates for 2011 through 2013 in these zip codes were, respectively, as follows: 45402 – 20.6, 45405 – 19.8, 45406 – 20.3, and 45414 – 18.7 (PHDMC, 2016b). White infant mortality rates in the targeted areas are as follows, 45402 - 0.0, 45405 - 13.7, 45406 - 8.3, and 45414 - 7.0 (PHDMC, 2016b). In comparison, the overall infant mortality rate for Montgomery County in 2011 for all races was 8.8, for Black infants, 17.1, and for White infants, 6.0 (PHDMC, 2016a). Overall infant mortality rate for Ohio in 2011 for all races was 7.9, for Black infants, 16.0, and for White infants, 6.4 (PHDMC, 2016a). Whereas, for the United States, the overall infant mortality rate was 6.1, for Black infants, 11.5, and for White infants, 5.1 (PHDMC, 2016a).

Statement of Purpose

The purpose of this study was to identify measurable predictors of infant birth weight in the four poorest zip codes (45402, 45405, 45406, and 45414) of Montgomery County, Ohio. Maternal characteristics included as predictors in the study were race, education, age, start month of prenatal checkups, choice to breastfeed, marital status, income, type of insurance and whether the mother utilized the federal Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (United States Department of Agriculture, Food and Nutrition Service [USDA], 2017). Another predictor was type of health care provider during delivery. Apgar score at five minutes was tested for association with infant birth weight.

Review of Literature

According to the CDC, the top five causes of infant mortality are birth defects, preterm birth/low birth weight, maternal complications of pregnancy, sudden infant death syndrome (SIDS), and injuries (CDC, 2016a). These five causes only accounted for 57% of infant deaths that occurred in the U.S. in 2014 (CDC, 2016a). Infant mortality is the death of a child before the child is one year of age. A study by Stockwell and Goza (1996), analyzed infant mortality and economic status in Metropolitan Ohio areas (Akron, Cincinnati, Columbus, Dayton, Toledo, and Youngstown). It was found that lower socioeconomic groups in all cities were characterized by a disadvantage when it came to the probability that a newborn infant would survive the first year (Stockwell & Goza, 1996). Another variable that has been linked to infant mortality and may possibly be a predictor of birth weight has been race. The background information available on birth certificates can only provide a limited about of information to address the cause of the gap between Black and White infant mortality rates. Despite the decrease in overall infant mortality rates, the racial gap between infant mortality rates is currently larger compared to the 1980s (Elder, Goddeeris, & Haider, 2010).

A study that examined factors that may influence the racial gap in infant mortality rates revealed three consistent findings; fitness at birth, conditional neonatal mortality, and conditional post neonatal mortality were all contributing factors to the differences in infant mortality between races (Elder, Goddeeris, & Haider, 2016). One of those factors, “fitness at birth”, is defined by the authors as birth weight, gestational age, or both combined (Elder et al., 2016, p. 43). Many experts believe that gestational age is a better measure of infant fitness than birth weight; however, birth weight is more accurately measured (Wilcox & Russell, 1986). To determine disparities in infant mortality across a variety of racial, ethnic, and socioeconomic factors, the reweighting approach was used to analyze the infant mortality gap between Black and White infants. The reweighting approach is a method to measure observable characteristics to analyze how background characteristics affect the overall distribution of an outcome variable (Elder et al., 2010). A study by Elder, Goddeeris, and Haider (2016) through the reweighting method revealed that Black infants had 50% higher chance of infant mortality compared to White infants (Elder et al., 2016). A proper understanding of the racial infant mortality gap is crucial to designing effective policy to reduce that gap.

As an attempt to improve the health of all Americans, Healthy People 2020 presented an array of researched objectives in order to achieve the goal of health improvement. One of those objectives declared breastfeeding as a national priority (U.S. Department of Health and Human

Services, 2014). The CDC states that in the U.S., more babies are born in a facility that promotes breastfeeding but less than five percent of U.S. babies are born in a hospital that is actually designated Baby-Friendly (CDC, 2011). The Baby-Friendly Hospital Initiative (BFHI) was started by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) as a global program to promote hospitals and birthing centers that offer greater care for infant feeding and bonding between the mother and the baby (Baby-Friendly USA, 2012). The support for an increase in breastfeeding rates is universally acknowledged, as many countries have dealt with decreasing rates of breastfeeding for the past several years (Wolf, 2003). Early initiation of breastfeeding is crucial to reducing early infant mortality (Neovita Study Group, 2016). Studies have shown there is a relationship between the onset of breastfeeding and the likelihood of infant death (Neovita Study Group, 2016). Another benefit of breastfeeding is the likelihood for the infant to suffer from SIDS decreases. SIDS is an unexpected death of a seemingly healthy baby who is less than a year old. Many infants die in their cribs, therefore SIDS is also known as crib death (National Institute of Child Health and Human Development, 2006). SIDS continues to be a problem in many countries today; breastfeeding has shown to reduce the risk of SIDS by over 50% (Vennemann et al., 2009).

Breastmilk contains numerous beneficial nutrients, for example, the antimicrobial, anti-inflammatory, immunomodulation, and bioactive molecules found in breastmilk that adapt to mucosal sites in the infant are not available from other nutritional sources (Oddy, 2004). Breastmilk is considered to have many additional benefits that are not provided through formula such as enzymes, hormones, growth factors, and immunomodulation factors that help the infant develop immunity to infectious agents (Guilbert, Stern, Morgan, Martinez, & Wright, 2007). This provides further evidence that infant formulas are unable to replicate all of the properties and benefits that are provided through human milk. Mothers who chose to utilize breast milk over formula have a reduced number of hospital visits and infant mortality rate (American Academy of Pediatrics, 2005). Breastfeeding is also related to benefits for the mother. Studies indicate that mothers who breastfeed lose their baby weight faster, have a reduced risk of breast and ovarian cancer, and have a lower risk of osteoporosis compared to mothers who do not breastfeed (Gartner et al., 2005). A factor that has been known to be associated with decreased breastfeeding is postpartum depression (PPD) (Bascom & Napolitanto, 2016). PPD is a type of depression that usually forms as a result of hormonal changes, psychological changes that may impair mothers from caring for their infants, and fatigue after childbirth. In developing countries such as Pakistan, breastfeeding was related to decreased malnutrition and also served as a cost effective method for the economy (Nisar et al., 2016).

In a study conducted in Nicaragua from 1983 to 1988, the influence of poverty and social inequality on infant mortality and differences in birth weight was assessed to find that maternal education may play an important role in preventing infant mortality and low birth weight (Peña, Wall, & Persson, 2000). An individual's level of education is a strong indicator of socioeconomic standing and geographic area of residence for that individual.

Studies have shown that infant survival rates are inversely related to maternal education; as the level of maternal education increases, the level of child mortality decreases (Ware, 1984). The direct correlation between maternal education and infant mortality is difficult to measure because of additional factors that may be confounding the relationship, such as the husband's education and income, as well as the mother's occupation. A study conducted in Nigeria indicated several factors that contribute to lower infant mortality rates for mothers with higher levels of education. One of the factors was that educated mothers are more adaptive to alternatives in childcare in a changing society rather than the use of traditional methods. An additional factor was that those mothers who are educated are better able to find their way in a modern world when in need of assistance. A third factor was that educated women often change the traditional roles of familial relationships that impact child care (Caldwell, 1981).

The marital status of the mother may also play a contributing role in infant mortality rates. Mothers who are married potentially have a partner to help care for the infant, potentially another income, and emotional support, whereas single mothers may be at risk for higher stress and be the sole person responsible for the infant. From 1980 to 1991 the number of births for women that were not married increased by 82% (Bennett, Braveman, Egerter, & Kiely, 1994). Maternal age could also be a potential influence on infant mortality. A study in Bangladesh observed the association between teenage motherhood and infant mortality and found that a younger mother has higher odds of her child dying as a neonate and, similarly, higher odds of a second child dying (Alam, 2000).

A test that is implemented to determine the risk for infant mortality is the Apgar test. This type of test is performed on the baby at three different time points, one, five, and ten minutes after birth. The one-minute score indicates how well the baby tolerated the birth process, whereas the five- and ten-minute scores indicate how well the baby is adjusting outside of the womb. The Apgar score evaluates five factors: breathing effort, heart rate, muscle tone, reflexes, and skin color (American Accreditation Healthcare Commission, 2017). Each factor is scored on a scale from zero to two, with two being the best score. A low Apgar score indicates the need for extra medical, and possibly emergency, care, and is associated with a higher risk of infant mortality.

“The Special Supplementation Nutrition Program for Women, Infants, and Children (WIC) provides federal grants to states for supplemental foods, health care screenings, referrals, and nutrition education for low income pregnant women, breastfeeding women, non-breastfeeding postpartum women, and children up to age five who are at a nutritional risk” (USDA, 2017, first paragraph). WIC was created to help ameliorate birth outcomes and to decrease disparities that existed for populations at risk of infant mortality. A study conducted in an at risk population in Kansas aimed to observe how the rate of infant mortality was related to mothers who utilized WIC as compared to those who did not; results indicated that WIC was not significantly associated with a reduction in infant mortality (Woods, Reyes, & Chesser, 2016). Including WIC as a variable in the study allows the possibility of targeting hospital funding to allocating resources in the CHIP to services that have a strong impact on the communities they serve. A study by authors Khanani, Elam, Hearn, Jones, and Maseru (2010) aimed to assess racial differences in the impact of WIC on infant mortality rates, finding that African Americans who participated in WIC had a significantly lower infant mortality rate compared to Whites who participated in WIC.

The multiple antecedents of infant mortality rates have led to various preventative and strategic processes in order to potentially reduce the risk of this crisis. One of those strategic processes is to achieve the overarching goal of improving length and quality of life while eliminating health disparities (CDC, 2016b). The ability to distinguish causes that influence pregnancy outcomes such as race, ethnicity, age, location, health care access, education, and income can aid to develop measurable outcomes and improve outcomes that are addressed with available resources. Through investigating the poorest zip codes in Montgomery County, OH (45402, 45405, 45406, and 45414) this study identified some of the specific factors that contribute to birth weight. Predictor variables aid to highlight areas that may utilize hospital funding in order to help reduce disparities in birth weight, in effect reducing infant mortality in the particular region.

Methods

All study data came from the cross-sectional Public Health - Dayton and Montgomery County Live Births datasets for the years 2013, 2014, and 2015. In accordance with the Health Insurance Portability and Accountability Act (HIPAA) guidelines (Data & Marketing Association, 2017), all data were de-identified prior to gaining access to the data to ensure confidentiality. Through the following steps Institutional Review Board (IRB) criteria were met to be considered exempt from submitting an IRB approval. A systematic activity designed to contribute to generalizable knowledge involving information about living individuals but does not involve intervention or interaction with the individuals and neither is the information individually identifiable (Appendix A). Exemption was applied to research involving collection of existing data that were not publicly available but information was recorded in a manner in which subjects were not identifiable (Appendix A). The population of interest was all Montgomery County live births in zip codes 45402, 45405, 45406, and 45414 for whom there was information on both maternal and infant characteristics.

Data Collection and Analysis

The outcome variable was infant's birth weight in grams. The predictor variables were maternal education (<high school degree, high school diploma or general equivalency diploma [GED], and some college or more), maternal age (years), maternal race (White, non-White), marital status (married, non-married), breastfeeding status (yes or no), month of first prenatal visit (1^{st}- 2^{nd} month, 3^{rd} month, 4^{th} month, 5^{th} month or later), payment method (Medicaid vs.

other) the mother had, WIC utilization, type of health care provider attending (MD, DO, or other) for delivery, and Apgar score at five minutes. A confounding variable was whether or not the mother smoked, which was measured in the dataset as the mean number of cigarettes utilized during pregnancy.

All data analyses were performed using the Statistical Package for the Social Sciences (SPSS) (IBM SPSS Statistics for Windows, Version 23.0, Armonk, NY: IBM, 2015). In order to summarize the sample characteristics, frequencies were computed for categorical variables (*n*, %) and descriptive statistics for continuous variables. Multiple linear regression was used to assess the relationships between each predictor variable and birth weight. Separate models were fit for each of the zip codes. An alpha level of 0.05 was set as the level of statistical significance for the analyses that were conducted.

Results

The sample characteristics displayed by zip code in Table 1 presents the distribution of predictor variables among the four zip codes. Zip code 45414 had the largest sample population of 857 and zip code 45402 had the smallest sample population of 319. Three of the four zip codes had a larger number of non-White mothers compared to White mothers and, for payment method, the majority of the sample in all four zip codes utilized Medicaid. Sample size and percentage of total sample was provided for all categorical variables. Mean and standard deviation was provided for all continuous variables.

Table 1

Sample Characteristics, by Zip Code

Independent Variable	**45402 (319)**	**45405 (674)**	**45406 (688)**	**45414 (857)**
Maternal Education, *n*(%)				
< High School Degree	93 (29.2)	175 (26.0)	176 (25.6)	181 (21.1)
High School Diploma / GED	115 (36.1)	233 (34.6)	221 (32.1)	291 (34.0)
Some College or More	111 (34.8)	266 (39.5)	291 (42.3)	385 (44.9)
Maternal Race, *n*(%)				
White	63 (19.7)	183 (27.2)	108 (15.7)	501 (58.5)
Non-White	256 (80.3)	491 (72.8)	580 (84.3)	356 (41.5)
Marital Status, *n*(%)				
Married	53 (16.6)	156 (23.1)	128 (18.6)	271 (31.6)
Not Married	266 (83.4)	518 (76.9)	560 (81.4)	586 (68.4)
Breastfeed, *n*(%)				
Yes	170 (53.3)	396 (58.8)	398 (57.8)	550 (64.2)
No	149 (46.7)	278 (41.2)	290 (42.3)	307 (35.8)
Month Prenatal Care Began, *n*(%)				
1st or 2nd month	112 (35.1)	204 (30.3)	232 (33.7)	289 (33.7)
3rd month	91 (28.5)	209 (31.0)	219 (31.8)	263 (30.7)
4th month	39 (12.2)	99 (14.7)	99 (14.4)	134 (15.6)
5th month + / none	77 (24.1)	162 (24.0)	138 (20.1)	171 (20.0)
WIC, *n*(%)				
Yes	207 (64.9)	435 (64.5)	456 (66.3)	472 (55.1)
No	112 (35.1)	239 (35.5)	232 (33.7)	385 (44.9)
Payment Method, *n*(%)				
Medicaid	261 (81.8)	522 (77.4)	542 (78.8)	558 (65.1)
Other	58 (18.2)	152 (22.6)	146 (21.2)	299 (34.9)
Attending, *n*(%)				
MD	249 (78.1)	541 (80.3)	537 (78.1)	660 (77.0)
DO	43 (13.5)	86 (12.8)	82 (11.9)	133 (15.5)
Other	27 (8.5)	47 (7.0)	69 (10.0)	64 (7.5)
Maternal Age, mean ± SD	26.08 ±(5.88)	25.59 ±(5.67)	25.78 ±(5.75)	25.57 ±(5.55)
Mean # of cigarettes smoked in pregnancy, mean ± SD	2.87 ±(6.48)	1.19 ±(4.85)	1.36 ±(4.07)	1.87 ±(4.77)
Apgar score at 5 minutes, mean ± SD	8.83 ±(.66)	8.71 ±(1.09)	8.67 ± (1.19)	8.81 ±(0.74)

Note. Values given as n (%) or mean ± SD. General education diploma (GED); The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); Doctor of Medicine (MD); and Doctor of Osteopathic Medicine (DO).

Table 2 provided the general linear model results for zip code, 45402. There were several differences among mothers that contributed to differences in the average birth weight of their child. Maternal education was a significant predictor of infant birth weight (*p*=.016). The difference in mean birth weight between mother's with less than a high school level education and mother's with some college or more was -238.65 grams (*p*=.015). Children born to mothers who had less than a high school education on average weighed 238.65 grams less than children born to mothers with some college or more. A one-unit change in the Apgar score at five minutes was associated with a 189.18 grams' difference in the infant birth weight. Children born to mothers who had a one unit higher Apgar score compared to another child weighed on average 189.18 grams more.

Table 2

General Linear Model Regression Results for 45402

Independent Variable	**Coefficient**	**95 % CI**	***p*-value**
Intercept	1643.08	(550.10, 2736.06)	.003
Maternal Education			.016
<High School Degree	-238.65	(-429.99, -47.31)	.015
High School Diploma or GED	-7.72	(-185.76, 170.32)	0.932
Some College or More	--	--	(ref)
Maternal Race			
White	176.38	(-7.98, 360.74)	.061
Non-White	--	--	(ref)
Marital Status			
Married	-153.59	(-364.89, 57.71)	0.154
Not Married	--	--	(ref)
Breastfeed			
Yes	--	--	(ref)
No	64.95	(-82.28, 214.19)	0.382
Month Prenatal Care Began			0.738
1st or 2nd month	58.92	(-128.67, 246.51)	0.537
3rd month	-3.03	(-199.76, 193.71)	0.976
4th month	-60.33	(-301.13, 180.47)	0.622
5th month + / none	--	--	(ref)
WIC			
Yes	--	--	(ref)
No	89.53	(-69.80, 248.87)	0.270
Payment Method			
Medicaid	-36.59	(-242.22, 169.05)	0.618
Other	--	--	(ref)
Attending			0.274
MD	-57.60	(-304.27, 189.07)	0.736
DO	-210.29	(-510.96, 90.39)	0.188
Other	--	--	(ref)
Maternal Age	-3.44	(-16.83, 9.95)	0.614
Mean # of cigarettes smoked in pregnancy	-11.44	(-24.29, 1.42)	.081
Apgar score at 5 minutes	189.18	(81.98, 296.38)	.001

Note. Regression coefficients for each of the predictor variables were provided along with 95% Confidence Intervals (CI), and p-values. General education diploma (GED); The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); Doctor of Medicine (MD); and Doctor of Osteopathic Medicine (DO).

In the zip code of 45405, disparities among mothers related to infant birth weight were found in maternal education, maternal race, the average number of cigarettes smoked during pregnancy, and the Apgar score at five minutes (see Table 3). The difference in mean birth weight between mothers with less than a high school level education and mother's with some college or more was -184.02 grams (*p*=.013). The difference in mean birth weight between mother's with a high school diploma or GED and mother's with some college or more was 33.55 grams, (*p*=.031). Maternal education was significantly associated to lower birth weight (*p*<.05). The difference in mean birth weight between White mothers and non-White mothers was 230.54 grams (*p*=.000). Children born to women who were White on average weighed 230.54 grams more than children to born to non-White women. An increase of one unit in the mean number of cigarettes smoked during pregnancy is associated with a decrease of 12.42 grams in the infant's birth weight. A one-unit change in the Apgar score at five minutes was associated with 160.71 grams' difference in infant's birth weight.

Table 3

General Linear Model Regression Results for 45405

Independent Variable	**Coefficient**	**95% CI**	***p*-value**
Intercept	1839.15	(1278.94, 2399.36)	.000
Maternal Education			.031
<High School Degree	-184.02	(-329.66, -38.38)	.013
High School Diploma or GED	-133.22	(-263.03, -3.40)	.044
Some College or More	--	--	(ref)
Maternal Race			
White	230.54	(104.396, 356.69)	.000
Non-White	--	--	(ref)
Marital Status			
Married	-77.16	(-214.02, 59.70)	0.269
Not Married	--	--	(ref)
Breastfeed			
Yes	--	--	(ref)
No	101.51	(-12.54, 215.55)	.081
Month Prenatal Care Began			0.985
1st or 2nd month	14.03	(-133.23, 161.28)	0.852
3rd month	12.80	(-131.59, 157.20)	0.862
4th month	-15.45	(-191.16, 160.27)	0.863
5th month + / none	--	--	(ref)
WIC			
Yes	--	--	(ref)
No	-76.54	(-189.42, 36.33)	0.183
Payment Method			
Medicaid	94.94	(-38.32, 228.20)	0.162
Other	--	--	(ref)
Attending			0.366
MD	-132.14	(-339.067, 74.78)	0.210
DO	-175.28	(-422.71, 72.16)	0.165
Other	--	--	(ref)
Maternal Age	-2.20	(-12.55, 8.14)	0.676
Mean # of cigarettes smoked in pregnancy	-12.42	(-23.83, -.991)	.033
Apgar score at 5 minutes	160.71	(113.29, 208.14)	.000

Note. Regression Coefficients for each of the predictor variables were provided along with 95% Confidence Intervals (CI), and p-values. General education diploma (GED); The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); Doctor of Medicine (MD); and Doctor of Osteopathic Medicine (DO).

For the zip code 45406, differences associated with infant's birth weight were found in maternal education, maternal race, and the average number of cigarettes smoked during pregnancy (see Table 4). The difference in mean birth weight between mothers with less than a high school level education and mothers with some college or more was -180.92 grams (*p*=.037). Lower maternal education was significantly associated ($p<0.05$) to lower birth weight for mothers who had less than a high school level education but mothers who had a high school diploma or GED were associated with higher infant birth weight. The difference in mean birth weight between White mothers and non-White mothers was 176.99 grams (*p*=.047). Children born to women who were White weighed an average of 176.99 grams more than children who were born to non-White women. An increase of one unit in the mean number of cigarettes smoked during pregnancy was associated with a decrease of 19.3 5grams in infant's birth weight.

Table 4

General Linear Model Regression Results for 45406

Independent Variable	**Coefficient**	**95% CI**	***p*-value**
Intercept	2699.330	(2014.45, 3384.22)	.000
Maternal Education			.032
<High School Degree	-180.92	(-350.50, -11.34)	.037
High School Diploma or GED	33.55	(-119.12, 186.22)	0.666
Some College or More	--	--	(ref)
Maternal Race			
White	176.99	(2.13, 351.84)	.047
Non-White	--	--	(ref)
Marital Status			
Married	-15.08	(-198.92, 168.76)	0.872
Not Married	--	--	(ref)
Breastfeed			
Yes	--	--	(ref)
No	44.68	(-89.25, 178.61)	0.513
Month Prenatal Care Began			0.469
1st or 2nd month	86.15	(-91.35, 263.64)	0.341
3rd month	-28.74	(-206.97, 149.49)	0.752
4th month	-17.59	(-230.56, 195.38)	0.871
5th month + / none	--	--	(ref)
WIC			
Yes	--	--	(ref)
No	7.97	(-130.60, 146.53)	0.910
Payment Method			
Medicaid	17.17	(-147.70, 182.04)	0.838
Other	--	--	(ref)
Attending			0.416
MD	-77.18	(-289.00, 134.63)	0.475
DO	-177.19	(-445.46, 91.08)	0.195
Other	--	--	(ref)
Maternal Age	3.31	(-8.74, 15.35)	0.590
Mean # of cigarettes smoked in pregnancy	-19.35	(-34.69, -4.02)	.013
Apgar score at 5 minutes	47.47	(-7.67, 102.61)	.091

Note. Regression Coefficients for each of the predictor variables were provided along with 95% Confidence Intervals (CI), and *p*-values. General education diploma (GED); The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); Doctor of Medicine (MD); and Doctor of Osteopathic Medicine (DO).

The sample population in the 45414 had several variables that contributed to lower infant birth weight presented in Table 5. The difference in mean birth weight between mothers with less than a high school level education and mothers with some college or more was -136.36 grams, (p=.018). Lower maternal education was significantly associated ($p < .05$) with lower infant birth weight. The different in mean birth weight between White mothers and non-White mothers was 264.67 grams, (p=.000). Infants born to White mothers on average weighed 264.67 grams more than infants born to non-White mothers, the association was statistically significant ($p < .05$). The difference in mean birth weight between mother who were married compared to mothers who were unmarried was 110.64 grams, (p=.035). Children born to women who were married weighed an average of 110.64 grams more than children born to non-married women. The difference in mean birth weight between mothers who had an MD as their attending compared to mothers who had another type of attending was -200.05 grams, (p=.004). Mothers who used an MD as their attending were associated with a lower infant birth weight. The difference in mean birth weight between mothers who used a DO as their attending compared to mothers who used another type of healthcare professional as their attending was -215.42 grams, (p=.008). Mothers who had DOs as their attending were associated with a lower infant birth weight. An increase of one unit in the mean number of cigarettes smoked during pregnancy was associated with a decrease of 14.86 grams in the infant's birth weight. Children born to mothers who smoked a mean number of cigarettes during pregnancy on average weighed 14.86 grams less than children born to mothers who did not. A one-unit change in the Apgar score at five minutes was associated with a 179.82 grams change in the infant's birth weight.

Table 5

General Linear Model Regression Results for 45414

Independent Variable	**Coefficient**	**95% CI**	**p-value**
Intercept	1762.22	**(**1238.18, 2286.26)	.000
Maternal Education			.030
<High School Degree	-136.36	(-247.45, -23.28)	.018
High School Diploma or GED	-11.14	(-103.17, 80.89)	0.812
Some College or More	--	--	(ref)
Maternal Race			
White	264.67	(181.94, 347.40)	.000
Non-White	--	--	(ref)
Marital Status			
Married	110.64	(7.59, 213.70)	.035
Not Married	--	--	(ref)
Breastfeed			
Yes	--	--	(ref)
No	-31.98	(-112.12, 48.16)	0.434
Month Prenatal Care Began			0.177
1^{st} or 2^{nd} month	36.36	(-69.30, 142.03)	0.500
3^{rd} month	-24.28	(-130.85, 82.30)	0.655
4^{th} month	-83.12	(-204.98, 38.77)	0.181
5^{th} month + / none	--	--	(ref)
WIC			
Yes	--	--	(ref)
No	-79.60	(-163.96, 4.76)	.064
Payment method			
Medicaid	33.92	(-63.35, 131.19)	0.494
Other	--	--	(ref)
Attending			.013
MD	-200.05	(-336.53, -63.57)	.004
DO	-215.42	(-374.69, -56.16)	.008
Other	--	--	(ref)
Maternal Age	-0.88	(-8.77, 7.01)	0.827
Mean # of cigarettes smoked in pregnancy	-14.86	(-22.87, -6.86)	.000
Apgar score at 5 minutes	179.82	(127.87, 231.78)	.000

Note. Regression Coefficients for each of the predictor variables were provided along with 95% Confidence Intervals (CI), and *p*-values. General education diploma (GED); The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC); Doctor of Medicine (MD); and Doctor of Osteopathic Medicine (DO).

Table six displays a comparison of the regression coefficients from Tables 2, 3, 4, and 5 across zip codes. Maternal education was found to be statistically significant across all four zip codes. Zip code, 45402 had the largest difference in birth weight for infants born to mothers with less than a high school degree education and mothers who had some college or more. White mothers were found to have a significant difference in infant birth weight for three zip codes. Marital status displayed significance for one zip code, 45414 (the largest sample), in infant birth weight. Type of health care professional demonstrated significance for one zip code, 45414 (the largest sample), in infant birth weight for both doctor of medicine (MD) and doctor of osteopathic medicine (DO).

Table 6

*Comparison of Regression Coefficients by Zip Code (**Bold** Indicates Statistical Significance)*

Independent Variable	**45402 (319)**	**45405 (674)**	**45406 (688)**	**45414 (857)**
Maternal Education				
<High School Degree	**-238.65**	**-184.02**	**-180.92**	**-136.36**
High School Diploma or GED	-7.72	-133.22	33.55	-11.14
Some College or More	--	--	--	--
Maternal Race				
White	176.38	**230.54**	**176.99**	**264.67**
Non-White	--	--	--	--
Marital Status				
Married	-153.59	-77.16	-15.08	**110.64**
Not Married	--	--	--	--
Breastfeed				
Yes	--	--	--	--
No	64.95	101.51	44.68	-31.98
Month Prenatal Care Began				
1st or 2nd month	58.92	14.03	86.15	36.36
3rd month	-3.03	12.80	-28.74	-24.28
4th month	-60.33	-15.45	-17.59	-83.12
5th month +/none	--	--	--	--
WIC				
Yes	--	--	--	--
No	89.53	-76.54	7.97	-79.60
Payment Method				
Medicare	-36.59	94.94	17.17	33.92
Other	--	--	--	--
Attending				
MD	-57.60	-132.14	-77.18	**-200.05**
DO	-210.29	-175.28	-177.19	**-215.42**
Other	--	--	--	--
Maternal age	-3.44	-2.20	3.31	-0.88
Mean # of cigarettes smoked in pregnancy	-11.44	**-12.42**	**-19.35**	**-14.86**
Apgar score at 5 minutes	**189.18**	**160.71**	47.47	**179.82**

*Note.*General education diploma (GED). The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Doctor of Medicine (MD) and Doctor of Osteopathic Medicine (DO).

Discussion

Across all four zip codes maternal education was significantly associated with infant birth weight. According to a study conducted in Canada comparing socioeconomic status on birth outcomes also indicated that a lower maternal education increased the possibility of a lower infant birth weight (Campbell et al., 2017). Three of the four zip codes observed indicated significant association between maternal race, mean number of cigarettes smoked during pregnancy, and Apgar score at five minutes with infant birth weight. The World Health Organization considers that the underlying social construct of race leads to unequal distribution of resources that are critical to health and are associated with non-White individuals linked to poorer health outcomes compared to White individuals (Rice, Goldfarb, Brisendine, Burrows, & Wingate, 2017). Consistent with previous literature, the results of this study indicated that infants born to non-White women had lower average birth weight compared to children born to White women. Only one zip code had statistically significant association for marital status and type of health care provider attending during delivery for infant birth weight, this zip code was also the only majority White zip code. Based on previous studies between birth weight and marital status, mothers whom were married were associated with a higher birth weight for their income (Short, Gannon, & Abatemarco, 2016). Only one zip code had statistically significant association for marital status and type of attending for infant birth weight, this zip code was also the only majority White zip code. There may exist a race interaction term for marital status and attending provider that can be added to the next phase of the study to analyze if marital status has an effect on infant birth weight for only certain races and if certain races prefer a specific attending such as a MD or DO over other providers that may impact their healthcare needs.

Data for the sample size collected over three years was recorded in the same manner. Data was collected through birth certificates therefore not subject to self-report bias. Based on the frequencies of race the sample population was diverse. Limitations of this study included the sample size: despite having three years of data, sample sizes for each of the zip codes were small after coding for missing values. The main methodological limitations of the dataset were the retrospective nature and the missing values that resulted in eliminating a portion of the data. The possibility of confounding bias by unmeasured variables may have altered the results that led to certain associations being significant and others being non-significant that are not a true representation of the population.

Recommendations

Future recommendations would include having a larger data set and including more predictor variables for both maternal and infant categories. Additional variables that could be added regarding mothers may possibly include salary, occupation, whether or not mother has familial support, mother's vaccination history, and drug and alcohol use. A larger dataset over a longer period of time than three years may lead to an accurate portrayal of the population represented, because of a more randomized selection of the sample population. Based on the findings of this study a program created to teach mothers about pregnancy and proper infant care may help to reduce the disparities that exist between different levels of maternal education. Improving birth outcomes promotes maternal and infant health, and that in turn enhances society. Eliminating inequalities that exist in the predictor variables identified in this study may lead to higher infant birth weight that would sequentially lead to lower infant mortality rates.

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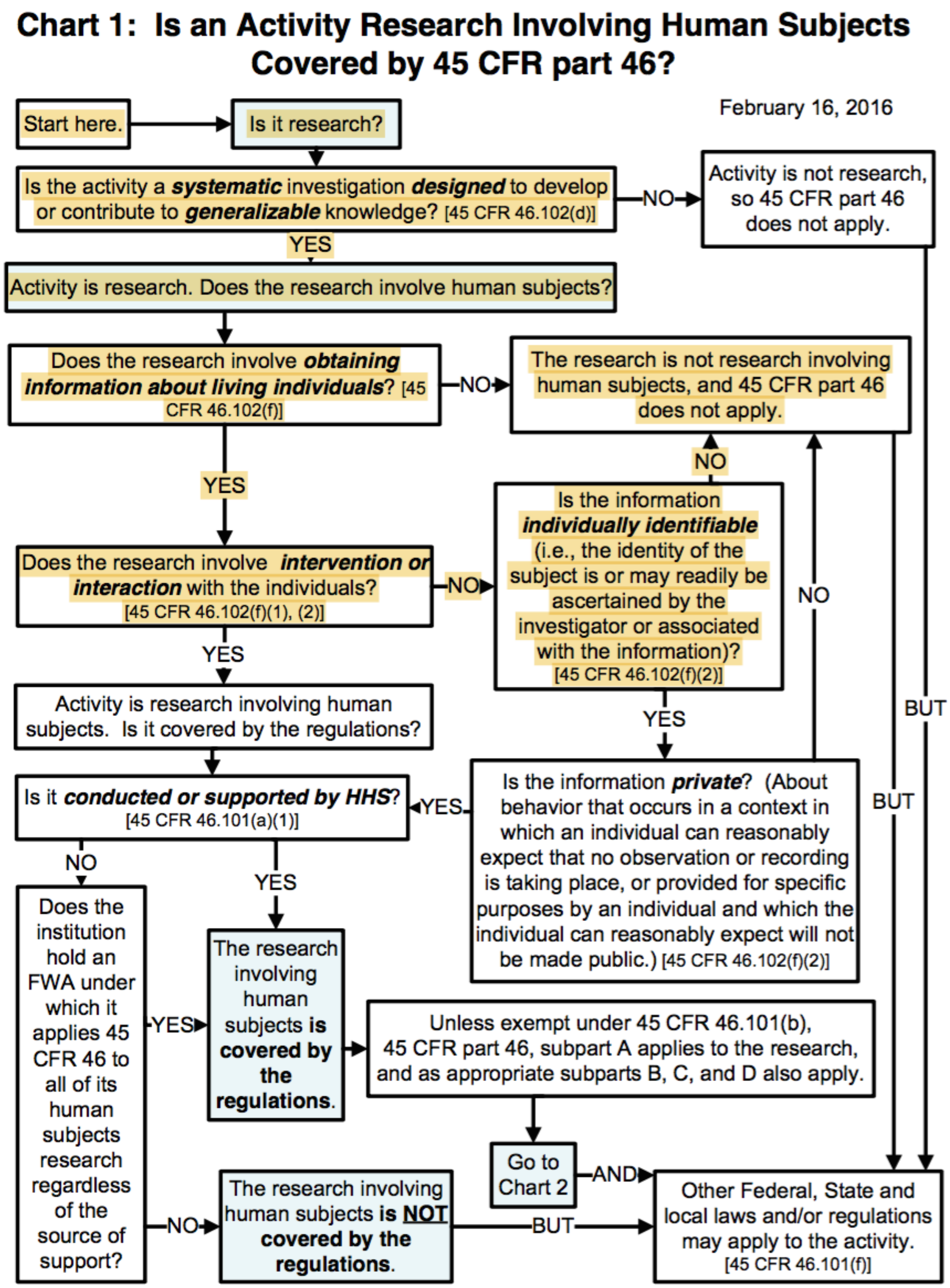
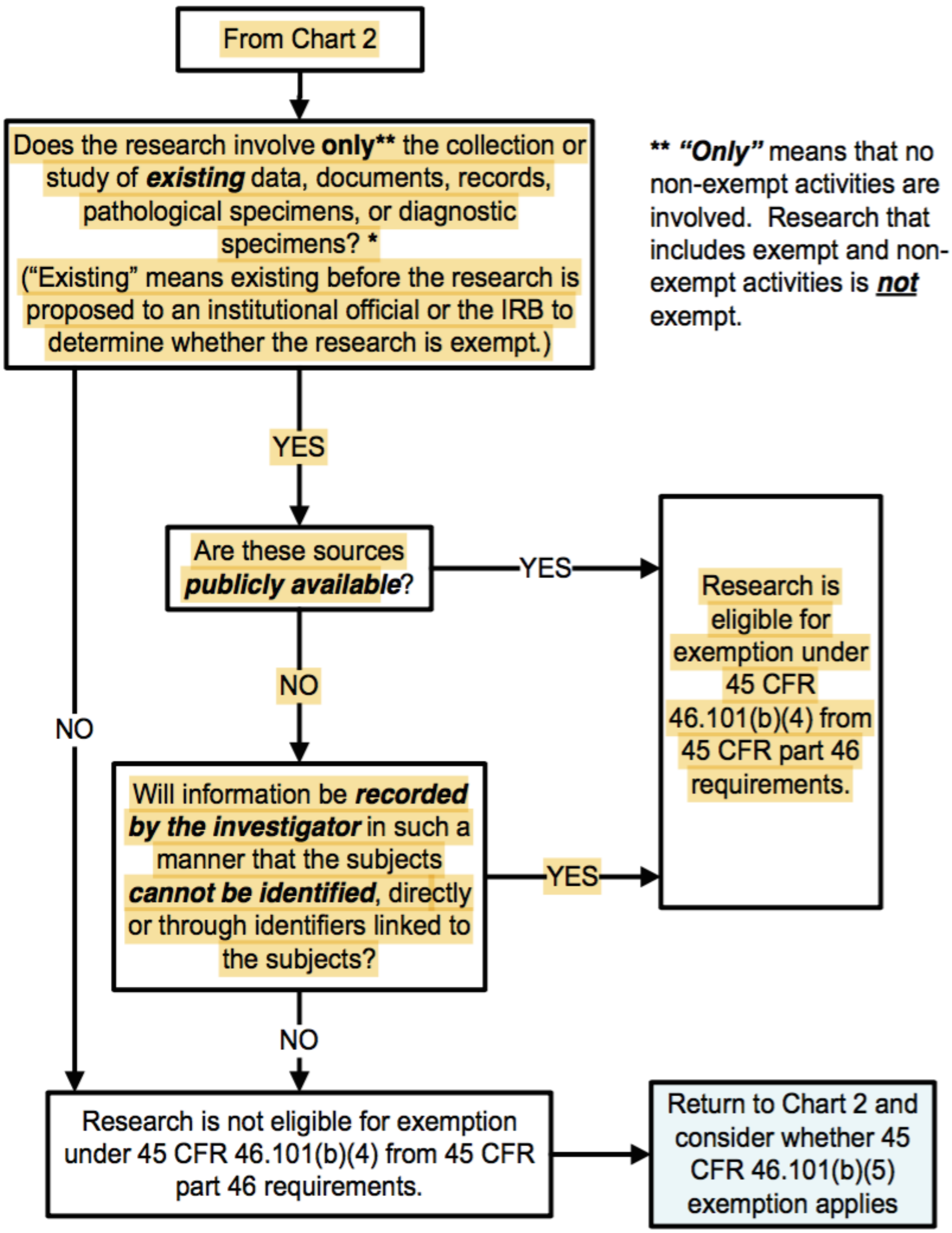
Appendix A: Institutional Review Board Exemption Status

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



charts/index.html)

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