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Impact of Adverse Childhood Experiences on Maternal Health and Birth Weight in Appalachia

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Abstract

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MPH, A.T. Stills University, 2007

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Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Adverse birth outcomes and adverse childhood experiences (ACE) are concerns in the United States, with potential to impact health indices now and in the future. The purpose of this study was to quantitatively examine the association between maternal exposure to ACE, low birth weight, and county of residence in the Appalachian population using the Life Course Approach as the theoretical framework. A cross-sectional study design and clustering strategy was used to randomly select potential respondents from a data set that was provided by Ohio Department of Health. Self-administered questionnaires were sent to potential respondents to collect information about ACE in the maternal population of Appalachia, Ohio with an overall response rate of 29.5% and 212 total participants. A chi-square analysis was completed and no significant association was found between county of residence and risk of low birth weight. However, statistically significant associations were found between the different types of ACE exposure and low birth weight delivery as well as Appalachian county of residence and exposure to ACE. As the sample of low birth weight deliveries was small, it is recommended that the relationship between ACE exposure and low birth weight be further studied to develop more purposeful health interventions to improve maternal health in Appalachia, Ohio specifically, as well as other rural communities. Reducing rates of adverse birth outcomes and chronic disease burden in Appalachia have potential to reduce health disparities between urban and Appalachian communities, allowing for positive social change for many socioeconomically disadvantaged communities and improving population health.

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Dedication

This work is to the millions of women that have been impacted by adverse birth outcomes, and my children Ethan and Elizabeth, for whom I strive to be the best I can be every day. May you learn from me half as much as I have learned from you.

Acknowledgments

I would like to thank my husband Adam for supporting all my endeavors wholeheartedly, my children for cheering me on and making life brighter, and my family (John, Alice, Jessica, Jeanann, and Charlie) for all the love, support, and sacrifice they have given me over the years. I wouldn’t be where I am today without you. I would also like to thank all the faculty that have assisted me this far with my work, especially Dr. Litton, who has motivated, supported, and pushed me to become successful. Thank you.

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Chapter 1: Background

Introduction

Low birth weight not only affects immediate health outcomes, but has also been linked to increased disease states later in life (Pies, Parthasarathy, & Posner, 2012). As the United States spends more than $1 trillion dollars annually on chronic diseases, this has led to the use of the life course approach (LCA) and thoughts that health is largely decided in utero, making maternal health a critical deciding factor for health throughout life (Barker, 2012; Pies et al., 2012). There is an inequity that exists within the United States in terms of health outcomes (Wilson & Pickett, 2010). Because of its unique culture and the economic hardships that still exist, the Appalachian population has higher rates of chronic disease (Esch & Herndryx, 2011) and infant mortality and morbidity (Kent et al., 2013).

As a number of researchers believe that health is partially determined in utero (Pies et al., 2012), it is important to understand which factors are causing adverse birth outcomes in the Appalachian population. A rather new concept is adverse childhood experiences (ACE), which are defined as potentially traumatic events that may have lasting negative impacts on health and wellbeing that occur before the age of 18 (Centers for Disease Control and Prevention [CDC], 2016). There are some studies that now link number of health concerns such as high blood pressure, sleeping trouble, and increased drug use (Flaherty et al., 2013). This study examined birth outcomes in Appalachian populations in order to understand if there is a difference between subpopulations in Appalachia. In addition, as growing evidence suggests that ACE can negatively impact health, and the Appalachian population is more at risk for ACE, the study also looked at rates of ACE in the Appalachian population and the association with adverse birth outcomes in terms of risk for low birth weight.

Through an extensive literature review, it has been determined that there is a gap in knowledge concerning maternal health in Appalachia and ACE. This chapter serves to summarize the current literature that exists on maternal health in Appalachia and the impact of ACE on low birth weights. In turn, the lack of research to determine the impact of ACE on Appalachian maternal health and adverse birth outcomes, such as low birth weights, are also briefly discussed.

This chapter also serves to fully define the research problem and discuss the research questions and hypotheses. The framework, nature of the study, definitions, and assumptions are also discussed as well as the general knowledge gap. The scope of the work is defined within this chapter and the limitations of the study design, data collection methods, and any biases that could impact the accuracy of data are discussed as well as possible mitigation techniques. Finally, included within this chapter is the impact the study may have as well as the social implications.

Background of Problem

As advanced as medicine is in the United States, low birth weight still affects over 320,000 births annually (CDC, 2016). This is alarming, as low birth weight is largely preventable. In addition to this, disease pathologies may begin in utero (Barker, 2012), meaning that adverse birth outcomes not only impact individuals in early years but throughout life, thereby increasing the burden of chronic disease in the United States. As the burden of low birth weight and the implications it may have are detrimental to population health, it becomes imperative to develop interventions targeted at reducing the risk of low birth weights.

In order to effectively do this, research must first ascertain what factors determine the risk of adverse birth outcomes such as low birth weights. This can be difficult, as there are a number of factors that could cause low weight at birth (Goldenberg, Culhane, Iams, & Romero, 2008). Factors studied so far in relationship to low birth weight include smoking, diet, dental care, stress, access to prenatal care, and infection (Goldenberg et al., 2008). However, when these factors are controlled for, there is evidence that disparities in low birth weights exists (Kent, McClure, Zaitchik, & Gohlke, 2013).

In addition, some populations are more at risk for having low birth weight offspring than others, as these effects seem to be exaggerated in rural populations, where they have continuously had higher rates of low birth weights (Goldenberg et al., 2008). Knight, Kurinczuk, Spark, and Brocklehurst (2009) attributed this to decreased prenatal care. Kent et al. (2013) found that Appalachian populations are more at risk for substance abuse, stress, and violence. Current research has begun to look at the impacts of these factors on the Appalachian population. However, to date, the impacts on substance abuse, violence, and stress on maternal health (and in turn inter utero development) have not been examined. This results in overall poor health in relationship to the disparity seen in these populations in terms of socioeconomic determinants.

While the exact causative factors of increased risk of low birth weight in Appalachia are yet determined, the effect is grave, creating both an immediate health disparity as well as risk for future complications. Increased risk for chronic disease begins in utero (Barker, 2012; Pies et al., 2011). It is important to consider increased risk of low birth weights in Appalachia, where the population suffers from higher levels of chronic disease (Esch & Hendryx, 2011) and higher numbers of low birth weights (Baily & Cole, 2009). As chronic diseases are largely preventable (Brownell & Frieden, 2009) and the LCA suggests focusing on maternal health for the earliest prevention of chronic disease (Pies et al., 2012), it is important to consider what factors may be causing Appalachian populations to have higher numbers of low birth weight deliveries than other populations.

To address this, Braveman et al. (2010) as well as Danese et al. (2009) have indicated a need for considering the relationship between the factors and how they impact maternal health in terms of adverse birth outcomes. Measuring ACE in relation to maternal health may address these concerns and provide information for future public health initiatives (Chung et al., 2010). Danese et al. (2009) and Herrod (2007) both chose to examine impacts of ACE on health later in life due to previous literature and the impact on health policy in addition to the ability to examine large populations easily through the ACE questionnaire for behavioral health risks. ACE has been associated with a host of adverse physical and mental health conditions in adults (Herrod, 2007). However, the experiences that have been measured differ depending on the literature. Herrod (2007) discussed the use of eight types of childhood experiences including verbal, emotional, poor home life, sexual, physical, neglect, and mental abuse, stating that all aspects of potential ACE should be considered in order to determine the true impact of ACE on health. Chung et al. (2010), however, did not include all of these as ACE, only considering neglect, physical, and sexual abuse, which serves as an example in the literature of how difficult it is to get a true comparative picture of ACE and the impact on health. Rates of ACE exposure also differ drastically as Chung et al. (2010) found that 72% of their population was affected by ACE, while census findings from America's Health Rankings (2017) found the rates of ACE exposure to be closer to 35%. This difference in exposure rate could be related to the use of different instrumentation or the fact that the researchers considered varying experiences as ACE.

Chung et al. (2010) found that mothers-to-be that were subjected to more ACE were four times as likely to smoke during pregnancy. Investigating associations between ACE and increased risk of adverse birth outcomes is the next step in addressing this concern and current health disparities. Exposure of mothers to ACE in early life has been found to affect offspring, as children with mothers exposed to ACE were 20% more likely to have behavioral problems (Braveman et al., 2010).

While considering the impact of maternal exposure to ACE in early years is important, it may be more critical to explore these effects on gestation and birth outcomes. Chung et al. (2010) found that exposure to ACE was twice as likely to adopt risky behaviors during pregnancy. The population selected for this study was low income and urban (Chung et al., 2010). Within this multiracial population selected, Caucasian mothers were at higher risk for engaging in risky behaviors while pregnant, impacting the health of the mother and fetus (Chung et al., 2010). Braveman et al. (2010) indicated that there are no health disparities between maternal health and race, while the work of Holzman et al. (2009) suggested that there was a difference in maternal health and increased incidence in adverse birth outcomes according to the mothers' race (Holzman et al., 2009).

Increasingly, socioeconomic determinants have been studied in terms of impacts on health inequities in order to improve population health (Wilkinson & Pickett, 2010). Socioeconomic inequities have been linked to increased violence, risky behaviors, obesity, and mental health illnesses in addition to other factors (Wilkinson & Pickett, 2010). Other countries have also begun to study the importance of social structure in terms of adverse health outcomes, although research in the United States has yet to address this.

Giving all children a healthy start at life is a priority in a number of countries, and they have largely focused on developing interventions focused on maternal health (Brown et al., 2011). Deprived neighborhoods, class of the mother, and income have been associated with the risk of adverse birth outcomes (Garcia-Subirats, Pe´rez, Rodrı´guez-Sanz, Salvador, & Jane, 2010). Brown et al. (2011) added knowledge to this through determining the mechanism behind the increased risk of adverse birth outcome in association with socioeconomic determinants and inequities. They found two possible pathways to explain this. One pathway being the effects of maternal stress on gestation as a mechanism to cause physiological changes in a fetus resulting in health inequities from birth, and the other pathway being risky behaviors in mothers cause increased incidence of adverse birth outcomes (Brown et al., 2011).

Changes in the development of the fetus on a cellular level due to maternal health has been shown to impact health outcomes in early life and beyond, to include concern in the next generation (Shonkoff et al., 2009). Traditionally, maternal behaviors such as smoking, drug use, prenatal nutrition, and drinking have been studied in relation to adverse birth outcomes (Short, Oza-Frank, & Conrey, 2012). This has provided support for the general acceptance in the field of maternal health that risky behavior impacts the development of the fetus in utero (Shonkoff et al., 2009; Short et al., 2012). In more recent years, the impact of factors such as maternal income level and hardships such as divorce, domestic violence, or lack of social support on maternal health has been examined (Braveman et al., 2010).

Shonkoff et al. (2011) indicated that ACE can impact the way children develop down to the molecular level. This directly affects their cognitive development as well as their predisposition to disease states in childhood and in later life. While traumatic events early in life and ACE can impact health later in life (Flaherty et al., 2013), there is little research to try to understand the impact that ACE may have on maternal health. In addition to this, Appalachian populations often have higher levels of stress and are susceptible to what is known as weathering, or chronic stress that transcends generations (Ochako, Fotso, Ikamari, & Khasakhala, 2011). This weathering in part may be due to ACE and the trauma associated with hardships in childhood.

Braveman et al. (2010) as well as Brown, Yelland, Sutherland, Baghurst, and Robinson (2011) found a strong link between stress during or around the time of pregnancy and adverse birth outcomes. Although their findings have increased knowledge through attempting to understand the impact of hardship and income on gestation, research has been limited in the fact that it only considers the impact of hardships around the time of birth and largely disregards the cumulative effects of these factors during gestation or earlier in the mother's life and their impact on offspring's health. In addition, to date most of the literature concerned with the health of the mother has not considered relationships between income, hardships, and birth outcomes. This has limited the social impact and influence on health policy.

Traumatic events such as violence, finanacial troubles, and abuse have been shown to affect over 60% of pregnant women (Braveman et al., 2010) and ACE has been shown to impact between 50% (Herrod, 2007) as well as 72% of research samples (Chung, et al., 2010). These findings support the need for more maternal health resources and further research into how maternal health affects birth outcomes. Increased risk of smoking, drug abuse, poverty, stress, and lack of education has overwhelmingly been associated with ACE (Herrod et al., 2007).

While the topic of weathering in Appalachia has been investigated, the potential effects on maternal health have not. Furthermore, while ACEs have been linked to poor health outcomes (Flaherty et al., 2013), the impact on maternal health and low birth weights have been mostly neglected in all populations. This creates a need to research the impact of ACE on maternal health, with the measurable outcome of birth weight. While ACE and low birth weight impacts the United States, a distinctive gap in literature and knowledge exists regarding maternal health in Appalachia, a population that has higher rates of low birth weight and traumatic events associated with ACE than non-Appalachian communities.

The difference between rural areas, particularly Appalachian, and urban populations regarding adverse birth outcomes have not been researched extensively. Initial literature searches on the subject returned less than five studies that considered an Appalachian population and adverse birth outcomes. Three of the five studies considered maternal smoking in relation to adverse birth outcomes in Appalachia, which is fitting as this population has higher smoking rates in general as this has been labeled tobacco country and the act is deeply rooted in heritage and culture (Bailey & Cole, 2009). Bailey and Cole (2009) found that Appalachian women had higher levels of preconception health indicators than women in non-Appalachian counties within the same state. Bailey and Cole (2009) also found the risk of poor maternal health varied, depending on the economic stability of the county. Bailey and Cole (2009) used the Behavioral Risk Factor Surveillance System (BFRSS), the nation's premier system of health-related telephone surveys used to collect data about residents regarding risky behaviors and chronic diseases, which enables them to determine demographics of this population in comparison to their non-Appalachian counterparts. These demographics were further defined to include less education, younger maternal age, less care under a physician, higher rates of smoking, higher rates of obesity, and poor nutrition (Short et al., 2012).

There is a distinct culture in Appalachia, making rurality and community factors to consider in the contribution to Appalachian health outcomes. Bailey and Cole (2009) considered the rural and cultural context in Appalachia in relation to smoking and adverse birth outcomes in Appalachia. More specifically, they were interested in finding if the community and the rural setting increased the likelihood of smoking during pregnancy (Bailey and Cole, 2009). The researchers were attempting to determine the causative agent for increased smoking in Appalachia rather than relate the rate to increased adverse birth outcomes. The study indicated that this is a trend in research as public health policy makers are looking at social determinants with long term effects in hopes of developing better health intervention strategies (Bailey & Cole, 2009).

While Bailey and Cole (2009) did not investigate the causes of the increased smoking trend in Appalachia, or what effects these health indicators have on birth outcomes in Appalachia, they did provide a foundation for determining what the best intervention may be for this population. their work also raised questions as to why there was such a difference from one county to the next regarding population health and how a subsegment of the United States population could have had so many poor health indicators. In consideration of this study and in order to identify better health interventions that are more pertinent for the specific population, examining the reason for increases of poor health indicators may be the best approach to improve population health. As many of the poor health indicators demonstrated in the Appalachian population parallel the factors that have been associated with increased rates of ACE (Braveman et al., 2010; Chung et al., 2010), further investigation into the incidence of ACE in the Appalachian maternal population and the impact on adverse birth outcomes seems warranted. Further supporting this is the findings of Short et al. (2012), where they were unable to fully explain adverse birth outcomes solely on socioecoimic factors and access to care alone.

Problem Statement

Infant mortality has been recognized as one of the best indicators of the health of the population (CDC, 2016). This is concerning as the United States, one of the most powerful nations, has higher rates of infant mortality than other countries (Central Intelligence Agency [CIA], n.d.), indicating that the health of the United States could be greatly improved. Rates of infant mortality in the United States are estimated at 6.17 deaths per 1,000 live births (CIA, n. d.). This rate is high when compared to other countries, such as Japan and Sweden, which have infant mortality rates of 2.13 and 2.60 per 1,000 live births, respectively (CIA, n. d.). There are also developing nations that have lower infant mortality rates than the United States, such as Serbia, whose infant mortality rate is 6.16 deaths per 1,000 live births, as shown in Appendix A).

Infant mortality rates in the United States vary greatly among regions, states, and even counties (shown in Appendix B). While the infant mortality rate has decreased in both the Appalachian and non-Appalachian areas of the United States over the past several decades, the disparity between infant mortality rates in the two populations has increased (Yao, Matthews, & Hillemeier, 2012). Current infant mortality rates in non-Appalachian populations in the United States are estimated to be 5.97 deaths per 1,000 live births while in Appalachia they are significantly higher at 6.73 deaths in 1,000 live births, as shown in Appendix B (Henry J. Kaiser Foundation, 2016). Decreased infant mortality rates in the United States would improve overall population health (CDC, 2016). Investigating factors contributing to the disparity in infant mortality rates in populations where rates are higher is crucial in identifying methods to decrease risk of infant mortality nationally.

In addition to infant mortality rates being increased, other adverse birth outcomes such as prematurity and low birth weight can also be telling in terms of a population's health. This is largely because adverse birth outcomes have not only been shown to impact health and development in early years, but they also have been linked to increased risk of developing chronic disease and poor health outcomes in later years. This suggests that addressing adverse birth outcomes may help decrease the burden of chronic diseases in the future (Pies et al., 2012). Maternal health is highly associated with birth outcomes (Pies et al., 2012). While adverse birth outcomes have been shown to be decreasing in urban areas of the United States since 2006 (Kent et al., 2013), low weight and preterm births as well as infant mortality have not decreased in rural populations (Braveman et al., 2010; Kent et al., 2013; Lisonkova, Sheps, Janssen, Lee, Dahlgren, & MacNab, 2011; Yao et al., 2012).

There has been little research completed to understand the disparity that exists between rural and non-rural populations in terms of adverse birth outcomes (Braveman et al., 2010), with little literature and research completed to understand relationships between rates of adverse birth outcomes and the causes in Appalachia specifically. Populations in Appalachia may be at increased risk for poor health, as it is impacted heavily by low SES and inequity (Yao et al. 2012). This inequity has been associated with increased rates of divorce, crime, violence, and risky behavior (Wilkinson & Pickett, 2010). These factors and others can be traumatic for a child and are collectively known as ACEs, which have been associated with everything from diabetes to depression and cardiovascular disease (Danese et al., 2009). No research exists to date to examine the relationship between a mother's exposure to ACE and the birth outcome of offspring, although research does indicate that rural Appalachian regions may be at greater risk for exposure to ACE. Over half of the population has had lifelong exposure to trauma, such as divorce, violence, neglect, or abuse, and 44% of the population reported exposure to three or more of these traumas (Sprang et al., 2013). As Appalachia is a unique culture that is more likely to be impacted from factors associated with ACEs (Danese et al., 2009), examining the rate and association of adverse birth outcomes in relation to exposure to ACE appears vital to better understand the disparity that exists regarding infant morbidity and mortality in this population, which is supported through statistics provided in Appendix A.

Purpose of Study

The purpose of this study was to quantitatively examine the association between maternal exposure to ACEs and adverse birth outcomes, such as low birth weight. This was completed while controlling for extraneous variables of pertinent medical history including history of diabetes, history of heart or cardiovascular disease, and acute conditions that would predispose women to risk adverse birth outcomes of children. Behavioral risk factors were also controlled for such as smoking status, use of prescription and nonprescription drugs, and consumption of alcohol. Obstetrical history, such as history of complicated pregnancy, were also considered. Demographics of age and race, as well as SES, were also controlled for in the respondents, who were selected at the county level in Appalachia, Ohio.

Research Questions and Hypotheses

This study utilized the LCA to examine the relationship between maternal health, exposure to ACE, and low birth weight. The study accounted for extraneous variables of socioeconomic determinants, demographics, and obstetrical history in an Appalachian population. There are a number of questions that deserve attention in terms of ACE in the Appalachian population.

RQ1: What is the difference between county of residence in Appalachian maternal populations in relation to ACE?

$H_0 1$: There is no difference between county of residence in Appalachian maternal populations in relation to ACE.

$H_A 1$: There is a difference between county of residence in Appalachian maternal populations in relation to ACE.

RQ2: What is the association between maternal exposure to ACE and increased risk of low birth weight infants in an Appalachian population?

$H_0 2$: There is no association between maternal exposure to ACE and low birth weight infants in Appalachia.

$H_A 2$: There is an association between maternal exposure to ACE and low birth weight infants in Appalachia.

RQ3: What is the difference in the impact of types of ACE on birth weight in the Appalachian population?

$H_0 3$: There is no difference in the impact of types of ACE on birth weight in an Appalachian population.

H_A3: There is a difference in the impact of types of ACE on birth weight in an Appalachian population.

Theoretical Framework

The LCA is a multidisciplinary paradigm initially made to study contexts, lives, and social change. Developed in the 1960s, it has been used to study how events impact involvement in crime, marital status, or even disease incidence (Mayer, 2009). The LCA has been used to study people within the social and historical contexts that they live, making this theory fully founded in the natural world and allowing the paradigm to be used in applying to populations when considering a myriad of factors (Mayer, 2009). The LCA has been used extensively to study exposure to ACE in relation to increased risky behavior and adverse health outcomes (Danese et al., 2009). As a result of Shonkoff et al.'s (2009) study examining biodevelopment and its association with poor health outcomes later in life, this theory has been used to provide a framework for research into early life in an effort to prevent adverse health outcomes.

In this, the concept of intergenerational health is an important tenant of the LCA model, which allows relationships between intergenerational health and individual health to be examined. Also, through the LCA and the impact of ACE on maternal health, the additive effects of smoking, diabetes, violence, and stress were considered in terms of incidence of low birth weight as these factors have been found to be associated with increased exposure to ACE. As LCA is founded in the natural world and considers tenets such as intergenerational health and society as impacting one's lifelong health, this theoretical framework allows the research conducted for this study to fully consider a number of factors impacting maternal health and birth outcomes in the population of interest.

Nature of Study

Based on the research questions and hypotheses, a quantitative methodology was chosen for the study. SES, stress, prior abuse, and neglect negatively impact maternal health and birth weight. However, studies have not yet examined associations that may exist between maternal exposure to ACE and birth weight, even though these risk factors of stress, abuse and neglect are all components of ACE. The purpose of the study was to determine if exposure to ACE in mothers was associated with increased incidence of low birth weight deliveries in an Appalachian population. This study used quantitative methods to better understand the relationship between maternal exposure to ACE and low birth weight incidence in a population, as this methodology best fits the research questions and hypotheses of the study. The design of this study was a cross-sectional analysis, a type of observational study that analyzes data collected from a population at a specific time (Campbell & Stanley, 1963). Cross-sectional analysis was chosen as the study design allowed for the collection of data using a survey in a specific population at one point in time. It is hoped that this study will help to provide the foundation for future studies into the associative nature of ACE exposure in maternal health and adverse birth outcomes, such as low birth weight.

Research to date has not considered what role maternal exposure to ACE may have on birth weight of offspring. Braveman et al. (2010) were interested in determining the exact influence of exposure to ACE has on a number of other health concerns, such as high blood pressure and cardiovascular disease (Braveman et al., 2010) but few have considered the impact on maternal health. Thus a basic foundation for future studies has not been created. A chi-square analysis was used by Braveman et al. (2010) and Chung et al. (2010) used trend analysis to examine effects of ACE in populations, while odds ratios were also used to predict the likelihood of factors affecting adverse birth outcomes in populations, supporting the use of chi-squared tests for use in studies examining ACE. A chi-squared analysis and log-linear regression were used for data analysis in this study due to the categorical nature of the data collected.

Study Design

The use of quantitative methods and the cross-sectional design for this study have a number of strengths to support its use. Strengths associated with the cross-sectional design include providing credibility to the association of maternal exposure to ACE and low birth weight as well as exposing the hypothesis to disconfirmation. In addition, cross-sectional studies are ideal as they do not require many resources and can be employed in a natural setting (Campbell & Stanley, 1963). An observational study was chosen rather than an experimentation due to the vulnerability of the population in question and adhering to ethics set forth by the Institutional Review Board. Also, maternal exposure to ACE (the independent variable) occurred in childhood or in the past, which was beyond the control of the researcher, thereby eliminating the opportunity for manipulation of the independent variable that is required in true experimentation.

Variables

Independent variable.

The independent variable, which was maternal exposure to ACE in this study, is defined as abuse (emotional, physical, and sexual), neglect (emotional and physical), and household dysfunction (witnessed domestic violence, household substance abuse, household mental illness, parental separation or divorce, and incarcerated household member) before the age of 18 (CDC, 2016). In regard to ACE, there are acts of commission, child abuse, acts of omission, and child neglect. Acts of commission include physical, sexual, and psychological abuse and have been defined specifically as ACE by the CDC for purposes of future studies (CDC, 2016).

These acts are deliberate and intentional, although harm to the child may not be intended. Physical abuse can be defined as a caregiver causing physical pain to a child. Examples include excessive hitting, biting, punching, smacking, and shoving (CDC, 2016). Sexual abuse can be defined as a caregiver forcing undesired sexual behavior on an adolescent (CDC, 2016). Psychological abuse is when caregiver's subject children to psychological trauma, including depression and anxiety. Examples of this are dominant behaviors, over controlling, verbal aggression, and diminutive speech (CDC, 2016; Merrick & Latzman, 2014).

Child neglect includes physical neglect, medical neglect, inadequate supervision, exposure to violence, emotional neglect, and educational neglect. Neglect is a passive form of abuse that can be just as detrimental to child development (CDC, 2016). Neglect occurs when the caregiver is responsible for care and has failed to provide this in some aspect to the child. For all forms of ACE, caregivers are considered those who provide help or support for daily living activities of those who are not able to (CDC, 2016; Merrick & Latzman, 2014).

Dependent variable.

The dependent variable for this study was low birth weight, which is defined as an adverse outcome, with offspring weighing less than 2,500 grams (g) at birth, where normal birth weight falls between 2,500 g and 4,200 g (World Health Organization [WHO], 1992). This is regardless of gestational age. Low birth weight can be further subcategorized into very low birth weight, which is less than 1,500 g, and extremely low birth weight, which is less than 1,000g

(WHO, 1992). Low birth weight may be caused by preterm birth, another adverse birth outcome (WHO, 1992). There is also an association between the age of the mother, having multiple pregnancies, poor nutrition of the mother, hypertension or heart disease in the mother, and substance abuse (Martin, Connelly, Bland, & Reilly, 2016).

Covariates*:* There are a number of covariates that were considered in this study. Respondents' personal history of diabetes was controlled for, as diabetes has been found to be associated with decreasing fetal nutrients and impacting gestational growth of the fetus negatively, often resulting in physiological responses of increased rate of insulin production (Martin et al., 2016). Diabetes is diagnosed based on high levels of blood sugar over an extended period of time. Diabetes was defined in the study as a medical diagnosis of such from a physician. Diagnosis of diabetes was determined through question 10 of the survey, and respondents were excluded if they answered yes to this question.

Presence of heart or cardiovascular disease can be associated with decreased size in offspring (Martin et al., 2016). For the purpose of this study, cardiovascular disease had to be diagnosed by a physician and included coronary artery disease, hypertensive heart disease, cardiomyopathy, valvar heart disease, aortic aneurysms, venous thrombosis, aortic aneurysms, rheumatic heart disease, and angina (WHO, 2011). This was determined through question 10 of the survey by asking if respondents had a history of cardiovascular disease, high blood pressure, stroke or diabetes as diagnosed by a physician. Respondents were excluded if they answered yes to this question.

Behavioral risk factors have been associated with increased risk of low birth weights and therefore were defined as a covariate (Martin et al., 2016). For this study, these behaviors included the use of tobacco in any form on a daily, weekly, or monthly basis (Sharby, 2005). In addition to smoking, substance abuse was determined in the respondents including alcohol, street drugs, and prescription medication. This includes medication that is not prescribed to the respondent or is prescribed and not taken in the recommended manner (Sharby, 2005). Evidence of respondents' participation in risky health related behaviors that was found in questions 9, 12, and 14 of the survey was used to exclude those respondents from the study.

Obstetrical history was also considered as a covariate. Respondents were asked if they had a complicated history or were ever diagnosed with a complicated pregnancy in question 4 of the survey. Those who answered positively were excluded from the study.

Demographics for use in this study included the respondents' age, race, ethnicity, education, income, marital status, and employment status. This was determined using questions 1, 5, 6, 7, 15, 16, and 17 of the questionnaire. None of these questions were used for exclusion purposes; rather, they were used for descriptive purposes. Sex is irrelevant to consider as all respondents had to have had a child, and were by necessity female. Respondents were between 18 and 34 years of age at the time of childbirth, as this is considered child bearing years, birth outside of these parameters become high risk increasing the chance of adverse birth outcomes (CDC, 2016). The overwhelming majority of respondents were Caucasian, which was expected as Appalachia is largely made up of this race.

Methodology

The population of interest were women that have given birth within the last two years (2014-2015) and are not currently pregnant. In addition, they were between the ages of 18 and 34 when they gave birth and reside in selected Appalachian counties in Ohio. Respondents were identified in collaboration with Ohio Department of Health (ODH). The approval for this protocol through the Institutional Review Board (IRB) at ODH can be found in Appendix K. The Office of Vital Statistics and Registry at ODH provided a list of women that have given birth in the last two years in the counties selected, including names and addresses. This information is stored in an electronic vital statistics database and is available in the ODH data warehouse. Random number generation was used to select the Appalachian counties in Ohio and used again to obtain specific respondents in the selected counties from the lists provided by ODH. Questionnaires were mailed to potential respondents with the purpose of obtaining medical history as well assessing risk factors impacting maternal health. In addition to this, the questionnaires provided information about the amount, type, and nature of maternal exposure to ACE. Birth weight of offspring was determined to be either low weight or not low weight through question three on the survey. Once respondents completed the questionnaire, they were instructed to return it to the researcher.

This study employed the use of questionnaire developed, available, and authorized for use by the CDC. The questionnaire is not copyrighted by the CDC and states that it can be used for the research community, as shown in Appendix J. There are two parts to the questionnaire: A family health history questionnaire (FHHQ) and a health appraisal questionnaire (HAQ). In order to ensure higher response rates, protect the respondents from undue stress, and provide better confidentiality, at the request of ODH IRB, the questionnaires have been condensed into one questionnaire. This questionnaire was used to obtain information about the respondent, such as race, SES, education, obstetrical history, and Appalachian status. This information helped to provide insight and account for variables. The questionnaire also collected data concerning past pregnancies, behavioral risk factors, and exposure to ACE.

Although it was originally intended to use correlation and regression to analyze the data collected in order for the researcher to better to understand the relationship between maternal exposure to ACE and low birth weight deliveries, chi-square analysis and log-linear regression were used to analyze the data based on the categorical nature of the variables. The respondents were divided into clusters to study the differences between and among counties regarding maternal exposure to ACE and birth weight. This study proposed that there was a significant relationship with maternal exposure to ACE and birth weight in Appalachia, with the predictor value being the birth weight of the offspring. The data provided were categorical and satisfied the assumptions for chi-square analysis.

A chi-square analysis was also used to understand if ACE exposure and low birth weight varied among the different types of counties in Appalachia, Ohio. Log-linear regression was used to understand the impact of type of ACE on low birth weight. These findings were reported in the results section in tables and graphs to better show relationships and differences in the Appalachian population of Ohio and the disparity that exists between counties. Effect size of these relationships were defined using Cramer's V.

Definitions

Adverse Birth Outcomes: Adverse birth outcomes refer to poor outcomes of birth, excluding mortality. Preterm birth, defined as birth before 37 weeks of gestation, and low birth weight, defined as weighing less than 2500 g at birth, are two types of adverse birth outcomes

(Anum, Retchin, & Strauss, 2010). They can lead to higher rates of infection and illness and may be linked to chronic problems later in life (Anum et al., 2010).

ACE: Adverse childhood experiences (ACEs) are defined as a traumatic event or a series of events that occur to a person before the age of 18. ACEs include forms of abuse, neglect, mental illness of a household member, divorce or separation of a parent, domestic violence towards a parent, incarceration of a member of the household, illegal drug use in the household, or problematic drinking in the household (CDC, 2016).

Appalachia: Appalachia is a geographic area in North America that is comprised of a mountain system and the surrounding foothills. It extends into Canada and down into Georgia and Alabama. The area touches 13 different states, with the State of West Virginia being completely in Appalachia (ARC, 2016). Historically, this area of the United States is harder hit by socioeconomic disparities and economic hardships (ARC, 2016). A map of the region is in Figure 1.

Figure 1. The Ohio Appalachian Region. This figure illustrates the Appalachian Region, specifically highlighting the Appalachian Region in Ohio. Taken from Appalachian Regional Commission (2016).

LCA: The Life Course Approach (LCA) has also been termed the life course perspective or life course theory (Mayer, 2009). It refers to looking at health within social, cultural, and structural contexts. The theory historically has looked at a person's life history in order to fully understand health of today (White & Klein, 2008). The approach looks at early life as a health foundation, with all medical implications or behavior to stem from this (White & Klein, 2008). The approach focuses on the interconnectivity of people, both through communities and intergenerationally, and looks explicitly at the socioeconomic context or history of the individual to fully understand their action or health today (Mayer, 2009).

Maternal Health: Maternal health is defined as the health of a female during pregnancy, including the childbirth process and the antepartum period (WHO, 2016). Maternal health includes chronic diseases, the female's nutrition, access to care, the education that she has had, and past obstetrical history (WHO, 2016).

Rural: Rural refers to geographic areas outside of towns with low population density (ARC, 2016). Agricultural areas and forests are common in rural areas and often these areas have less access to financial resources and support than urban areas (ARC, 2016).

SES: SES is a term that pertains to the class or social standing of a person (American Psychological Association [APA], 2016). It has also been defined as the combined total of a person's work experience and the position or economic status of the person's family (APA, 2016). It is often used as a measure of three factors: education, occupation, and income.

Assumptions

There are a number of assumptions that this study operated under. The following are a list of these assumptions.

- The data collected were categorical. This assumption supported the selection of the study design, statistical analysis, and use of the selected measurement scale as categorical data must be analyzed using specific statistical tests.
- The birth records used for mailing from ODH were accurate and correct.
- Archived records obtained were correctly interpreted and coded for data analysis.
- The instrument used to obtain data had been verified to be valid and was reliable to use with the population in question. The CDC has worked to ensure the validity of the tool as this tool has been used in numerous studies concerning ACE (CDC, 2016).
- Estimates on infant mortality rates and low birth weights provided by other studies and national data warehouses are accurate and current. These estimates were obtained through census information which is assumed to be a fairly accurate portrayal of the population (America's Health Ranking, 2017; Henry J. Kaiser Foundation, 2016).
- The impact of ACE on maternal health is moderate. This assumption comes from the results of other studies that found this.
- The people of the population were born and resided most of their childhood years in Appalachia. This was determined through birth records and question 5 of the survey. Those respondents that were not considered Appalachian were excluded for the purposes of this study.
- The population was not able to modify their exposure to ACE.

- ACE increases the likelihood of risky behavior, as well as the likelihood of negative health consequences.

Scope and Delimitations

Scope

This study intended to look at specific aspects of ACE as related to maternal health and adverse birth outcomes. These aspects were as follows:

- The rate of occurrence of low birth weights in various Appalachian counties was determined. This was compared to data obtained from census tracking on non-Appalachian populations in surrounding areas as well as other types of Appalachian counties. This was to determine if trends exist in low birth weights among various Appalachian counties in Ohio.
- Comparisons between groups were made to determine differences in impact of ACE on maternal health. This was completed by using predetermined groups of counties as defined by ARC and improved the internal validity of the study.
- There was a comparison of low birth weights in surrounding communities, both Appalachian and non-Appalachian, to examine the possibility of trends or differences in Appalachian Ohio counties in terms of low birth weight. Again, this helped to improve internal validity.
- The exposure of mothers to ACE in this population was determined through the use of a valid measurement tool, the questionnaire that was developed by the CDC in collaboration with Kaiser Permanente that has been used in a number of other studies tracking the impact of ACEs.

- Associations between ACEs and increased risk of low birth weights were determined through statistical analysis using the software SPSS. The specific tests that were completed included Pearson's chi-square and Cramer's V.
- Further statistical analysis of data, using log-linear regression through SPSS software, differentiated between the types of ACE the mother was exposed to and impact on low birth weight.

Theories.

The study used the LCA theory in order to look at the history of women in terms of exposure to ACE and the relationship to health now, in terms of impact on birth weight.
The LCA considers a number of factors including social, historical, and cultural aspects (Mayer, 2009). These aspects are necessary to understand in order to fully appreciate the impact of ACE on women. The LCA provides the contextual background to the audience in order for them to understand the results in a contextual capacity.

The health belief model was considered as a theoretical foundation for the study as it is derived from the numerous behavioral choices of the mother impacting the child (Pies et al., 2012). However, it assumes that the population has a choice of modifying the behavior, and in this case the behavior, ACE, is not one that the respondents had control over. Biopsychosocial model, which considered disease outcomes in terms of psychological, social, and biological factors (Creswell, 2013) was also considered for use in this study as it was suspected that a number of factors impact low birth weight. While this theory was relevant to the topic of study, it did not address the independent variable, which was exposure to ACE that occurred in the past. This theory does not consider health as cumulative, like the LCA does, and therefore it was excluded as well.

Generalizability

Software systems were used in analysis of data, as well as the tracking and selection of respondents. The use of software systems for random selection of respondents helps to improve the generalizability of the study (Creswell, 2013). In addition to this, the study occurred in a natural setting where there was no manipulation of variables, increasing the generalizability of results to populations at large. This study used a tested and validated measurement tool developed by the CDC and Kaiser Permanente. The validity of the test has been proven with use in studies (CDC, 2016), also increasing the generalizability of the results from this study. Lastly, as this study was a cross-sectional study and a large number of respondents were surveyed, findings were reflective of a greater population at large, which is one of the strengths of choosing the cross-sectional design (Creswell, 2013).

Delimitations

There were boundaries to consider for both the study population and theory. The population consisted of women born and living in the Appalachian area of Ohio, which was determined by ODH and verified by question five in the measurement tool. Women that were not born in the area but have given birth in the area were excluded from the study population. In addition, the respondents were selected from specific counties of Noble, Monroe, Perry, Highland, Jackson, Pike, Morgan, Meigs, Scioto, Athens, Coshocton, Jefferson, Washington, Muskingum, and Guernsey.

Figure 2. Appalachian counties in Ohio. The highlighted counties are all considered Appalachian counties in Ohio. Women were between the ages of 18-34 as determined by ODH and verified by question one of the survey. Those older or younger have an increased risk for complications of birth (Kent et al., 2013) and thus were not included in the initial data query from ODH, where the age range was set from 18 to 34 years of age.

Limitations

Study Design

There were several limitations that are present in the study. One of the limitations was associated with inherent weaknesses of the study design that was chosen. A cross-sectional design does not allow for direct control of variables, including confounding variables (Campbell & Stanley, 1963). This study attempted to account for many of the confounding variables through using a largely homogeneous population. This population is largely of the same SES, educational levels, and racial and ethnic backgrounds (ARC, 2016).

Confounding variables can impact the search for statistically significant relationships (Campbell & Stanley, 1963). To account for confounding variables, the questionnaires were developed to reduce the potential impact of confounding variables on the results of the study.

This was accomplished through the removal of respondents that answered affirmatively to the confounding variables presented on the questionnaire and previously defined in the chapter. While these variables have been minimized as much as possible, they still existed within the study.

Construct Validity

Other limitations of the study included concern with the population itself as well as the construct of ACE. The Appalachian population is not trusting of outsiders and a distinctive culture exists (Esch & Hendryx, 2011). Because of this, it may have been difficult to obtain accurate information from the respondents without forging a trusting relationship first. As the study operated under time constraints, forging a trusting relationship would be difficult and could have impacted the results of the study.

There were also concerns with ACE that were present in this study. Questionnaires concerning ACE often require respondents to share information that is difficult to discuss and individuals may not be forthcoming with this information, affecting the accuracy of the information obtained. This concept aligns with social-desirability bias, which is the bias that exists when respondents want to portray things as how they think society feels they should be rather than how they truly are (Stuart & Grimes, 2009). As this study was concerned with measuring the amount of negative childhood experiences, it was difficult to fully understand the impact of this bias and account for it, although there were measures taken to reduce social-desirability bias.

The questionnaires were reviewed and all non-pertinent questions were removed to facilitate residents answering the questions. In addition, the respondents were asked not to provide return addresses and the questionnaires were tracked only at the county level with color coding. This was to ensure as much privacy and anonymity as possible in hopes of accurate data collection.

Population

Another limitation was segmentation within the Appalachian population and the fact that some subsections of the population are difficult to reach, including those subsections that may not be a part of the census or file for birth certificates. This would include people associated with Amish culture, which has a stronghold in Appalachia, and their numbers are estimated to be relatively substantial (ARC, 2016). It is difficult to obtain information concerning this group of people as they do not participate in census gathering. As a result, they are often discounted, as their information is not available to the public.

There was no chance that these segments of the population were selected as part of the sample, which reduces the validity of the random sampling of the study. Another limitation that was considered were the literacy rates in Appalachia. As Appalachia has lower rates of literacy, conducting interviews would have been the best option for collecting data. However, this study had resource and time constraints that would not allow for in-person interviews. In order to accommodate for this limitation, the questionnaire was reviewed and the reading level was suggested to be 5th grade (CDC, 2016), which would be considered adequate for this population.

This study was dependent on respondents' accurate recall from childhood, which can prove difficult especially in terms of trauma, where memories may have been blocked as a coping mechanism. As a result, the construct validity of the study in regard to the questionnaire was considered. This study used a questionnaire that asked only if things happened rather than any details in order to reduce the limitations of recall bias. It is also important to note that there may have been outside factors that affected the answers of respondents, such as fear of family members finding out or fear of being judged from answers given in regard to ACE.

Significance

The findings of this study have great potential to facilitate social change. Results and data of the study have provided a more in-depth knowledge concerning the factors that contribute to the differences in adverse birth outcome rates in Appalachians vs. non-Appalachian populations. In addition, the study has provided data that could be used to support changes in policy with resulting improvements in programs related to maternal health programs. As the study used the LCA as a framework, insights about programs to improve maternal health could also be used to address increased rates of chronic disease in populations or even to reduce rates of chronic disease (Pies et al., 2012). The study also helped to further define variables that are associated with low birth weight in the population. Data and results obtained from the study could inform the direction of future funding of programs to reduce health disparities impacting this population.

While this study focused on Appalachian populations, the findings have potential to impact populations on a global level. Rural populations in general share a number of characteristics with this population and predictive models could be developed from the data in this study regarding maternal exposure to ACE and risk of low birth weight. Through further investigation of other populations in the United States, commonalities may be identified with the population that was selected in this study, with resulting changes in programs and health interventions. The data, relationship between variables, insight into rural populations, and best practices identified through this study should now be discussed with policymakers, allowing the findings to impact policies at all levels of government and in many populations.

Summary

This chapter has provided information and a background regarding the impact of maternal exposure to ACE on low birth weight in Appalachia. Infant mortality is still a concern in the United States, with areas such as Appalachia having higher rates (Henry J. Kaiser Foundation, 2016). In addition to mortality, this population is also at greater risk for adverse birth outcomes (Kent et al., 2013). While urban populations have been studied more to better understand causative agents of adverse birth outcomes, little research has been completed on maternal health in Appalachia in general and even less specifically targeting low birth weight.

In addition to this, research is beginning to look at the effects of ACE on health in early years as well as later years to understand the true impact of childhood. Many researchers have used the LCA to better understand the impact of ACE in its totality on one's health to include Barker et al. (201), Pies et al. (2012), and Shonkoff et al. (2009). Moreover, some populations may be at greater risk of exposure to ACE than others, such as Appalachian populations (Kent et al., 2013). As a result, a distinctive gap in knowledge has been established concerning Appalachia and the impact of maternal exposure to ACE on birth weight. The intent of this work was to study this further in hopes of improving Appalachian population health and supporting future research for better health interventions. Therefore, this chapter provides substantial background for the succeeding chapters.

Some of the information in this chapter specifically shows the gap in knowledge regarding maternal health in Appalachia. This gap is further explained in Chapter 2, which serves as a synopsis of the literature. The strategy for research and literature review is also outlined in Chapter 2.

Following the literature review, Chapter 3 serves to further discuss the research dynamics that have been introduced in this chapter. This includes a more in-depth discussion of the variables, the design, and any constraints. In addition, the population is discussed in terms of definition and size. The population is further discussed in terms of sample size and power of the study. While discussed in this chapter partly, validity is further discussed in Chapter 3, as well as operationalization. Finally, ethical considerations are also discussed in Chapter 3.

Chapter 4 reports the results from collecting data through methods outlined in Chapter 3. In addition to baseline demographic data, Chapter 4 also describes the sample and delineates the time frame for data collection. Tables and figures are provided in this chapter as well as a discussion of the statistical analysis, including post-hoc testing.

Chapter 5 serves to summarize the key findings of the study and offers an analysis of the findings. Limitations in Chapter 1 were revised in this chapter as well, with reflections on findings and the study itself. This builds on the findings in Chapter 4 to provide both recommendations for future research and social change implications.

Chapter 2: Literature Review

Introduction

Problem Statement

Infant mortality has been recognized as one of the best indicators of the health of a population (CDC, 2016). This is concerning as the United States, one of the most powerful nations has higher rates of infant mortality than other countries (CIA, n. d.), indicating that the health could be greatly improved. Within the United States, there is great variation among regions as far as infant mortality is concerned, indicating a disparity (as shown in Appendix B). The disparity between Appalachian and non-Appalachian populations in terms of infant mortality has increased in the past several years, indicating a growing problem (Yao, Matthews, & Hillemeier, 2012). As a result, more factors that could contribute to this disparity should be investigated to determine what the root cause is in order to develop more effective health interventions while improving infant mortality rates on a national basis.

Adverse birth outcomes such as low weight and preterm births are also increased in Appalachian populations (Yao et al., 2012). Adverse birth outcomes have the potential to impact individuals well into their future and cause chronic diseases later in life (Pies et al., 2012). This suggests that addressing adverse birth outcomes may help decrease the burden of chronic diseases in the future (Pies et al., 2012). While adverse birth outcomes have been decreasing in urban areas of the United States since 2006 (Kent et al., 2013), low weight and preterm births as well as infant mortality have not decreased in rural populations (Braveman et al., 2010; Kent et al., 2013; Lisonkova et al., 2011; Yao et al., 2012).

There has been little research to understand the disparity between rural and non-rural populations in terms of adverse birth outcomes (Braveman et al., 2010), with even less understanding about rates and causes of adverse birth outcomes in Appalachia specifically. Populations in Appalachia may have increased risk for poor health as it is impacted by low SES and inequity (Yao et al. 2012), which has been associated with increased rates of divorce, crime, violence, and risky behavior (Wilkinson & Pickett, 2010). These factors and others can be traumatic for a child and are collectively known as Adverse Childhood Experiences (ACE), which have been associated with everything from depression to diabetes and cardiovascular disease (Danese et al., 2009).

No research to date exists that has examined the relationship between exposure to ACE of the mother and the birth outcome of offspring. Rural Appalachian regions may be at greater risk than urban populations for experiencing ACE. Over half of study populations have reported lifelong exposure to trauma, such as divorce, violence, neglect, or abuse, with 44% of the population reporting exposure to three or more of these traumas (Sprang et al., 2013). As Appalachia is a unique culture that is more likely to be impacted by factors associated with ACE than urban counterparts in the same area (Danese et al., 2009), examining the rate and association of adverse birth outcomes in relation to ACE and maternal health appears vital to better understanding the disparity that exists regarding infant morbidity and mortality in this population.

Purpose of Study

The purpose of this study was to quantitatively examine the association between maternal exposure to ACE and low birth weight. This was accomplished while controlling for extraneous variables, such as any significant medical history. This included history of diabetes, history of heart or cardiovascular disease, and other chronic and acute conditions that have been associated with increased risk for adverse birth outcomes. Behavioral risk factors were also controlled for including smoking status, use of prescription or nonprescription drugs, and alcohol use. Obstetrical history was considered in terms of history of diagnosis of high risk or complicated pregnancies. Demographics such as age and race as well as SES were controlled for in the respondents. This was accomplished through the use of a homogenous population. Selection occurred at the county level.

This chapter serves to further highlight the knowledge gap concerning maternal health in Appalachia related to ACE and low birth weight offspring. The theoretical foundation is discussed in relation to current literature as well as how it supports research questions and hypotheses of the current study. Methods for conducting the literature search are delineated in the chapter as well as a summary of the major themes found in current literature. From this, a major gap in research is defined that the current study intends to address concerning maternal exposure to ACE and risk of low birth weights in Appalachian populations.

Literature Search Strategy

An extensive literature review was completed using several databases to determine current findings about maternal health and low birth weight deliveries in relationship to ACE. As the population for the proposed study was Appalachian, there was also a focus on maternal health in Appalachia. The Walden University Library and PubMed were searched for articles with the following key words: *birth outcomes*, *low birth weight*, *infant mortality*, *maternal health*, *adverse childhood events*, *trauma in childhood*, *violence*, *abuse*, *rural*, and *Appalachia*.

This search initially yielded over 500 articles. After careful analysis, it was found that less than 50 articles could be considered relevant to the research. While these articles provided information about ACE, maternal exposures, low birth weight, and Appalachia, none of the articles consider all key elements at once. This indicated a gap in the current literature in terms of birth outcomes in Appalachia and certain maternal risk factors, such as exposure to stress or traumatic events in early life, which should be examined to develop more effective interventions.

Theoretical Foundation

The theoretical framework that was determined to be most in line with the purpose of the study was the LCA. It was initially developed as a way to examine how events in early years impact social concerns, such as crime and development of relationships. In recent years, it has been increasingly used as framework to determine impacts on health and disease states (Mayer, 2009). LCA has been used extensively in studies to determine what impact a population's social status and history has on current health, thus considering a myriad of factors when assessing current health concerns (Pies et al., 2012). It is the leading framework to examine associations with ACE, such as high blood pressure, diabetes, and chronic disease (Danese et al., 2009; Holzman, 2009; Pies et al., 2012;). As Shonkoff et al. (2009) used LCA in order to examine biodevelopment and its association with poor health outcomes later in life, this theory has been used to provide a framework for research into early life and efforts to prevent adverse health outcomes.

There are numerous studies that have been completed concerning ACE. The validity of these studies often comes into question, as most rely solely on retrospective methods for collecting data. Pinto et al. (2014) was concerned that recall bias, which is the systemic error caused by difference in accuracy and completeness of recollections by study participants, could be impacting the accuracy of all retrospective research completed on ACE. They used the Pearson correlation to determine if adversity of study participants in regards to ACE was felt equally at two different points in time (Pinto et al., 2014). The findings were not in total agreement with previous reliability testing of ACE questionnaires, especially regarding the stress felt when sexual assault occurred. However, after looking at multiple questionnaires and comparing adversity felt by study participants across various time periods, it was found that feelings of adversity in study participants remained markedly the same at all time points, and it was concluded that recall bias impacted most ACE studies minimally (Pinto et al., 2014).

Whereas Pinto et al. (2014) found that reliability of the ACE questionnaire was impacted by some factors more than others, i.e. sexual assault, Ford et al. (2015) found evidence in greater support of the reliability and validity of the ACE questionnaire. By considering each type of ACE as a single construct rather than a groups of experiences, data analysis revealed positive Pearson's correlation between the reliability of ACE questionnaire and actual exposure to ACE. This supports the use of the ACE questionnaire developed by the CDC, as an appropriate measure of ACE as long as each type of ACE is considered as a single construct, such as neglect, physical abuse or sexual abuse rather than ACE considered as a groups of experiences.

Looking further at the methods and design of previous research concerned with low birth weight, maternal health, and ACE, most studies indicated that questionnaires were developed and sent in the mail for individuals to answer. However, a number of studies used actual interviews with clients (Christiaens et al., 2015; Leneers et al., 2013; Seng et al., 2011; Seravalli et al., 2014; Witt et al., 2014). All of these researchers indicated the same drawback to using personal interviews rather than questionnaires. They all indicated that their research was likely limited by social desirability bias, although response rates were improved (Leneers et al., 2013; Seravalli et al., 2014; Seng et al., 2011; Witt et al., 2014). This indicates that while the response rates may be decreased for self-administered mailed surveys, they are less likely to be impacted by social desirability bias and more likely to accurately reflect the sample.

Literature Review

Birth Outcomes

As Gluckman, Hanson, Cooper, and Thornburg (2008) found that health was substantially impacted before birth by showing that insulin production increased during gestation, it is important to examine the factors that negatively impact maternal health in order to adequately address health. Focusing programs and research on early life and maternal health could have the largest returns in population health, as these findings could prevent negative impacts on health from the very beginning (Gluckman et al, 2008). Maternal health is a complex myriad of a number of factors, all which affect both the mother and the baby as indicated in Pies et al. (2012) work examining the impacts of mother's poor health on the cardiovascular health of babies. Knight, Kurinczuk, Spark, and Brocklehurst also added to this in their work with risky behaviors and mothers. Knight et al. (2009) completed an extensive meta-analysis examining how smoking, substance abuse, poor nutrition, stress, and socioeconomic determinants can impact maternal health, which in turn affects health of the child.

Specifically, one adverse birth outcome from poor maternal health that has been recognized is low birth weight in infants. Low birth weight can cause developmental delays as well as increased risk of chronic disease such as diabetes and cardiovascular anomalies, which has led to its consideration as an adverse birth outcome (Goldenberg, Culhane, Iams, & Romero, 2008). Love, David, Rankin, and Collins (2010) completed extensive research in order to determine relationship of maternal health risk factors and the incidence of low birth weight, finding that increased levels of risk factors had a positive correlation with incidence of low birth weight. (Love, David, Rankin, & Collins, 2010). As many of these studies define their problems as the high levels of low birth weight and their purpose as determining what effect independent variables such as smoking or poor nutrition has on it, the LCA has been the most widely used theory in this associated research (Goldenberg et al., 2008; Love et al., 2010). The framework provides an integrated concept that allows researchers to examine a number of factors at specific times in a person's life in relation to poor health outcomes, including low birth weight (Love et al., 2010).

Infant mortality is used frequently to measure the health of a nation (CDC, 2016). This is used as an indicator of health largely because factors that contribute to the mortality rate also impact the health of the entire nation (CDC, 2016). Directly associated with infant mortality rates are adverse birth outcomes such as low birth weight and preterm birth, which can impair offspring viability and health of an individual in later years (Johnson, Patel, Jegier, Engstrom, & Meier, 2013). Current research on infant mortality rates and adverse birth outcomes in the United States are conflicting, leaving many questions unanswered. MacDorman, Hoyart, and Matthews (2013) found that infant mortality rates have dropped since 2005 while Lau, Ambalavanan, Chakraborty, Wingate, and Carlo (2013) have found that infant mortality rates in the United States have not decreased.

Disparity in Birth Outcomes

Regardless of whether the trends are increasing or have plateaued on a national level, researchers agree that infant mortality rates in the United States are higher than they should be given medical advances and in comparison to other developed nations (MacDorman et al., 2013, Lau et al., 2013). In addition, disparities in rates between subpopulations in the United States have been found (MacDorman et al., 2013). Current research has become interested in determining why some areas still have high rates of infant mortality, allowing health disparities to persist.

Most current research on infant mortality rates have been in developing countries, as this is where it still poses the largest threat (Kim & Saada, 2013). A number of factors have been investigated in relation to infant mortality, preterm birth, and low birth weight. As developing countries still lack basic public health programs and environmental regulations, research about factors impacting infant mortality and morbidity has been limited to finding correlations between infectious disease such as HIV and syphilis (Hawkes, Gomez, & Broutet, 2013; Zack, Golan, Aboud, Msamanga, Speigelman, & Fawzi, 2014). Hawkes et al. (2013) and Zack et al. (2014), found that women with infectious processes had a greater risk to deliver preterm or low weight offspring. The impact of physical environment on birth outcome has also been studied in developing areas. The impact of use of fuel in rural areas of India has been studied in regard to increase in neonatal deaths (Epstein, Bates, Arora, Balakrishnan, Jack, & Smith, 2013).

As the number of infectious diseases is considerably lower in developed countries and environmental regulations more stringent, the focus of research has been on the natural environment. Stieb, Chen, Eshoul, and Judek (2012) completed a meta-analysis of current research to determine the impact of ambient pollution in developed countries on low birth weight and preterm birth. It was found that increased levels of ozone and other pollutants had no real bearing on birth outcomes such as preterm birth and low birth weight (Stieb et al., 2012), indicating that disparity in birth outcomes is likely due to other factors rather than pollution. Review of current research indicates that maternal nutrition maybe the most studied causative agent for preterm and low birth weight. Cnattingius et al. (2013) found that mothers being overweight could be malnourished leading to increased risk of preterm and low birth weight, where Katz et al (2013) found that women being underweight also led to increased risk of low birth weight.

Yu, Han, Zhu, Sun, Ji, and Guo (2013) argue that both obesity and being underweight impact birth outcomes. Their findings suggest pre-pregnancy underweight females have increased risk of small for gestational age and low birth weight infants (Yu et al., 2013). Their research also suggests that obese mothers are more likely to deliver large for gestational offspring (Yu et al., 2013). Yu et al. (2013) identified a number of covariates that should be explored in further studies, specifically studies within and among subpopulations of the United States. This research also suggests that malnourishment of populations exists across subpopulations in many developed nations. While the research has shown that nutrition does impact birth outcomes, it does not explain the disparity that exists among subpopulations, such as that found in the United States.

MacDorman et al. (2013) investigated infant mortality rates in the United States specifically and trends in time that may have developed. Their research suggests after rates plateaued in 2005, and infant mortality began to drop by 12% in the United States over the next 6 years (MacDomran et al., 2013). Mac Dorman et al. (2013) also suggest the most significant decrease in infant mortality was in the southern portion of the United States, an area marked by more of the population living at or below poverty levels. These findings suggest that current health interventions and research are correctly targeting causes of infant mortality. However, there is disagreement from other Kent McClure, Zaitchik, and Gohlke (2013) that state that disparity in infant mortality still exists in the United States in spite of current practices.

Kent et al. (2013) chose populations in Alabama to determine if surrounding environment played a role in determining birth outcomes in the United States. They chose this population as they were interested in determining if there was an association between area level variables and adverse birth outcomes, specifically if there were differences between rural and urban populations. Kent et al. (2013) used logistic regression to look at populations within one geographic location. They found that overall, levels of adverse birth outcomes such as preterm birth and low birth weight have decreased since 2006, which is what MacDorman et al. (2013) found. However, there was an increase in both preterm and low birth weight in areas of dense population or highly isolated areas. This suggests that there is increased risk of poor birth outcomes in highly urbanized areas and very rural areas. Kent et al. (2013) go on to argue that this difference in risk of adverse birth outcomes can be explained by population specific social or environmental factors, which exist in both very urbanized and very ruralized communities. This indicates that geographical location or type of community may not be the only factor affecting birth outcomes in a community, but also the ability of interventions to effect change.

Rural Health.

Further investigation by Kent et al. (2013) found that rates of adverse birth outcomes have not decreased in rural isolated regions in Alabama. Kent et al. (2013) considered race and SES as well, which had some bearing on rates of adverse birth outcomes and may have impacted results. These findings may in part explain the disparity in adverse birth outcomes, as isolated rural communities were found to be more at risk for adverse birth outcomes than their urban counterparts within the same state (Kent et al., 2013).

The correlation between rurality and increased risk of adverse birth outcomes has been studied more in depth in recent years. Hendryx et al. (2014) have looked at this connection in populations in West Virginia, a state located entirely in the Appalachian Region. This population was chosen as the rate of low birth weight was increased well above the national average and to understand what factors about rurality may increase the risk of adverse birth outcomes (Hendryx et al. 2014). Using latent class analysis, risk factors such as smoking, stress, drug use, prenatal care, low educational level, and parity were considered in regard to risk of low weight offspring (Hendryx et al., 2014). Hendryx et al. (2014) found that when mothers reported drug use and stress, they were at more at risk for delivering a low birth weight infant than their counterparts.

Kim and Saada (2013) have also investigated possible causes to the wide variation in infant mortality. Their approach was more holistic, considering the impact of social determinants of health on infant mortality rates as they felt that this may contribute to the disparity. A meta-analysis of current literature was completed to understand infant mortality rates in their context in the Western hemisphere (Kim & Saada, 2013). While their findings suggested that socioeconomic status (SES) plays a role in determining birth outcomes, when rates were considered at individual levels, there was a marked difference between rural and urban populations in the United States. In addition to this, Kim and Saada (2013) found it difficult to determine how much rurality impacted low birth weight as race confounded their research.

Maternal Health

Negrato and Gromes (2013) specifically researched trends in low birth weight offspring. Their work was founded on the premise devised by David Barker, that events occurring in the uterus and early in infancy predict likelihood of disease later in life (Negrato & Gromes, 2013). This is based partially on evidence of molecular changes that occur to the offspring in uterus. Negrato and Gromes (2013) were able to associate increased risk for a number of chronic pathologies to low birth weight. Negrato and Gromes (2013) speculate that low birth weight is a culmination of factors, such as stress, nutrition, and socioeconomic determinants. However, they did not investigate causative reasons for low birth weight specifically. In addition, while they did consider that in utero health of the infant impacts birth outcomes, they do not consider preconception health of the mother.

As evidence has shown that maternal health directly impacts adverse birth outcomes (Bailey & Byrom, 2007), it is important to consider maternal exposures to health risks. Maternal risk factors that have been studied in relation to low birth weight include access to care, socioeconomic, environmental, physical environment, nutrition, substance abuse, and smoking (Bailey & Byrom, 2007). Modifiable health behaviors such as nutrition, smoking, and substance abuse were the focus of the Ehrenthal, Minkovitz, and Strobino (2014) study in recent research, were the effectiveness of public health interventions to address low birth weight was examined. However, Braveman, and Gottlieb (2014) found that focusing on interventions further upstream determinants such as SES, there is a reduction in the risk of poor health choices, indicating that this is where focus of interventions should occur.

Modifiable Risk Factors.

Eisenhauer, Uddin, Albers, Paton, and Stoughton (2011) focused their research on completing a database on mothers that delivered low birth weight offspring in hopes of better understanding the role of modifiable behaviors in determining weight of infants. The registry was developed using birth registries, medical records, and interviews with women. Eisenhauer et al. (2011) found the modifiable risks most associated with low birth weights were alcohol use in pregnancy, drug abuse, and smoking. In addition, those with low birth weight offspring reported strain and stress in their life and an inability to cope (Eisenhauer et al., 2011). This database provides information on local data but also has the ability to provide information on a larger basis.

Mumbare et al. (2012) completed a comprehensive study of maternal risk factors by using a matched-pair case control study. This is unique as most studies looking at maternal risk factors are retrospective cross-sectional studies (Mumbare et al., 2012). Factors considered in relation to birth weight were weight gain prior to pregnancy, age, parity, economic status, and tobacco use, type of family, height, birth spacing, and pre-delivery weight. Covariates such as race and rurality were not considered, as well as prior exposure to stress. The study was mixed methods in nature and found that birth spacing, shorter status, decreased access to maternal health care, less maternal education, and lower maternal weight had the greatest impact on birth weight of the infant (Mumbare et al., 2012).

Mumbare et al. (2012) concluded from their results that maternal education level has an impact on birth weight of offspring. When maternal education level was considered in addition to low maternal weight and low maternal height, the risk for low birth weight was even greater (Mumbare et al., 2012). Considering all factors together in connection with birth outcomes is critical, especially as Mumbare et al. (2012) found that smoking itself had little impact on birth weight, but when considered as a covariate it greatly impacted outcomes.

Hendryx et al. (2014) were also interested in the interaction of maternal risk factors that impact low birth weight. Using latent class analysis, they were able to find the highest risk of delivering a child with low birth weight was associated with drug use and stress. Smoking was found to impact birth weight only when considered with these other factors. These studies highlight the importance of considering multiple factors in association with low birth weight. Hendryx et al. (2014) goes further to study a specific population in addition to considering a number of risk factors.

SES.

Recently in public health there has been a push to understand the root cause of health disparities in order to develop interventions that are more focused to address health concerns (Braveman & Goetlieb, 2014). Yao, Matthews, Hillemeier (2012) mapped poverty and population type against infant mortality in Appalachia. Yao et al. (2012) found that infant mortality rates have not changed in the Appalachian area that was studied, which corresponded to an area with stable rates of poverty. This finding suggests that poverty levels in some areas, such as Appalachia, haven't changed as rates have in other areas of the country. In addition to this, their findings suggest an association between infant mortality rates and the level of poverty in a population. As poverty is a large component of SES, it can be inferred that SES plays a large role determining birth outcomes.

Kent et al. (2013) also compared poverty and SES to infant mortality. Their study included the confounding variable of race as well. While Yao et al. (2012) found that infant mortality rates remained the same in Appalachian regions; Kent et al. (2013) demonstrated that infant mortality rates in rural regions were not decreasing as they were in other populations. In actuality, infant mortality rates in the more isolated areas of Appalachia had increased, especially those areas with dense populations. Kent et al. (2013) attributed this to increased smoking and lack of care from full-time physicians rather than strictly poverty alone, as the most isolated regions in the study had the worst infant mortality rates. Yao et al. (2012) also indicated that low SES and environmental burdens impact the rates of infant mortality.

SES and low birth weight have also been associated with other factors impacting maternal health. Gavin, Thompson, Rue, and Guo (2012) analyzed this trend with their focus on SES of mothers, including their early life. Data were abstracted from the National Longitudinal Study of Adolescent Health, a database developed in London based on answers to a cross-sectional questionnaire, in order to develop structural equations that could predict birth weight in terms of mother's SES history. Gavin et al. (2012) found that maternal mistreatment in childhood was associated to birth weight of offspring as well as cigarette use, substance abuse, and depression. Gavin et al. (2012) recognized that birth weight was not considered in light of gestational age or gender. While this may have had some bearing on their results, the correlation they found between early life experience of the mother and birth weight were too significant to be discounted by this oversight.

Perhaps the largest study of SES and adverse birth outcomes was completed by Garcia-Subirats, Pe´rez, Rodrı´guez-Sanz, Salvador, and Jane (2011) in Spain. The researchers looked at almost 200,000 births in varying economic stratospheres finding that those in lower SES, where poverty is more prevalent, have higher rates of adverse birth outcomes. This is in large agreement with previous findings, such as that of Gavin et al. (2012). Their findings went further to stratify findings, considering maternal age. Additional findings from Garcia-Subirats et al. (2012) was that immigrating populations living in the communities did not follow this trend, suggesting that the impact on birth outcomes in low SES communities happens way before conception and through life events. This would indicate those that live in areas with financial hardship and low SES are more likely to have adverse birth outcomes.

Prenatal care.

Prenatal care has also been considered as a risk factor associated with adverse birth outcomes, especially in recent years with the push for universal healthcare. Coley and Aronson (2013) were concerned about the disparity in birth outcomes for mothers in North Carolina. Using birth records and a cross-sectional study, they found that there was a difference in birth outcomes between races, with the African American population more likely to have adverse birth outcomes (Coley & Aronson, 2013). Coley and Aronson (2013) attributed the disparity in birth outcomes to access to care, as the Caucasian population had higher levels of prenatal care and better birth outcomes.

While increased prenatal care could attribute to better birth outcomes, there are other factors that should be considered as well in terms of understanding the disparity. Coley and Aronson (2013) suggest the need for further examination of social and economic disparities in relation to birth outcomes, however, they fail to consider the difference between rural and urban, or Appalachian and non-Appalachian, as North Carolina has counties that are part of Appalachia. Yao et al. (2012) studied the Appalachian population and found that access to care and hospital beds have largely increased over the last 20 years, while the SES in Appalachia and the infant mortality rates have not. This suggests that SES has more of an impact on infant mortality than access to care.

Also, as SES impacts infant mortality and impacts populations in Appalachia differently than other urban and rural populations (Denham, 2015), these should be considered as confounding variables in research. In addition to these findings, much of Appalachia is in lower SES than the rest of the country (Denham, 2015). Braveman et al. (2010) found that those with lower SES were increasingly more likely to suffer hardships around the times of pregnancy, meaning that the effect of stress in the mother impacts the unborn child to a great extent. The hardships Braveman et al. (2010) examined included a number of traumatic events that are also considered ACE, such as domestic violence, incarceration of a loved one, and divorce or separation. Through this evidence that Braveman et al. (2010) provided, it could be inferred that it is likely populations including children in lower SES suffer from increasing ACE that impacts them through adulthood.

In light of the unexplained disparities in birth outcomes, Pies et al. (2012) have indicated that even with drastic improvements in access to prenatal care, infant mortality is still a concern. While improving access to prenatal care has helped to reduce disparity in birth outcomes (Coley & Aronson, 2013), a disparity still exists indicating that there are other factors to consider in terms of adverse birth outcomes (Yao et al., 2012). Emerging trends and literature demonstrates that there is importance in the health of the mother prior to conception and her entire history plays a role in birth outcomes (Pies et al. 2012).

Violence.

While some researchers have looked at mistreatment of children, Peek-Asa et al. (2011) wanted to understand the impact of mistreatment of women on pregnancies. They based their study on findings that intimate partner violence is a major concern in the United States, especially in rural areas where women reported an 8% higher rate of abuse than urban counterparts (Peek-Asa et al., 2011). If women in this area are reporting more abuse, ACE in the form of children witnessing domestic violence could be higher as well. Braveman et al. (2010) also looked at violence, specifically around the time of pregnancy, finding that violence increased with lower SES. This is alarming as over half of their respondents reported low-income levels during or around the time of pregnancy (Braveman et al., 2010).

Other researchers found that lower rates of pregnant women were exposed to hardships such as violence and physical abuse during pregnancy. An ecological model was used in an Appalachian county by Li, Kerby, Sigler, Hwang, and Lagry (2010) to research intimate partner violence, specifically in Appalachia. They found that only 8% of the respondents were exposed to abuse from a partner while pregnant (Li et al., 2010). While the percentage of respondents reporting violence while pregnancy may vary, Li et al. (2010) found that those with lower SES had increased probability of exposure to violence. To date, much of the research associated with violence in pregnancy is to determine the prevalence rate. There have been few studies completed to determine the direct impacts of violence on birth outcomes.

Stress.

Stress, however, has been considered in terms of impact on adverse birth outcomes. Stress is perhaps the most studied maternal factor associated with adverse birth outcomes yielding numerous results from literature searches. Bloom, Bullock, and Parsons (2012) considered stress in rural women, finding that most stress came from financial hardships. In addition, Bloom et al. (2012) found that 56% of their respondents reported lifetime exposure to abuse and these past events still caused stress. In addition, 60% of the rural population reported witnessing abuse and 43% were subject to sexual abuse of some sort, all of which persisted as noticeable stress (Bloom et al., 2012). Bloom et al. (2012) reported that this amount of stress was significantly different than the urban population that was used for comparison, suggesting that rural populations are exposed to more preconception stress than other populations due to exposure to traumatic events over their lifetime.

Seravalli, Petterson, and Nelson (2014) considered perceived stress and the association of preterm birth. This expanded current research to think beyond the scope of present health in pregnancy and consider health leading up to pregnancy as important. The researchers looked at a number of factors causing stress during pregnancy (Seravalli et al., 2014). They also state the importance of pre-pregnancy health, but fail to consider any factors prior to pregnancy besides weight.

Gavin, Nurius, and Logan-Green (2012) considered the stressor of social disadvantage. Gavin et al. (2012) determined how social disadvantage impacted birth outcomes. They found that stress factors played a huge role in birth outcomes, with those reporting more stress delivering preterm or low birth weight infants more frequently (Gavin et al., 2012). Their discussion indicated that social disadvantage significantly impacted women, as those that were not socially disadvantaged reported less adverse birth outcomes even when they indicated same levels of stress.

Witt et al. (2014) also considered stress in life and the impact on preterm births. Their study focused on traumatic events that occurred prior to conception. According to their findings, over 20% of the participants were exposed to traumatic events prior to conception (Witt et al., 2014). In addition, Witt et al. (2014) found that those that were exposed prior to conception to traumatic events were more likely to have a preterm delivery. This is in agreement with findings of Class, Khasshan, Lichtenstein, Langstrom, and D'Onofrio (2013) who also associated stress felt in preconception with a greater likelihood of adverse birth outcomes in comparison to women who were impacted by stress only during pregnancy. This indicates that trauma, even in childhood, may impact maternal health and birth outcomes.

In one of the most recent studies, Zhao et al. (2015) used logistic regression to understand the association of a number of types of stress and low birth weight. Zhao et al. (2015) found significant differences between African Americans and Caucasians in terms of low birth weight and stress. Zhao et al. (2015) contributed this difference to financial hardships, suggesting that those of lower SES are exposed to stress in a greater way. Current research in the field of birth outcomes has seen a trend in trying to understand the mechanism for which stress impacts maternal health. Bussières et al. (2015) completed a meta-analysis to understand the fetal programming hypothesis. The most astounding finding of Bussières et al. (2015) was that there was a lack of a standard way to measure maternal stress in the studies used for the meta-analysis that have been completed to date. Their findings also indicated that maternal stress felt during pregnancy was associated with adverse birth outcomes such as low birth weights, but the effect size was small, indicating that stress felt during pregnancy has less of an impact than previously found (Bussières et al, 2015).

Child Abuse.

Seng, Low, Sperlich, Ronis, and Liberzon (2011) looked at what impact post-traumatic stress disorder (PTSD) had on birth weight and gestational length. Seng et al. (2011) found that women that reported PTSD during pregnancy had offspring weighing on average less than 283 g than those not exposed to PTSD. In addition to this, Seng et al. (2011) also found that the factor most associated with PTSD in mothers was child abuse. In addition to this, their work found that women in low SES communities were more likely to suffer from PTSD as a result of child abuse or violence.

As child abuse may play a role in birth outcomes of mothers, research has begun to look at early life of mothers in addition to current health status to determine the exact impact on birth outcomes. Almond, Currie, and Hermann (2012) found connections between the exposure to disease, such as diabetes, in early life and adverse birth outcomes of mothers later in life. Almond et al. (2012) found that this was increasingly associated with lower SES of the mother. This was found to be race dependent however, as with higher exposure to diabetes in early life, Caucasians were found to have increased risk of low birth weight in comparison with African Americans (Almond et al., 2012). This indicates that maternal health begins in early life and supports the growing trend that birth outcomes are impacted by maternal life course health.

Adverse Childhood Experiences.

Various studies have been completed to understand the association between ACE, such as abuse in childhood, and impact on health later in life. Mersky, Topitzes, and Reynolds (2013) considered ACE in terms of substance abuse, mental health, and health of those impacted. While the findings were limited to a small urban population, they found that the more ACE an individual was exposed to, the more adverse health experienced in adult life. Salinas-Miranda et al. (2015) produced similar results when they looked at an urban population in Florida, finding that ACE was associated with high levels of stress and sleep disturbances later in life.

Most ACE have been associated with economic hardships, divorce, alcohol violence, and mental illness respectively. Sacks, Murphy, and Moore (2014) demonstrated this in their research, in addition to showing that as the child gets older, they are likely to be exposed to more ACE. It is thought that ACE is a problem in the United States, as 46% of the children have had exposure to least one ACE. These data have also been determined for each state separately (Sacks et al., 2014). For instance, in Ohio, which ranks in the top 20% of states for exposure to ACE, 36% of the children have been exposed to 1 or 2 ACE, with more than 14% being exposed to at least 3 or more exposures (Sacks et al., 2014).

Su et al. (2015) found that increased exposure to ACE impacted blood pressure both in life before 12 years of age and life in adulthood, 35 years and beyond. Smith, Gotman, and Yonkers (2016) looked at the rate of ACE in general populations, finding that in some populations, over 72% of the population has been impacted in some way by ACE, providing support that the prevalence of ACE is much higher than originally expected. It has also been theorized that some populations may be at increased risk for ACE.

The amount of those exposed to ACE was examined by Flaherty, Thompson, Dubowitz, Harvey, English, Proctor, and Runyon (2013) as they found that over 90% of the population they studied have been exposed to ACE in the past and that this decreased overall good health in adolescents. Bellis, Lowey, Leckenby, Hughes, and Harrison (2013) found 47% of the population sampled reported an exposure to at least one ACE and that they were more likely to engage in risky behaviors.

Price, Kao, Burgers, Carpenter, and Tyrka (2013) attempted to provide new evidence of a mechanism in the way that ACE impacts low birth weight and adverse birth outcomes. Price et al. (2013) provided support for telomeres being shorter in those that had been impacted by adverse birth outcomes. Reduced telomere length is impacted by oxidative stress, which has been shown to occur when people are under extreme stress (Price et al., 2013). At certain points in life, such as early life, telomeres are more sensitive to changes, indicating that they would be more sensitive to changes early in life.

This means that stress in childhood could change telomeres and impact reproductive health. Shaley and Belsky (2016) completed a study that also supports the theory of telomeres being impacted by stress, finding that early life adversity impacted the size of telomeres, therefore impacting reproductive health. This adds to the current research that ACE impacts maternal health, as their work starts to look for mechanisms that cause adverse birth outcomes in mothers that have been exposed to ACE (Shaley & Belsky, 2016).

Drawing from findings that early life impacts maternal health, Gavin et al. (2012) were among the first to find a correlation between early life experiences of a mother and birth outcomes. They found that childhood mistreatment of the mother was associated with lower birth weight in offspring. Gavin et al. (2012) also found that mothers that were abused in early life were more likely to use cigarettes, substance abuse, and depression increasing likelihood of adverse birth outcomes.

Kingston, Soward, Krueger, Hanna and Markle-Reid (2012) also used LCA to examine childhood stressors and the impact they had on pregnancy in adulthood. While there has been a considerable number of studies completed to demonstrate the link between stress and adverse birth outcomes, there is little work in determining where this stress comes from, which was the interest of Kingston et al. (2012). They used two specific age categories to determine stress in a middle-class population. Kingston et al. (2012) found that low family cohesion was found to impact prenatal stress, and those that stated they felt a lack of support when young had higher stress levels. These findings are significant, as it was found that lack of family cohesion when younger, impacts birth outcomes, however, the study was limited as other traumatic childhood events were not considered.

Kelly-Irving et al. (2013) considered more traumatic events in childhood and their impacts on adult health using a cohort study. Their study found that those that experienced ACE such as violence, abuse, neglect, incarceration of a loved one, and divorce, were more likely to die early, in particularly women. This suggests that ACE impact women more than men. The amount of exposure to ACE also impacted age of death, as those experiencing two or more ACE were 57% more likely to die prematurely (Kelley-Irving et al., 2013). As this was a longitudinal study, it was not limited by recall bias and better defines the causal relationship between ACE and poor health outcomes. Kelly-Irving et al. (2013) explain this through the possibility of biological embedding and changes on the molecular level.

Leneers, Rath, Block, Gorre and Tschudin (2013) considered associations between abuse in childhood and risk factors in obstetrical health specifically, taking Kelly-Irving et al. (2013) findings even further. Those respondents that were impacted by ACE were more likely to be depressed, to smoke, and to have partners that abused drugs. In addition, it was found that premature births were more likely to be associated with people that had exposure to ACE in early life (Leneers et al., 2013). Bublitz and Stroud (2013) examined the compounding of stress, as they looked at impacts of daily stress in women with a history of child abuse. Cortisol levels were measured, a chemical associated with stress, in both pregnant women with a history of child abuse and those without (Bublitz & Stroud, 2013). It was found that women exposed to child abuse had higher levels of cortisol throughout the day than those who had no history. Thus, women exposed to ACE, such as child abuse, are more likely to suffer from higher levels of cortisol that could impact birth outcomes.

Christiaens, Hegadoren, and Olson (2015) also considered stress in childhood and current stress levels, labeling this chronic stress experienced in mothers over the course of a lifetime. They completed a retrospective study to determine if this could be associated with preterm birth. Multivariate logistic regression was used, showing that maternal exposure to more than two ACEs could be associated with a greater risk of preterm deliveries, two-fold to be exact (Christiaens et al., 2015). Further analysis indicated that the more exposure to ACE, meaning more adverse events occurring in childhood, the higher risk of preterm delivery. Analysis of covariates was also completed including the use of drugs, maternal age, alcohol, and educational status (Christiaens et al., 2015). Their findings further support that stress from ACE and trauma as a child impact adverse birth outcomes more consistently and to a greater extent than stress experienced in pregnancy.

Wosu, Gelaye, and Williams (2015) considered childhood sexual abuse (CSA), another ACE, and the impact on the adverse birth outcome preterm birth. Extensive literature reviews on the topic dating back to 1992 only yielded six relevant articles, indicating that not much research has been completed on CSA and adverse birth outcomes (Wosu et al., 2015). Their research indicated that the association of CSA and adverse birth outcomes is unclear, further supporting the need for more investigation.

ACE in Rural Populations.

Studies have also examined the difference in adverse birth outcomes in various populations, which is often associated with differences in SES. While urban areas have been studied to a greater extent, some researchers such as Brown et al. (2011) have begun to look at rural populations as well, finding a disparity between urban and rural populations in terms of adverse birth outcomes. Brown et al. (2011) considered socioeconomic inequities in their study, determining that populations that were impacted by inequity to a greater extent were more likely to have adverse birth outcomes. Seng et al. (2011) found that populations in low SES settings were more likely to have been exposed to child abuse and suffer PTSD from this exposure.

Other researchers found that rurality impacted adverse birth outcomes. Lisonkova, Sheps, Janssen, Lee, Dahlgren, and McNab (2011) found that mothers in rural areas were at higher risk for adverse birth outcomes, including death. Strutz, Dozier, Wijngaarden, and Glantz, (2012) looked at birth outcomes across several different rural typologies. They found that in comparing rural populations there was no significance of rurality and preterm birth. However, there was an association between rurality and low birth weight (Strutz et al., 2012). Salom, Williams, Naiman, and Alati (2014) provided evidence that early socioeconomic disadvantage increases the risk of alcohol and drugs, both of which have been linked to adverse birth outcomes. This disadvantage is seen more in rural areas, with Appalachia being at even greater risk with lower SES than most rural regions (ARC, 2016).

Kim and Saada (2013) also investigated possible causes to the wide variation in infant mortality. Their approach was more holistic, considering the impact of social determinants of health on infant mortality rates, as they felt that this may contribute to the disparity. A meta-analysis of current literature was completed to understand infant mortality rates in their context in the Western hemisphere (Kim & Saada, 2013). While their findings suggested that SES plays a role in determining birth outcomes, when rates were considered at individual levels, there was a marked difference between rural and urban populations in the United States. In addition to this, it was difficult to determine how much rurality impacted low birth weight as race confounded their research (Kim & Saada, 2013).

Witt et al. (2015) sought to examine differences that might occur in preconception health related to neighborhood disadvantage. Witt et al. (2015) looked at low birth weight and factors that may be associated with this, including preconception health. Witt et al. (2015) determined that women that lived in disadvantaged neighborhoods were more likely to deliver very low birth weight infants. This trend even held true when compared to women in non-disadvantaged neighborhoods at the same level of stress (Witt et al., 2015).

Birth Outcome Disparities in Appalachia.

As this literature review has demonstrated, there is a difference in rural populations and urban populations. However, there are subsets of rural populations that may impacted to a greater extent. One population to consider would be the Appalachian population that differs in culture and health outcomes (Denham, 2015). To date, the Appalachian population is a largely under researched population with regards to health concerns. This is concerning, as the people of

Appalachia are more at risk for adverse health outcomes as well as adverse birth outcomes (Short, Oza-Frank, & Conrey; 2012). Esch and Hendryx (2011) completed one of the most comprehensive studies on Appalachian health, finding that individuals in Appalachian areas have decreased life spans and significantly greater risk of cardiovascular disease than non-Appalachian counterparts. These findings included accounting for such variables as urban vs. rural residence, education, race, and poverty level (Esch & Hendryx, 2011).

Borak, Salipante-Zaidel, Slade, and Fields (2012) also investigated health disparities found in the Appalachian population. Not surprisingly it was found that this population is at greater risk for having diabetes, as these individuals have turned to more sedentary lifestyles than their ancestors while making no changes to diet (Borak et al., 2012). Evidence indicates that rates of diabetes are growing in this population (Borak et al., 2012), which is a concern as Negreto and Gomes (2013) found an association between maternal diabetes and increased risk for low birth weight. This indicates that Appalachian populations are more at risk than non-Appalachian populations for having low birth weight offspring. There are even fewer studies completed on Appalachian women and pregnancy outcomes. Many of the studies completed on Appalachian women in regard to birth outcomes looks at intimate partner violence and other maternal exposure to violence (Shah & Shah, 2010). This research indicated that there were higher rates of violence in Appalachia and that this correlated to an increased risk for low birth weight deliveries (Shah & Shah, 2010).

To date, Bailey and Byrom (2007) have completed the most thorough research on adverse birth outcomes in Appalachia. The sample chosen from Appalachia had little variation in background and were at otherwise low risk for developing complications from pregnancy.

Bailey and Byrom (2007) found that smoking and alcohol rates in this population were increased and associated with an increase in risk of low birth weight. Bloom et al. (2012) determined that rural populations are exposed to higher levels of traumatic events in life that may led to increased rates of adverse birth outcomes, as this adds to preconception levels of stress in women. These findings both suggest that the maternal health in Appalachian women is concerning and should be considered further in terms of birth outcomes.

Gavin et al. (2012) did not study the Appalachian population directly, but through the development of intergenerational models, and found social disadvantages in populations were associated directly with psychological stress and indirectly with lower birth weight offspring. As the Appalachian population is considered largely socially disadvantaged (Denham, 2015), these findings suggest that their population is more likely to have adverse birth outcomes. Yao et al. (2012) based their work in Appalachia on the premise that Appalachia has historically higher rates of infant mortality in comparison to non-Appalachian populations.

The work of Gavin et al. (2012) also demonstrated the need for further study of the Appalachian population, as they found that socially disadvantaged populations (such as those in Appalachia) are more likely to report adverse birth outcomes. Using Student t-tests and spatial mapping, they found that rates of infant mortality had not changed in twenty years, and neither had poverty rates, suggesting that disparities in infant mortality rates will continue until disparities in SES are addressed in this population. Kent et al. (2013) also looked specifically at the Appalachian population, considering race as a confounding variable using linear regression. Their work revealed that infant mortality was increasing in Appalachia, further supporting more focused research on maternal in this population.

Other research, such as that from Peek-Asa et al. (2011), suggests that intimate partner violence is significantly higher in rural areas. While no studies have been completed on the Appalachian subpopulation specifically, it stands to reason that rates of intimate partner violence would be higher in this population as an association between low SES and violence has been found (Wilkinson & Pickett, 2010). This supports an even greater need to study the Appalachian population in terms of adverse birth outcomes.

Short et al. (2012) examined factors that could be impacting birth outcomes, comparing Appalachian and non-Appalachian populations to determine if there were any disparities. Short et al. (2012) found that there were not only differences between Appalachian and non-Appalachians populations in terms of risk factors associated with adverse birth outcomes, there were also differences between Appalachian populations depending on the economic environment of the residential community of the mothers.

Smith and Holloman (2011) also investigated differences between Appalachian counties in Ohio to determine if there were differences in these populations that could impact health. While both counties were Appalachian, they were subject to different geographies and their economies were found to be different (Smith & Holloman, 2011). Using Bayesian modeling and controlling for access to healthcare, Smith and Holloman (2011), were able to determine that there was a difference in the health of children in Appalachian counties. Specifically, those living in the counties that border the river were more likely to have asthma and be overweight. This further supports the fact that health is impacted to varying degrees depending on county of residence.

Holzman et al. (2009) introduced the concept of weathering. Looking at populations of lower SES that were impacted by elevated rates of adverse birth outcomes, such as preterm birth, Holzman et al. (2009) compared factors such as maternal age, disease states, and timing of pregnancies. Through a comprehensive literature review, they were able to develop two hypotheses about the decline in health status of some women due to age and that social inequalities could lead to decline in health status quicker in some populations. This concept of weathering then draws upon notions of chronic stress and poor SES (Holzman et al. 2009). Holzman et al. (2009) found that those populations that lived in socially deprived communities were more likely to have preterm births.

Life Course

While there are differences in findings in regard to causes of infant mortality and adverse birth outcomes, there is one theory or perspective that is overwhelmingly used in research concerning maternal health or ACE exposure. Most research studies considering maternal health and the impact on birth outcomes used the LCA (Pies et al., 2012). As the LCA allows for the simultaneous study of a person's history, biology, sociology, and SES, it is fitting that studies in maternal health should look to this theory to improve knowledge.

Bailey and Byrom (2007) expand upon this by stating that as infant mortality and low birth weight can be predictors for the health of a nation, it may also predict early mortality and increased morbidity across the life span, making it imperative that it is considered in the appropriate context, such as LCA. The most successful research, such as Pies et al. (2012) has applied the LCA to research in order to understand the connections between maternal health and low birth weight. Pies et al. (2012) also stressed how using the LCA to examine early child health allowed them to draw connections to health later in life. Pies et al. (2012) found that adverse birth outcomes impact people throughout their lives, leading to poor health throughout life. The study of the person, their process through life, and how life impacts them is the hallmark of LCA.

Kingston et al. (2012) used a transactional LCA in order to understand childhood stress and the impact it had on birth. They found that without considering the life courses of the participants, their results would not have been as accurate or conclusive. They determined that one of the strengths of their study was to use the LCA in terms of determining how early life impacted maternal health (Kingston et al. 2012). Salinas-Miranda et al. (2015) used LCA to develop a more accurate questionnaire for determining the impact of ACEs on a community. Through using the LCA, research has been able to develop a more comprehensive understanding of the quality of life and the significant impact exposure to ACE had on children.

Other researchers using the LCA helped to provide further support that exposure to ACE impacts birth outcomes for mothers late in life. Christiaens et al. (2015) considered stress, not just stress during pregnancy, but stress across the life span and how it impacts maternal health. Because they used the LCA, they were able to understand that chronic stress impacts mothers greater than just current stress levels. Bellis et al. (2013) also used the LCA in a completely retrospective study to understand how personal history and maternal exposure to ACE could impact health through all stages.

Haflon, Larson, Lu, Tullis, and Russ (2013) chronicled the use of the LCA and looked at the advances that have been made in science. They stated that advances in research for biology and epigenetics have far surpassed the current level of the United States healthcare system

(Haflon et al., 2013). Their look at LCA has supported the need for further reform of the maternal child healthcare system. Haflon et al. (2013) suggest that the LCA could accelerate development of improved maternal child healthcare and make impacts on infant mortality.

Russ, Larson, Tullis, and Haflon (2014) also worked with LCA in order to consider new pathways for disease development. Russ et al. (2014) used the LCA to apply a Life Course Health Development Model to identify gaps in current research. Their meta-analysis found that gaps in the LCA include completing longitudinal studies rather than just cross-sectional studies, as well as more advanced statistical analysis. Their findings support advancing the nations' long-term health by using the LCA to improve maternal child health.

Summary and Conclusions

Limitations of Current Research

While the reliability and validity of the research is supported through studies about the ACE questionnaire, there were still a number of limitations recognized by researchers in terms of maternal health exposure to ACE and low birth weight. In the broad sense, after an extensive literature search, it was obvious that there is not a lot of information or findings about maternal exposure to ACE, and no research about exposure to ACE in Appalachian populations specifically.

Other limitations identified in review of the current literature included the limitation to account for race and ethnicity (Kent et al., 2013; Seravalli et al., 2014). As race and ethnicity has been determined to be a risk factor associated with adverse birth outcomes (CDC, 2016), controlling for these confounders would lead to more conclusive evidence that rurality may play a larger role in determining birth outcomes than originally thought. Kim and Saada (2013) were also unable to control for the confounding variable of race, which impacted their ability to see how much geographic residence, particularly rural verses urban, may impact birth outcomes. Yao et al. (2012) also stated their work was limited in the fact they did not account for the relationship or effect size of factors including ethnicity, maternal age, as well as residence of the mother. They felt that all these factors could have impacted the results of the study.

There were a number of other limitations that were found to be identified repeatedly in research considering maternal health and low birth weight. Bussières et al. (2015) recently found that stress in pregnancy has minimal impact on birth outcomes. Seravalli et al. (2014) also found that maternal health and stress present at birth had only marginal associations with birth outcomes. They felt that considering stress prior to pregnancy would have given them more accurate results. However, they failed to consider the mother's health prior to conception, which limits the conclusiveness of their findings, as evidenced by countless studies providing support that stress across the life course can impact birth outcomes drastically (Gavin et al., 2012).

While studies accounted for numerous factors that may impact birth weight, a number of studies failed to consider the impact of SES initially, stating this as a limitation and that should have been considered. Eisenhauer et al. (2011) did not account for SES or the residency of the population in question, and neither did Mersky et al. (2013) or countless others when considering only urban populations. Wosu et al. (2015) suggested using a homogenous population in studies on adverse birth outcomes, as their study was also impacted by race and SES, thereby skewing results.

Coley and Aronson (2013) suggested further need for investigation of social and economic disparities in relation to birth outcomes, however, they fail to consider the difference between rural and urban, or Appalachian and non-Appalachian, as North Carolina has counties that are part of Appalachia. This had potential to act as a confounding variable and was not considered as such in the study, listed as a limitation by the authors.

It has been indicated that there are a number of concerns with validity of studies when the population is spread out. This includes possible exposure to different environmental factors (Smith & Holloman, 2011) as well as certain cultural beliefs that may impact birth outcomes or the collection of data (Short et al., 2015). Choosing the Appalachian population, which is largely homogenous, allows this confounder to be controlled as this population predominantly Caucasian (Bailey & Byrom, 2007; Gavin et al., 2012) as well as allows for easier control of the SES of the population.

By far, the largest limitation that was found in the literature search was recall bias. Peek-Asa et al. (2011) identified recall bias by respondents as their studies major weakness. The major limitations of the study include reliance on self-report data and memory bias, which is a limitation of a number of studies involving ACE (Ford et al., 2015). Selection bias also has impacted the literature associated with maternal health and adverse birth outcomes. While Kingston et al. (2012) found that stress in childhood could impact maternal health, the integrity of their study was limited by selection bias, as two specific communities were chosen to provide respondents for their study.

Implications

From the limitations of current research, naturally comes the need for future research of maternal health in terms of low birth weight. One of the most significant findings is the need to study specific populations that may be impacted by low birth weight at increased rates. Esch and

Hendryx (2011) found that those living in Appalachia were at greater risk for health disparities than their counterparts, while accounting for the covariates of urban or rural residence. This supports the need for further study in Appalachia, as the population is at higher risk for health disparities than other rural populations and should be considered in context as a distinct population.

Current research then suggests that interventions that have reduced levels of preterm birth and low birth weight in a number of populations may not be reaching rural areas that are more isolated, as their rates of these are considerably higher (Kent et al., 2013). This is also supported by the research of Kim and Saada (2013) as they call for further research of rural populations in association with increased risk of adverse birth outcomes. Their findings found disparity in a meta-analysis of the work on infant mortality, suggesting the greatest disparity may be associated with rural residence (Kim & Saada, 2013). Hendryx et al. (2014) stressed the importance of considering the complex myriad of risk factors associated with low birth weight deliveries. They feel that considering these factors in specific populations would help to make more effective interventions. The public health implications of the study include the ability to examine populations or cross-sections of entire populations in terms of ACE (Ford et al., 2015). This could be used to develop more targeted interventions addressing ACE in future endeavors.

In addition to studying specific populations, findings of Peek-Asa et al. (2011) support the need for further study of violence and its impact on maternal health and ACE. Their study found that there was an increase in intimate partner violence in rural areas. This violence could be considered an ACE, becoming a factor for poor maternal health in future generations. Interestingly enough, this also supports the need for studying maternal health in Appalachia as

Shah and Shah (2010) found that increased violence in Appalachia was correlated to increased rates of preterm birth and low birth weight.

Others feel that further research about ACE and the impact on maternal health would be of value. Mersky et al. (2013) called for further study of exposure to ACE, specifically on the populations that are impacted most by it. Implications of other studies, such as the study of Seng et al. (2011), indicate that there is a call for developing better programs in low resource settings that are culturally acceptable to the women in question, in order for them to handle posttraumatic stress from ACE. Their study also suggests further study specifically of childhood trauma in association with low birth weight of offspring, as offspring born to mothers experiencing PTSD from childhood exposure to trauma weighed over 200 g less than those born to mothers not exposed (Seng et al., 2011).

Through extensive literature review it becomes apparent that there is a need for further study in terms of infant mortality, especially in those populations that are impacted to a greater extent, such as Appalachia. Little research has been completed on this population even though there is a significant disparity in terms of infant mortality and adverse birth outcomes. Of interest, is the concept of maternal exposure to ACE and impact on health. ACE has the potential to impact maternal health and birth outcomes, as evidenced by the current research. To improve the health of United States, it is important to consider what impact exposure to ACE has on maternal health, looking at the Appalachian population specifically, as this is where the disparity in terms of infant mortality is the greatest.

Based on the background research and extensive literature review that was completed concerning maternal health in Appalachia and the increased risk for adverse birth outcomes, it was apparent that further research should be completed. As a result, a study has been designed to determine if exposure to ACE in early life impacts Appalachian women, especially in terms of birth weight. In chapter three, the design of this study is described and methods discussed as well as possible analysis of results to determine what impact ACE has on mothers and low birth weight in Appalachian populations.

Chapter 3: Research Method

Introduction

Adverse birth outcomes are still a problem in the United States in spite of advances in medicine (Henry J. Kaiser Foundation, 2016). A number of factors have been investigated to determine their impact on infant motility rates and other adverse birth outcomes, such as low birth weights. The field has long since understood that there was an association between maternal health and these outcomes (Almond et al., 2012) and as a result, birth outcomes are mostly studied in correlation with the mother's health. Kent et al. (2013) completed a study that demonstrated showed positive correlation between adverse birth outcomes, such as low birth weights, and risky behavior in mothers like smoking and drug abuse. More recently, Bloom et al. (2012) expanded knowledge of maternal health by examining the impacts of stress in the mother or her SES regarding birth outcomes of offspring, showing that with increased stress and lower SES offspring had increased risk of adverse birth outcomes. In addition, Bublitz et al. (2013) studied the history of maternal abuse and adverse birth outcomes, providing evidence that abuse of mothers leads to increased rates of pre-term delivery.

Abuse, stress, neglect, and SES are all associated with exposure to ACE (Holzman et al., 2009). While the impact of abuse, stress, SES, and risky behaviors on maternal health have all been studied, research has yet to examine associations that may exist between maternal exposure to ACE and birth weight. In addition, while maternal health has been studied in rural populations, those living in Appalachia suffer in terms of adverse birth outcomes and are understudied (Kent et al., 2013). The purpose of this study was to determine if increased ACE in mothers is associated with increased incidence of low birth weight in an Appalachian population.

This study was designed to address two distinct gaps in knowledge, the first being determine rates of low birth weight are increased in Appalachia, Ohio. The second gap in knowledge that was addressed by this study was determining if exposure to ACE in Appalachian mothers increased the likelihood of low birth weight deliveries.

This study was designed to better understand the relationship between maternal exposure to ACE and low birth weight incidence in a population, as this methodology best fit the research questions and hypotheses of the study (Campbell & Stanley, 1963). The purpose of the study is to determine if there is evidence of association between low birth weight and ACE exposure. The hypotheses and questions that were developed for this study were quantitative in nature, as they were looking to see if this was present in the population and quantify it. The study design chosen was a retrospective cross-sectional analysis, as it will help to see if this hypothesis surveys disconfirmation (Campbell & Stanley, 1963). Through cross-sectional analysis, the population can be surveyed at one specific point and time and the data analyzed. As the events occurred in the past, the answers to the questionnaire are retrospective. It is hoped that this study will help to provide the foundation for future studies concerning the influence of ACE on maternal health as measured by predicted associated adverse birth outcomes such as low birth weight.

Purpose of Study

The purpose of this study was to quantitatively examine the association between maternal exposure to ACE and adverse birth outcomes such as low birth weight. This was completed while controlling for extraneous variables such as any pertinent medical background including history of diabetes, history of heart or cardiovascular disease, and other chronic and acute conditions that would predispose women to be at risk for adverse birth outcomes of children. Behavioral risk factors were also accounted for as extraneous variables including smoking status, use of prescription and nonprescription drugs, and alcohol. Obstetrical history such as gravidity and parity were also considered, as well as outcomes of previous pregnancies. Demographics such as age, race, and SES were also controlled for in the selection of respondents at the county level in Appalachia, Ohio.

This chapter discusses the research design. The research design and rationale section discuss the variables and connection between the design of the study and the research questions. Time and resource constraints are discussed as well. The target population and sampling methods are the focus for the methodology section. Procedures for recruitment and data collection are defined in this chapter. In addition to this, the measurement tool is discussed in terms of validity and origination, with discussion of instrumentation and operationalization following. The validity of the study is further discussed in the following section of this chapter in terms of sources and threats. This section also considered the ethical procedures completed as a result of the study.

Research Design and Rationale

Variables

As previously stated, the independent variable was maternal exposure to ACE. The dependent variable was low birth weight and defined as weight less than 2,500g at birth. Covariates included history of diabetes, heart or cardiovascular disease, and any other clinically diagnosed obstetrical conditions.

Health behaviors such as smoking, drinking, and use of drugs were also considered covariates in this study and respondents were screened for these behaviors using the questionnaire. Complicated obstetrical history was also considered a covariate and was accounted for by respondents' answers to the questionnaire. In addition, demographics such as age, race, and SES were the final covariates to be considered. However, the impact of the demographic covariates was minimal as the Appalachian population as a whole is rather homogenous. This is supported by Short et al. (2012) who were able to control for a number of confounders in their study and determine that the Appalachian population was a homogenous population. This largely helped control for differences in variables such as race, income, insurance, and education (Short et al., 2012).

Research Design

In order to determine the interaction of these variables as well as the impact of exposure of ACE on maternal health and birth outcomes in Appalachia, a quantitative approach was utilized for this study. A descriptive retrospective cross-sectional analysis was completed first to determine what the prevalence of ACE is in Appalachian women and these results were compared to national prevalence rates among states as documented by the Henry J. Kaiser Foundation (2017) and America's Health Rankings (2017). This was completed in order to determine if there was a higher rate of ACE exposure in Appalachian Ohio compared to non-Appalachian populations in Ohio.

The use of a cross-sectional survey also allowed for the determination of possible relationships between maternal exposure to ACE and low birth weights within the target population. This was accomplished through respondents' answers to questionnaires developed by the CDC concerning exposure to ACE. The cross-sectional design not only provided creditability to the association between independent and dependent variables of the study, it also helped to reduce time and resources used in the study, eliminating constraints often recognized in quantitative research. In addition, through using a mailed questionnaire, a larger number of respondents were reached, allowing potential for greater statistical power within the study and generalizability.

Bearing in mind constraints inherent in quantitative research designs and drawing on the broad knowledge found in the literature review, the research questions for this study were specific to the population in question. There were both time and resource constraints that impacted this study. As far as resources are concerned, there was no external funding source to allow for the hiring of extra interviewers or data processors. This was one factor limiting the use of interviewers. As there were no funds for additional help, there was also a time constraint involved with phone interviews that could not be overcome. This largely ruled out face to face or phone interviews. As there was no practical way to complete the number of interviews required to provide an adequate sample size for the study, this excluded use of any qualitative methods or mixed method research designs that require lengthy interviews with participants. This, in addition to the epidemiological nature of the research questions, made selection of a cross-sectional quantitative study design inevitable.

In regard to using a self-administered questionnaire to obtain data within a specific population, the majority of studies included in the research and literature review for this study utilized population-based surveys, such as the CDC's Pregnancy Risk Assessment and Monitoring System (PRAMS). The nature of the data are self-limiting, leaving only general relationships to be studied in regards to maternal health and low birth weight, yielding little information about the complex relationships in specific populations (Braveman et al., 2010). There are currently no specific data available about Appalachian populations in terms of ACE exposure and adverse birth outcomes. Using a self-administered questionnaire rather than secondary data allowed the research questions to be answered and a more in-depth knowledge to be gained about the specific population.

Short et al. (2012) used secondary data obtained from a census involving maternal health which resulted in the stated limitation that secondary data may not include populations that are more at risk for adverse birth outcomes. With the growing research indicating a life course approach to health starting before conception (Pies et al., 2012), PRAMS and other population-based surveys give a rather narrow perspective of maternal health focusing only on current beliefs and stress, limiting its application. A self-administered questionnaire was used for this study in order to reach the specific population of Appalachian women that is thought to have increased risk of low birth weight. In addition, the self-administered questionnaire allowed the research to ask questions that were relevant to determining if the participant had been exposed to the dependent variable. The use of secondary data in this situation would not be specific for either the population or in determining exposure to ACE.

Cross-sectional analysis design can be used in a natural setting, which was essential when considering the research questions that were derived according to the variables maternal health and low birth weight. As there was no way to conduct a true experiment using this population through manipulation of maternal exposure to ACE due to ethical considerations and the occurrence of the exposure in the past, retrospective cross-sectional analysis was used to elicit trends and determine associations.

Cross-sectional design allowed for the impact of the historical independent variable, maternal exposure to ACE, to be studied in relation to the dependent outcome of low birth weight of offspring in the present. The choice of cross-sectional design also allowed for a better descriptive analysis and the measure of prevalence for all factors that were investigated (Campbell & Stanley, 1963). In addition, the use of cross-sectional analysis helped to define the prevalence of public health burden of ACE exposure in relation to low birth weight, a hallmark of cross-sectional design as defined by Creswell (2013). This is critical as little is known about the topic of maternal health and exposure to ACE, meaning that the information derived from this study could be used for the generation of hypotheses of future studies.

The use of retrospective cross-sectional analysis design in this study was also supported through study design of prior successful studies. Previous research on the health impact of ACE included a chi-square analysis, which has been used in multiple studies for trend analysis in populations (Braveman et al., 2010; Chung et al., 2010). Studies concerning maternal health have considered exposure to ACE as well, using odds ratios to predict the likelihood of factors effecting adverse birth outcomes in a population were used most frequently in studies. Brown et al.'s (2011) used odds ratios to look at the social determinants of low birth weight in Australian populations and Holzman et al. (2009) used odds ratios to understand the concept of weathering in relation to racial differences in incidence of adverse birth outcomes.

The causes of low birth weight have been investigated by Kent et al. (2013), who found that low birth weight is related to a number of variables. The impacts of ACE have been researched as well, with Braveman et al.'s (2010) study to serve as an example where exposure to ACE was found to be related to increased blood pressure and diabetes in later life. However, research to-date has not considered what role maternal exposure to ACE may have on birth weight of offspring. In addition to this, according to Mersky et al. (2013) who completed a meta-analysis on ACE exposure, few of the studies looking at the impact of ACE on health have used correlation and regression and thus a basic foundation for future studies has not been created. The use of a retrospective cross-sectional study design served to provide the groundwork for understanding possible factors associated with low birth weight in Appalachia.

One of the weaknesses of this study to consider was associated with not being able to directly control variables, including many cofounding variables as Campbell and Stanley (1963) state is a weakness of cross-sectional design. This study accounted for many of the confounding variables through using a largely homogeneous population, as Short et al. (2012) found the Appalachian population largely homogeneous in their work comparing preconception indicators in Appalachian and non- mothers. This population was mostly of the same SES, educational levels, racial, and ethnic backgrounds. Another weakness often associated with cross-sectional design is misinterpretation of data as it can be difficult to interpret identified associations, as defined by Creswell (2013). To account for this, associations were identified and interpreted to the best of the researcher's ability and discussed fully in chapter five. Extraneous variables were also a weakness of this design as well, which can affect determining if there is an association between independent and dependent variables of a study. This was partly accounted for due to nature of ACE, as it has been associated with an increase in maternal risk factors, such as diabetes, smoking, and substance abuse (Braveman et al., 2010). In addition, measures were taken in the exclusion process to minimalize impact of extraneous variables on results of the study.

Methodology

Population

The target population of the study were women who gave birth within the last two years and were not currently pregnant, residing in Appalachian counties in Ohio, specifically Noble, Monroe, Perry, Highland, Jackson, Pike, Morgan, Meigs, Scioto, Athens, Coshocton, Jefferson, Washington, Muskingum, and Guernsey. While the reproductive age range is 15-49 years, this study only included women who became mothers between the age of 18 and 34, when they gave birth. This was to account for the impact of the confounding variable of age, as there has been a relationship found between low birth weight offspring and mother's younger than 18 and older than 35 (Katz et al., 2013). In addition, it was selected respondents had to have lived in Appalachia in adolescence in order to correctly determine the impact of ACE on this population.

As the questionnaire was in English, respondents had to be able to basic reading skills and an understanding of the English language. Criteria was given to Ohio Department of Health (ODH) Office of Vital Statistics and Registry to serve as parameters for their data query. This included county of residence (Noble, Monroe, Perry, Highland, Jackson, Pike, Morgan, Meigs, Scioto, and Athens, Coshocton, Jefferson, Washington, Muskingum, and Guernsey), age of mother (18-34 years), and year of offspring birth (2014-2015). Women that meet the criteria were compiled by ODH and given to this researcher. Random number generation was used to select potential respondents from the list according to county of residence. The potential respondent that met these criteria were mailed questionnaires to obtain medical history as well as assess for risk factors that impact maternal health, as seen in Appendix H.

It was difficult to obtain exact numbers for the population in question without completing a census on everyone in the Ohio Appalachian region. As a result, a rough estimate and rationale is provided. According to census data, as of 2010, there were 11,542,645 people residing in Ohio that were living in the Appalachian foothills (ARC, 2016). Of this number, approximately 5,771,323 were women and 1,073,713 were childbearing women between the ages of 18-34 years (ARC, 2016), which is about 18% of the total Ohio Appalachian population. Thus, the estimated target population size for this study was 1,073,713 people.

Sampling

The sample chosen for the study was representative of the Appalachian population, as there are factors affecting maternal health and adverse birth outcomes that are unique to this specific population that is grossly under researched (Short, Oza-Frank, & Conrey, 2012). Specifically, the study measured risk of low birth weight in relationship to maternal exposure to ACE, or trauma in childhood.

Inclusion and exclusion criteria.

Criteria for inclusion included females that had given birth in 2014-2015 and were between 18-34 years of age at the time they gave birth. In addition, they had to have resided in Appalachia during adolescence. Respondents also had to be able to read at a basic level in English, as the questionnaire provided was in English. Exclusion rules included those younger than 18 and older than 34 at the time of birth; serious medical conditions such as stroke, hypertension, cardiovascular disease, or diabetes; substance abuse; and significant pregnancy history. In addition, respondents were excluded if they were currently pregnant or they did not live in Appalachia during adolescence.

Sampling strategy.

Probability sampling was chosen in order to ensure that the sample was representative. No exploratory methods were used in this study, as it was quantitative with a well-defined population. The specific strategy for this study was clustering. This allowed for larger groups to be selected and compared, such as clusters of respondents from various counties in Appalachia, Ohio. The number of clusters was dependent on the distribution points in data as defined by Milligan and Cooper (1985). Cluster sampling was intended for the study in order to help group data, as well as reduce use of resources and thereby working to eliminate constraints. In addition, the clusters served to help answer the first research question, involving a comparison of rates of ACE exposure in categories of Appalachian counties.

15 clusters were selected using statistical analysis software with a justification for the selection of the number of clusters provided in a subsequent section of this chapter. The number of clusters was based on the sample size and discussed in the sample size section of the chapter. The clusters selected were derived from the sampling frame previously described. Simple random sampling was then used to select specific respondents in the cluster, which according to Frankfort-Nachmias and Nachmias (2008) reduces bias and improves accuracy of data. Williams (2000) stated that cluster samples are used most often when there is a natural population that is homogenous in demographic characteristics, which is fitting for studies in Appalachia. Random sampling and simple sampling were not as practical or applicable in terms of sampling strategy in regard to this study. Both these methods assume the population is

localized. As determined through analysis of study design and cluster samples by William (2000), clustering is beneficial when studies are dispersed over large geographic regions, which was the case for this study spanning 15 counties.

Other reasons why cluster sampling was more applicable than random or stratified sampling in this study included reducing the impact of confounding variables that could isolate members of the population. In order to improve validity and accuracy of data, clusters were as equivalent in size as possible. Large clusters were then reduced to achieve as uniform size as possible while still ensuring adequate population size was met. The Appalachian population has been found to be homogenous, which worked to negate the fact that cluster sampling is considered the least representative of sampling designs. The use of random sampling for specific units also helped to reduce this impact of clustering on data, improving accuracy and validity.

As cluster sampling is a two-phase process, the initial step was to select the larger groups. The number of groups selected was dependent on the population size of the counties, as an adequate number of sample units needed to be available to select from to ensure that intended sample size was met. All 15 clusters came from counties within Ohio. The use of cluster sampling allowed for a comparison of maternal health, ACE, and adverse birth outcomes between different counties. ARC (2016) has noted that while all Appalachian counties endure worse SES than non-Appalachian counterparts, some counties struggle more economically than others. Thus, they have broken the counties into categories based on socioeconomic indicators.

As a result, the counties in Appalachia are ranked according to their economic status into five categories including attainment, competitive, transitional, at-risk, and in distress (ARC, 2016). Ohio does not have any Appalachian counties that are considered to be competitive or to have reached the attainment level. A list of the Appalachian counties in Ohio and their ranking is provided in Appendix C. Comparing these counties enabled this researcher to determine if there were differences among the counties based on their ranking by ARC and address the first research question. As the ranking is a continuum of economic development, it also has the potential to demonstrate to what degree rurality impacts maternal exposure to ACE and low birth weight.

Cluster selection was based on the ranking provided by ARC (2016). Counties were randomly listed in an excel spreadsheet, with all counties of the same ranking (transitional, at-risk, and distressed) being put in the same column. The categories were broken down based on socioeconomic indicators when compared to national averages. A random number generator was used from an online source using 1 as the minimum and 32 as the maximum, the number of Appalachian counties in Ohio. The number 5 was generated. Using the spreadsheet, every 5th county was selected within each ranking. The at-risk counties that were selected were Noble, Monroe, Perry, Highland, and Jackson. The distressed counties selected were Pike, Morgan, Meigs, Scioto, and Athens. The transitional counties selected were Coshocton, Jefferson, Washington, Muskingum, and Guernsey.

A cluster of 32 respondents were selected from each of the 15 counties based on data provided by ODH. A random number generator was used again from an online source using 1 as the minimum and 100 as the maximum, the number of potential respondents provided by ODH per county. The number 49 was generated. Using the spreadsheet supplied by ODH, every 49th person was selected in each county until the number of 32 potential respondents was met. This multi-step use of random assignment helped to reduce bias in the study through ensuring a representative sample (Halkidi, Gunopulos, Vazirgiannis, Kumar, & Domeniconi, 2008) and is outlined in Appendix D. The use of statistical analysis software in the form of a random number generator increases generalizability and reliability of studies according to Creswell (2013), thus the use of random number generation helped to improve the reliability of this study. Packets containing questionnaires were mailed out to the 32 randomly selected women within the counties in Appalachia, Ohio that were selected for the study.

Envelopes to return the study were included in the packet, with a stamp and the researchers return address. Respondents were asked not including their return address on the envelopes with the completed survey in order to ensure anonymity and increased the chance that surveys were filled out honestly. The researcher marked each return envelope in order to determine from what county it came. This was completed using different colored check marks, with the colors corresponding to a specific county. The data collected from each survey were placed under each corresponding county identifier. Respondents that met the criteria of the sample frame were randomly selected within the defined clusters. The selection of specific units occurred once questionnaires were returned and vetted to ensure inclusion and exclusion criteria were met. Once this was completed, respondents were chosen randomly from the remaining pool for each identified cluster separately. This ensured that a representative population from each county was polled.

Sample size.

The sample size required to achieve significant statistical power for this study was determined using G*Power 3.1 software. The desired statistical power for this study was .80, the standard that most research studies strive for (Trochim, 2006). The effect size that ACE has on health in adulthood was found to be moderate at 0.42 (CI=0.39-0.45). This was found through a meta-analysis of 78 effect sizes in 24 different research studies in trying to determine what the impact of ACE is on health later in life (Wegman & Stetler, 2009, p. 806). Wegman and Stetler (2009) go on to state the effect size was even larger when the sample was limited to females. As there is no research to determine the effect of maternal exposure to ACE on birth weight of offspring, it must be assumed that the effect of ACE on maternal health would be roughly the same.

The alpha criterion for the study was $p<0.05$, indicating that any significance values that are lower than this were considered statistically significant. This significance level helped to reduce the random error that might have occurred with higher alpha levels but allowed differences in populations to be found that might be missed if using a lower alpha level. As this effect has been determined to moderate, any impacts on maternal health as measured by low birth weight could be found with reasonable statistical certainty.

The data obtained in this study were analyzed through chi-square analysis. An A priori power analysis was used to estimate the sample size needed. Applying the moderate effect size (0.42), alpha level (0.05), and the power (0.80), given the preceding justifications, it was calculated that a sample size of 184 was required. As literature review associated with the Appalachian population revealed response rates of about 40% (Danese et al., 2009; Kent et al., 2013), it was recommended that at least 460 potential respondents be contacted. This was to ensure that adequate numbers responded and participated to ensure a statistical power of .80.

Research into survey methodology suggests that the best response rate for mailed surveys includes using what is known as a tailored design (Dillman, 2000; Kaplpowitz, Hadlock, &

Levine, 2004), which was employed for this study. Initially, the respondents were contacted with an informational postcard explaining what was to be coming in the mail. A hard copy survey, cover letter explaining the purpose of the study, information about privacy protection and informed consent, a thank you card, and a self-addressed return envelope with a stamp followed within a week. A reminder post card was mailed a week after the surveys were sent out. For the respondents to remain anonymous, they were asked to not provide return addresses when mailing the questionnaire. Therefore, the researcher did not know the identity of those that returned the survey.

The desired sample size was not met by the first mailing, so an additional 32 respondents were chosen from the data provided by ODH using random selection and the methods used in selecting the first group of respondents. Those individuals selected were mailed an informational post card, followed by the survey packet and other documents, followed by a reminder in the same manner that the first group received the information. This was completed in order to avoid mailing the surveys to individuals that already completed the survey, as no return addresses were provided and the identity of actual respondents could not be tracked.

Using the calculated sample size, the number of clusters needed was 14, meaning at least 32 potential respondents from each county were to be contacted with hopes that 12 responded. The number of clusters needed for this study was determined through application of the *k*-means model developed by Jain (2010). There are three economic rankings that Appalachian counties in Ohio fall under according to ARC (2016). As a result, an additional cluster was added to make 15, allowing for clusters from 5 different counties that fall under each ARC category present in Appalachia, Ohio to be studied with 32 potential respondents being contacted in each cluster. This led to contact with 480 women for each mailing, with a total of 960 women being mailed surveys to participate.

Recruitment, Participation, and Data Collection

Recruitment and participation

Potential respondents for the study were obtained through using vital statistics registry databases in collaboration with ODH. ODH facilitated this through endorsement of the project. ODH Office of Vital Statistics and Registry agreed to provide a list of names and addresses of mothers in the selected counties for the time frame of 2014-2015. Random number generation was used to select from the possible pool of respondents, 32 from each county two times. Packets were then mailed to all possible respondents that were randomly selected.

These packets had the researchers return address listed and postage included. The returned questionnaires from the respondent had no return address or identifiable information in order to respect the privacy of individuals. This provided anonymity to the respondents as there was no discernable way to determine who returned the questionnaires. The use of vital statistics registries to understand maternal health and birth outcomes is supported as it has been used in many studies including that of Braveman et al. (2010), Brown et al. (2011), and Holzman et al. (2009).

For both groups that were selected, the initial contact was a postcard with some information about the study, including notification that the survey packet would follow in the mail within a week. The second contact contained the cover letter, informed consent, the color-coded questionnaire, a thank you card, and a postage paid self-addressed envelope. It was mailed five days after the initial contact. The cover letter contained information such as the intent of the study and the role of the participant (see Appendix E). In brief, this document contained a summary of the research study and its goals. It also outlined what participation in the study meant and how much time the respondent should expect to devote to participating in the study, as well as instructions to the respondent in the case of any psychological trauma or stress that may incur. In addition, exclusion and inclusion rules were explained to the respondents as well as any inconvenience or risk the respondent might incur if participating in the study.

The informed consent contained protocols that were followed to ensure the privacy and confidentiality of the responders (see Appendix F). The questionnaire that was mailed to respondents have been adapted from two questionnaires that can be found through accessing links on the CDC website (http://www.cdc.gov/violenceprevention/acestudy/pdf/haqfweb.pdf and http://www.cdc.gov/violenceprevention/acestudy/pdf/fhhflorna.pdf). The questionnaires were marked at the top with a colored check mark corresponding to a specific county in order for the researcher to determine from what county the survey came. The questionnaire that was used in the study has been attached in Appendix H for convenience, with permission for use attached in Appendix G. There questionnaire has been shortened, complying with recommendation from the IRB at both Walden and ODH, to ensure that response rates were higher and respondents did not experience any undue stress as a result of the collection of extraneous data.

There was a reminder postcard sent out within one week following the mailing of the questionnaire packet. This was part of the tailored design method and used to ensure a better response rate. After 6 weeks from the mailing of the questionnaires, the desired number of respondents was not met. The initial post card, questionnaire packet, and follow up reminder were mailed to another randomly selected group, as outlined previously. The same timeline and process was followed for the second group of potential respondents that were contacted. This was due to the fact that the researcher had no way of determining who returned the survey and who had not, so no follow up could be attempted with the first group of respondents that had not returned surveys.

Data Collection

Data were collected anonymously using the returned questionnaires provided in Appendix H. Demographics such as mother's age, race, ethnicity, education level, marital status, weight of latest birth, and employment status were collected using the questionnaire. In addition, area of residence and residential history was also collected with this tool. Exposure to trauma, stress, abuse, neglect, and drugs (potential ACE) was also be captured. The purpose of using these questionnaires was to obtain medical history as well assess risk factors impacting maternal health. Once respondents had completed the questionnaire and returned it, the information recorded electronically for analysis in SPSS.

The use of questionnaires as a method of data collection is supported by the fact that this method is used by other studies concerned with impacts of ACE or maternal health. This process of data collection yielded between a 46% (Danese et al., 2009, p. 1135) and 62% (Brown et al., 2011, p. 196) participation rate. While Chung et al. (2010) successfully used telephone services increasing participation rates to 74% and 77% respectively, the resource constraints associated with this study practically prohibited this method. In current research, the use of the internet for administration is appealing for cost and time reasons (Frankfort-Nachmias & Nachmias, 2008). However, the Appalachian population is largely rural, lacking widespread computer and internet use (Parker & Thorson, 2009). Thus, using internet based surveys would serve to discount a large number of people from the population. This in turn would have affected the random assignment of the samples to be used. The use of the tailored design method and mailed surveys has had response rates of over 30% (Kaplowitz, Hadlock, & Levine, 2004). Using this design method and accounting for this by increasing the number of potential respondents served to ensure that sample size was met.

The date that the initial packet was mailed to potential respondents was recorded. The study design calls for only one interview, so there was no follow-up necessary for the researcher or potential respondents, except through mailed correspondence in the form of a reminder card. However, if respondents had any questions or needed assistance, they were informed to contact the researcher who would promptly respond within one business day to all inquiries. There was no formal debriefing associated with this study, but if respondents were seeking additional resources, education, or information about maternal health, they were referred to their local health department.

Instrumentation

Previous studies concerning maternal health and ACE have used a variety of instruments and data collection methods. Secondary data, such as state or jurisdictional vital statistics information, were utilized in a number of studies included in the literature review such as Braveman et al. (2010), Brown et al. (2011), Holzman et al. (2009). In these studies, the secondary data used in their studies allowed researchers to cross population boundaries and provide data that could be analyzed in regard to a number of populations, increasing relevancy. Use of vital statistics greatly reduced the flexibility of Holzman et al.'s (2009) study, while it improved validity of other studies when used in combination with administered surveys, as these survey gave more specific information about specific populations. (Braveman et al., 2010; Brown et al., 2011). Behavioral Risk Factor Surveillance Systems (BRFSS) were utilized in many studies to determine the incidence of risk factors in given populations (Chung et al., 2010; Short et al., 2012).

Research in maternal health with respect to adverse birth outcomes has utilized questionnaires that are adapted using specific questions in relation to ascertain information regarding factors. Brown et al. (2011) used a Healthy Mothers Healthy Families Survey that was adapted to fit the specific needs of the study. While this would provide more specific information, the survey was not subjected to psychometric testing and not validated, leading to reliability concerns in the study's methods and ultimately the results to be questioned. Electronic health records (EHR) have also been used to study the birth outcomes in a population. However, researchers using this method to collect data have faced challenges with institutional HIPAA regulations at hospitals delaying onset of study (Bailey & Cole, 2009). EHR are also limited as they often do not contain accurate information for maternal risk factors, in part because of how they are obtained and also in part because risk factor identification questions are not asked as frequently as they should be (Short et al., 2012).

This study used a questionnaire adapted from two different questionnaires. The questionnaires are not copyrighted and are for use of the research community (CDC, 2016). The questionnaires have been developed and tested for validity, and were used to measure ACE in mothers. As exposure to ACE has been applied as the independent variable in many studies, the surveys and questionnaires to measure this construct have been validated and reliability studies completed on it (CDC, 2016). The CDC developed the original questionnaire and it has been adapted over the years to study specific populations. Currently, there is a Family Health History Questionnaire (FHHQ) and Health Appraisal Questionnaire (HAQ), both being available in a female and male version. These questionnaires are available for use and adaptation from the CDC website (CDC, 2016). Demographics such as race, SES, education, obstetrical history, and Appalachian status, can be obtained using the questionnaire.

In addition, the questionnaire also contains questions about pregnancies, drug abuse, and other behavioral risk factors as well as history of exposure to adverse experiences, such as divorce, incarceration of a parent, sexual abuse, and verbal abuse (CDC, 2016). All questions have been reviewed to ensure that they are applicable to the study and necessary, therefore reducing the time spent participating by the respondent and minimizing the information required. In addition, no extraneous data were collected from respondents.

As this study was concerned with relating exposure to ACE in maternal health, which is assessed through the questions regarding abuse and neglect, to low birth weight in offspring, the questionnaires were well suited for use in this study. Through application of the questionnaire in this study, data was collected giving the researcher the ability to determine if there was a relationship between the variables. The reliability of the questionnaires has been established through prior use in studies and Cronbach's alpha was found to be .87 (McGavok & Spratt, 2012).

Data Analysis Plan

Data from completed questionnaires were entered into electronic files within SPSS. The questionnaires were color coded prior to mailing out based on the county of residence of the respondent. This was used for data entry as the data were broken down by county to answer research question 1. Entries were screened for duplicates and quality assurance by the researcher prior to analysis of data using SPSS. No duplicates were found in the data entered. In addition, once entered, all data obtained was compared individually by the researcher to the questionnaire once more to ensure accuracy and verify data input.

Data cleaning and screening.

SPSS was used to clean the data after entry. This was accomplished through running descriptive statistics on the independent, dependent, and confounding variables and obtaining the mean, standard deviation, minimum, maximum, kurtosis, and skewness. Output was to be examined to ensure that no extraneous data existed. There were no outliers found in the data either when completing SPSS analysis. SPSS was used to determine if any of the data were entered incorrectly. This was accomplished through use of frequencies in descriptive statistics. Prior to analysis, missing data were scrutinized to determine if trends or patterns exist. No missing data were detected among the returned questionnaires, so no further cleaning of the data was required prior to analysis.

The data were examined prior to analysis for outliers using the explore option under descriptive statistics and running a plot. Multivariate outliers were also analyzed. Outliers were to be looked at to determine if the value or variable needed to be deleted or transformed, however, the plots revealed no outliers. Normality was assumed with this study, but was checked through SPSS using the histogram option under frequencies and descriptive statistics. This histogram revealed that the data followed normality.

Research questions.

This study utilized the LCA to examine the relationship between maternal health, exposure to ACE, and low birth weight while accounting for socioeconomic determinants, demographics, and obstetrical history in an Appalachian population. There are a number of questions that deserve attention in terms of ACE in the Appalachian population.

RQ1: What is the difference between county of residence in Appalachian maternal populations in relation to ACE?

H_01: There is no difference between county of residence in Appalachian maternal populations in relation to ACE.

H_A1: There is a difference between county of residence in Appalachian maternal populations in relation to ACE.

RQ2: What is the association between maternal exposure to ACE and increased risk of low birth weight infants in an Appalachian population?

H_02: There is no association between maternal exposure to ACE and low birth weight infants in Appalachia.

H_A2: There is an association between maternal exposure to ACE and low birth weight infants in Appalachia.

RQ3: What is the difference in the impact of types of ACE on birth weight in the Appalachian population?

H_03: There is no difference in the impact of types of ACE on birth weight in an Appalachian population.

H_A3: There is a difference in the impact of types of ACE on birth weight in an Appalachian population.

Statistical tests.

This study used chi-square and log-linear regression through SPSS software to analyze the data collected in order to determine if there was an association between maternal exposure to ACE and low birth weight deliveries in Appalachia. The research questions and hypotheses have been restated above and a table provided for convenience to delineate the statistical tests that were completed for each question, see Appendix J. The data were entered into SPSS according to cluster assignment, or county of residence. Descriptive analysis was completed on the groups individually and a chi-square analysis completed in order to help support associations or relationships between the variables that were found.

Chi-square analysis and log-linear regression were completed using the collected data in order to address the hypotheses and research questions. This study proposed that the amount of maternal exposure to ACE correlates to birth weight in Appalachia, with the predictor value being the birth weight of the offspring. This is categorical data and satisfies criteria for assumptions of cross-sectional studies involving a chi-square analysis.

Chi-Square analysis and log-linear regression were used to further define any associations found between maternal exposure to ACE and birth weight in offspring. Differences in findings of birth weight and maternal exposure to ACE were also analyzed and shown in tables in order to show disparities that may exist. Log-linear regression was also used to determine if there are differences in the impact on low birth weight based on the type of ACE (such as different types of abuse, different types of neglect, or unsafe environments). The Cramer's V was used in all cases as part of the chi-square analysis to determine effect size of any statistically significant findings.

Reporting.

Data were reported in the fourth chapter, but the format is discussed here. A chi-squared test was completed to determine if there were differences in maternal exposure to ACE based on county of residence. It was also used to determine if increased maternal exposure to ACE in Appalachia impacted chance of low birth weight. Any significant *p* values were stated in chapter 4, with the reporting of data. Any statistically significant results were reported and their relationship clearly defined. Acceptance or rejection of the null hypothesis for each research question were discussed in terms of any significant findings in chapter 4 as well. In addition, the answer to the research question about differences in risk of low birth weight according to maternal exposure to ACE in Appalachian counties is discussed.

Chi-Square and log-linear regression were completed to understand difference of impact of various types of ACE and to determine if there was a difference in birth weight in the Appalachian population based on maternal exposure to ACE. The results for the chi-square analysis state the effect size (Cramer's V), whether it is a positive or negative relationship, and the *p* value, which then defines any statistically significant relationships. Descriptive statistics were also reported for this analysis in chapter 4 as well. Finally, answers to these corresponding research questions were stated. A table has been provided in the appendices for convenience discussing the tests used, results, and rejection or acceptance of the null hypothesis for each of the three research questions in this study, see Appendix J.

Operationalization

In order to improve the reproducibility of this study, precise definitions of the variables in question have been provided in Appendix I. Independent variables were more difficult to measure, as these variables were measured through developed constructs in the questionnaire. Respondents were asked questions that quantified drug use, sexual experiences, exposure to neglect, exposure to violence, and exposure to abuse prior to the age of 18. The measurement tool being used with regards to the independent variable in the study was categorical in nature, meaning it indicated only exposure but did not indicate quantity. The tool has been developed specifically for the study and tested for reliability and validity (CDC, 2016). The main dependent variable, birth weight of offspring, was obtained in collaboration with ODH and from the questionnaire, as respondent answered if their offspring were below 2500g, which by definition is a low birth weight. This again was a categorical variable.

Threats to Validity

External

Threats to external validity were greatly reduced as there was no manipulation of the independent variable, thus no treatment or test effects occurred. External threats to consider for this study included selection bias, situation, and reactivity concerns. As this study looked at the impact of ACE on birth weight of a very specific population, correlations in this study may not be repeatable in other populations. Generalizability may also be reduced because of the population chosen. As the Appalachian population is a complex people with a definitive culture (Danese et al., 2009), there may have been distinct differences among the respondents, thereby impacting their responses to questionnaire. As a result, repeating the study in other populations may yield drastically different results.

In order to account for this threat, the researcher used random sampling to the greatest extent possible and an anonymous self-administered survey. Selection bias was also an external threat to validity. This was partly accounted for because respondents were selected prior to knowledge of their exposure to the independent variable, a post-treatment condition. In addition, as the study was a cross sectional snap shot, there was no need to account for respondents dropping out of the study and the results being erroneously affected by this as stated in Marcellesi's study (2015).

Internal

History maturation, testing, experimental mortality, and selection maturation interaction are internal threats to validity that did not impact this study to any great extent. This was due to the fact that the study was a snap shot and did not last years, as some cohort studies can. This was a limitation identified by Cahit et al.'s (2015) study lasting 10 years with history maturation greatly impacting results. As a result, there was no change in the individual's environment, age, or physiological being during the study. Testing effects have been eliminated from this study as the respondents were given the questionnaire once, eliminating the ability of them to become test wise. Internal validity threats of concern to this study include instrumentation and testing. Threats concerning instrumentation have been accounted for using a questionnaire that has been tested for validity by a number of other studies (CDC, 2016).

Construct

Threats to the constructs in the study included apprehension of the respondents, researcher expectancies, restrictions in generalizability, and confounding variables. Responding to the questions may have been impacted by social desirability, creating an apprehension in respondents to answer honestly mainly due to the invasive nature of the questions. This was partly reduced through a more anonymous route of data collection in avoiding face to face encounters in lieu of mailed surveys. In addition, explanation of the care of data provided by the respondent may have also decreased this bias. Confounding variables have been clearly defined and were controlled for as much as possible. In addition, a rather homogenous population has been chosen for the study. As a result, the effects of differences in maternal age, race, ethnicity, education, and SES were minimalized.

Construct validity of the study was improved through defining specifically what is being measured in the variables, as Yaghmale (2009) states defining the variables of concern serves to improve construct validity. This has been accomplished in this study through operationalization of the variables and methodology. Through a research review of the measurement tool, the threat of restrictions to generalizability has been addressed, as the surveys have been tested for validity on a number of different populations. In addition, the constructs of the independent variable of ACE were considered individually in terms of neglect, physical abuse, poor home life, emotional abuse, and sexual abuse. This improved reliability of the study according to Ford et al. (2015). In previous studies, cross-sectional analysis has been completed using the ACE questionnaires according to the meta-analysis by Herrod (2007), which supports the use of the questionnaire in this study and improves the construct validity.

Empirical Validity

This study was dependent on accurate recall from several years ago. This can be difficult for people. However, Pinto et al. (2014) completed a study on the ACE questionnaire adapted for use in this study and found that recall bias had little or no impact on the data collected using this instrumentation. It is also important to consider the construct validity of the study in regard to the questionnaire. There could have been outside factors that affected the answers of respondents, such as fear of family members finding out that the respondent shared personal information or fear of being judged from answers given in regard to ACE. Every effort was made to develop a trusting relationship and environment to ensure that answers were accurate and data valid, which included offering information, support, and a promise of anonymity.

Another threat to empirical validity included the study design chosen. Cross-sectional design does not allow for direct control of variables, including many confounding variables (Campbell & Stanley, 1963). This study accounted for a number of the confounding variables through use of a largely homogeneous population, the Appalachian population. This population is largely of the same SES, educational levels, racial, and ethnic backgrounds (ARC, 2016).

Ethical Procedures

Agreements and Permissions

Permission has been granted to use the trialed instrumentation in order to obtain data from the CDC. In seeking cooperation for the mailing of packets to constituents, agreements with the Ohio Department of Health (ODH) has been obtained, see appendix K. Final results will be shared with ODH in order to provide insight onto part of their population. This information was entirely deidentified.

Treatment of Participants

This study protected participants as much as necessary to ensure their safety and wellbeing. To accomplish this goal, the project was submitted to the Walden University IRB for review and approval. Approval was received and data collection began. As this researcher requested no return address be given when participants returned their surveys, the questionnaire was essentially anonymous and had no identifiable information. Data on the respondents were collected and put into an excel spreadsheet for tracking purposes. This data was also put into SPSS. The resulting spreadsheets and data analysis will be kept on a secure external hard drive and be password protected. The hard drive will be kept in a locked safe with only the researcher having access for five years to comply with confidentiality standards of Walden University.

Participants were given information about the study as well as the risks associated with participating (see Appendix F). The individual's response and return of the questionnaire served as acknowledgement of their rights in the form of implied consent. This delineated any possible benefits or risk that a person could incur from participating in the study. There was minimal risk associated with this study. However, due to the nature of the questions, there could have been psychological trauma or memories that were recalled that gave the respondent some discomfort. As a result, there were instructions on the consent form to the respondent that should they experience any ill effects from answering the questionnaire, they had the option of calling the researcher at any time for assistance in finding help. In addition, the researcher was available to answer questions or concerns. There was no reported psychological trauma, no questions from respondents, and no request for additional help during this study.

Ethical concerns.

No legal rights were waived by the participants and language was adapted from informed consent guidelines to meet IRB approval (Office for Human Research Protection [OHRP], 1993). The consent has been written in a way for participants to clearly understand. Contact information has been clearly delineated in the event that questions should arise, as required by OHRP (1993). Other ethical considerations included ensuring that the same basic resources are available to all participants, as this is a core public health value in terms of ethics (Shore et al., 2011).

Recruitment materials were sent in the mail with a detailed explanation, brief synopsis of the intended study, the respondent's rights, and the risk involved in participating, see Appendices E and F. The material was reviewed and approved by the Walden University IRB prior to the packets being mailed. Potential respondents were advised of their rights to participate or leave the study at any time with no concern for retribution in any form or at any level. This information is contained in Appendix F. There were no concerns of researcher bias as the researcher was not affiliated with any respondents or in the potential pool of respondents.

Confidentiality

Privacy of the participants was considered and protected, as HIPPA guidelines define (OHRP, 1993). Privacy laws are stringent and meant to protect the population. As there were several clusters involved in the study and a steady exchange of information between researcher and community health workers, it was important to consider the information exchange. Potential respondent information remained as deidentified as possible and information was not shared with external sources for any reason. The respondents were asked not including names or addresses on the questionnaire or return envelope. This removed the possibility of the researcher identifying who answered the questionnaire and served to protect the confidentially of the person responding and the integrity of the study. All data received were sent in encrypted emails with password protection requirements. Data were then stored on an external hard drive in locked box and will be kept for five years to ensure compliance with Walden University standards. Only the researcher will have access to the data during the study and the five years following. After five years of storage the external heard drive will be destroyed.

Research has been and will be disseminated on a deidentified basis only, and results shared with the ODH should they want to see the final results as well as with Walden. No names or other information that could be considered personal protected information have been shared with the public in order to maintain the respondent's anonymity. The final results and paper will be shared electronically through secured interfaces and confidential emails. General trends found within the study will be shared with maternal health audiences, and as there are no names to associate with the data, privacy will be protected.

Summary

This study intended to look at the impact of ACE exposure in mothers in relation to the risk of low birth weight in Appalachia, Ohio. It was a retrospective cross-sectional analysis that used a chi-square analysis and log-linear regression to understand differences in risk of low birth weight regarding exposure to ACE among Appalachian counties in Ohio. It also examined impact of different types of ACE exposure in mothers in relation to birth weight of their offspring. It was intended that this study produced results to either support or reject the hypotheses and researcher questions listed earlier in this chapter. The data that were collected as a result of the study and is discussed in Chapter 4.

Chapter 4: Results

Introduction

The purpose of this study was to quantitatively examine the association between maternal exposure to ACE and low birth weight deliveries in an Appalachian Ohio population. The first research question looked at categories of counties as defined by the ARC within Appalachian Ohio to determine if there were differences in exposure to ACE. The second research question was developed to determine if there was an association between increased exposure to ACE and increased risk of low birth weight. The third research question looked more specifically at the type of ACE experience of the mother to determine if one type of ACE had more of an impact than others. The research questions and hypotheses follow. The results of the study are presented in Chapter 4. This begins with description of data collection methods including time tables and discrepancies or variances from the proposed method in Chapter 3. Baseline descriptive statistics are included in this section as well as a discussion of how representative the sample was of the population. The results follow, including statistical analysis findings, effect sizes, post-hoc analysis, tables, and figures. Answers to the research questions that were from this study are included in the summary.

Research Questions and Hypotheses

RQ1: What is the difference between county of residence in Appalachian maternal populations in relation to ACE?

H_01: There is no difference between county of residence in Appalachian maternal populations in relation to ACE.

H_A1: There is a difference between county of residence in Appalachian maternal populations in relation to ACE.

RQ2: What is the association between maternal exposure to ACE and increased risk of low birth weight infants in an Appalachian population?

H_02: There is no association between maternal exposure to ACE and low birth weight infants in Appalachia.

H_A2: There is an association between maternal exposure to ACE and low birth weight infants in Appalachia.

RQ3: What is the difference in the impact of types of ACE on birth weight in the Appalachian population?

H_03: There is no difference in the impact of types of ACE on birth weight in an Appalachian population.

H_A3: There is a difference in the impact of types of ACE on birth weight in an Appalachian population.

Data Collection

Potential respondents were selected by using names and addresses supplied by the Office of Vital Statistics and Registry at ODH. This department was given the parameters to search for mothers who had given birth in 2014 and 2015, were over the age of 18, and living in one of the counties that were selected from Ohio's Appalachian counties. These counties were selected randomly using a random number generator. The counties were given to ODH and they developed a database of potential respondents. 32 respondents were selected within each county using a random number generator. The 15 Appalachian Ohio counties selected for this study were Athens, Coshocton, Guernsey, Highland, Jackson, Jefferson, Meigs, Monroe, Morgan, Muskingum, Noble, Perry, Pike, Scioto, and Washington. All items were mailed to respondents with addresses in these counties. The addresses were obtained at the time of birth by the ODH to request a birth certificate.

Data collection took place over a period of 10 weeks. Initial postcards containing information about the research project were sent to potential respondents, detailing that they would receive a questionnaire, as well as other pertinent information, to participate in the research study within one week. The questionnaire packet was mailed out exactly one week after the initial post cards were mailed out and contained the questionnaire, study information, privacy notifications, notifications of respondents' rights, thank you card, and a self-addressed, stamped envelope. The questionnaire was color coded to indicate what county the respondent was from upon return to the researcher. This way, the respondents retained anonymity and the researcher could determine which county to assign the questionnaire and data.

One week after the questionnaire packet was mailed, the reminder post card was sent to all respondents, as the researcher had no way of knowing who responded and who did not. One week after the reminder cards were sent out to the initial group of respondents, another 32 respondents from each county were selected using random generation. Initial post cards were mailed out to the 32 newly selected respondents in each county for a total of 480 mailed postcards. As before, the questionnaire packet was sent out exactly one week after the initial post cards were mailed out. After one week, all potential respondents chosen for the second mailing were sent a reminder card.

For both the first and second rounds of mailing, 480 potential respondents were contacted with the initial post card, 32 from each of the 15 Appalachian Ohio counties selected. This resulted in a total of 960 potential respondents being contacted for participation in the study. For the first mailing, 57 of the postcards were returned due to the respondent moving and leaving no forwarding address. Of the 57 returned, 34 of the post cards were returned prior to questionnaire packets being mailed. As a result, 446 questionnaires were mailed out to potential respondents. Of the 446 questionnaires mailed out to potential respondents the first time, 138 questionnaires were returned, yielding an overall response rate of 30.9%.

There were 480 initial postcards mailed out for the second mailing and 36 of these initial postcards were returned due to no forwarding address. 27 of these postcards were received prior to the questionnaires being mailed to respondents. As a result, there were 453 questionnaires mailed to respondents for the second mailing. There were 128 questionnaires returned by this group of respondents, meaning a lower response rate of 28% for the second mailing. In total, 899 questionnaires were mailed out and 266 questionnaires were received back from respondents over the 10-week data collection period. This resulted in an overall response rate for the study of 29.5%.

These questionnaires were screened to ensure that respondents met criteria set forth in the protocol. No returned questionnaires had any missing data. There were four discounted questionnaires because the respondents had not spent their adolescence in an Appalachian Ohio county. There were 27 more questionnaires that were discounted due to histories of complicated pregnancy, as this could be considered a confounding variable for low birth weight deliveries. There were 13 respondents that indicated that they had been diagnosed with heart disease, however 10 of these individuals also had a history of complicated pregnancy, so only 3 questionnaires were discounted for heart disease alone.

While no respondents indicated that they drank while pregnant, 30 indicated that they smoked while pregnant and 8 indicated that they continued using drugs while pregnant. 17 of the individuals that indicated smoking while pregnant also had either a diagnosis of heart disease or a history of a complicated pregnancy. As a result, 13 questionnaires were discounted due to the confounder smoking while pregnant alone. Of the 8 respondents indicating the use of drugs, 7 of these individuals indicated they smoked while pregnant, resulting in one additional questionnaire being discounted. After respondents not meeting criteria were removed, there were a total of 212 questionnaires left for data analysis. This resulted in a 79.7% inclusion rate of respondents and a 21.3% exclusion rate based on the total number of respondents and the predefined inclusion and exclusion criteria.

The total number of questionnaires received from each county ranged from 15 to 26, with response rates ranging from 23.4% to 42.2%. This response rate was prior to screening for exclusion. After screening for exclusion purposes, there were at least 12 respondents selected for every county, with the least number of respondents coming from Meigs and Monroe counties and the most number of respondents coming from Morgan County. The number of respondents per county can be seen in Table 1. Response rates per county are reported as well.

Table 1

Number of Respondents per Appalachia, Ohio County

County	Total number of Respondents	Number of Respondents Chosen	Total Response Rate
Athens	17	14	26.6%
Coshocton	16	13	25.0%
Guernsey	17	14	26.6%

Highland	15	13	23.4%
Jackson	16	13	25.0%
Jefferson	18	13	26.6%
Meigs	15	12	23.4%
Monroe	19	12	29.7%
Morgan	26	20	42.2%
Muskingum	18	15	28.1%
Noble	17	13	26.6%
Perry	19	15	29.7%
Pike	16	13	25.0%
Scioto	19	17	29.7%
Washington	18	15	28.1%

Data collection was completed per the plan initially presented in the proposal with one discrepancy. Originally the plan was to send out reminder postcards and wait another two full weeks prior to mailing out initial postcards to the second group of potential respondents in the case of desired response rate not being met. However, the actual time between the mailing of reminder postcards for the first group and mailing of initial postcards for the second group was one week, as this still left three weeks for initial respondents to return questionnaires. This also was enough time to allow the researcher to determine that the desired response rate of 180 was not going to be met.

Participants Characteristics

All respondents were female, determined by the Ohio Department of Health to be between the ages of 18 and 34, and had given birth in the years 2014 and 2015. This was accomplished through use of their vital statistics registry. This age range and gestation was confirmed by questions one and two of the questionnaire. In general, the respondents of the study were white, high school graduates that were employed and married, with over 98% residing in Appalachia during adolescence. In addition, respondents were relatively free of histories of complicated pregnancies (10%) and heart disease (4.9%). 1.2% of the respondents indicated that they were of Latino descent. 94.3% of the respondents identified themselves as white, with 2.1% indicating they were Black, and 1.0% indicating that they were Asian. 1.4% did not wish to answer the question. 93% of the respondents indicated that they graduated from high school and 78% indicated that they were employed. 68% of the population indicated that they were married.

Demographics.

The demographics collected for the sample mirrors the population of Appalachia, Ohio. In the counties of Appalachia, Ohio, the racial demographics were like that found in this study, as 95% of the total population of Appalachian Ohio was found to be white, with 1.2% identifying themselves as black, 1.8% identifying themselves as Hispanic, and 0.4% identifying themselves as Asian (United States Census Bureau, 2017). In addition, 86% of the population in Appalachia, Ohio have stated that they have graduated high school (United States Census Bureau, 2017), which is lower but still comparable to the 93% of the sample that stated they graduated high school.

The only marked difference found in the demographics when comparing the sample and the population was in terms of employment. Over 78% of the sample indicated that they were employed, whereas only 51% of the total Appalachian Ohio population indicated that they were employed (United States Census Bureau, 2017). This is most likely due to the fact the sample only included those of child bearing years between 18-34 years old, whereas the population data were abstracted from a census that considered the entire population. This would have included those that were retired and those younger that have still not joined the workforce.

The sample was composed of women, aged 18-34 that resided in Appalachia, Ohio. As a result, statistics for women specifically were obtained for a more accurate comparison. A closer look at the behavioral risk factors of the sample indicated that the respondents engaged in moderately risky health behaviors, some extending into pregnancy. Comparison of the descriptive statistics between the sample and the population at large can be seen in Table 2.

Table 2

Comparisons of Demographics and Population of Appalachia, Ohio

Demographic	Study Sample from Appalachia, Ohio	Population of Appalachia, Ohio
White	94.3%	95%
Black	2.1%	1.2%
Asian	1.0%	0.4%
Hispanic	1.2%	1.8%
Employed	78%	51%
High school Graduate	93%	86%

Note. Data from United States Census Bureau, 2017.

Results

Behavioral Risk Demographics

After screening and exclusion of those respondents that did not meet criteria, of the remaining 212 respondents, 39% of the sample indicated that they smoked, with 11% continuing during pregnancy. While the number of those that reported smoking in the sample was higher than in the general population, the number that reported smoking during pregnancy was less than that compared to the larger population. While no respondents of this study reported that they continued to drink during pregnancy, 34% stated that they drank alcohol on a regular basis outside of gestation. This was compared to the 20.6% of the population of Ohio that reported drinking and the 7.8% that reported drinking while pregnant (America’s Health Rankings, 2017).

Drug use was not high in the respondents of the study, with 4% reporting use. However, 3% stated that they had used illicit drugs while pregnant, as seen in Table 3. Illicit drug use was equivocal in both the study sample and the general population.

Table 3

Behavioral Risk Factor Comparison of Sample and Population

Risk Factor	Outside of gestation		During pregnancy	
	Sample	Ohio	Sample	Ohio
Smoking	39.5%	26.3%	11%	16%
Drinking	34%	20.6%	0%	7.8%
Illicit Drugs	4%	4.9%	3%	4%

Note. Data from the website provided by America's Health Rankings, 2017.

Low birth weight

The number of low birth weight deliveries among respondents was determined by answers from question three of the questionnaire, which asks respondents if the child they gave birth to weighed less than 5 pounds 8 ounces (2,500g). Low birth weights were reported by 25 women, 12% of the study sample of Appalachian women in Ohio. This is higher than the 8.5% reported by the general population in Ohio (America's Health Ranking, 2017). The number of low birth weights ranged from 0-3 in each county, with the mean calculated at 1.7 and the median being 1.5 low birth weights per county. 17.6% (3 respondents) from Scioto County reported low birth weights, which was the highest number of low birth weights reported in the 15 counties selected. There were no low birth weights reported by Noble county. The number of low birth weights per county as well as the prevalence are listed in Table 4. In addition, information about the type of Appalachian county is listed as well. The classification is from the Appalachian Regional Commission (2016).

Table 4

Low Birth Weights per Selected Appalachian County of Ohio

County	Number of Respondents	Number of Low birth weights	Rate of Low birth weights	Type of Appalachian County
Athens	14	2	14.2%	Distressed
Coshocton	13	1	7.6%	Transitional
Guernsey	14	1	7.1%	Transitional
Highland	13	2	16.7%	At-Risk
Jackson	13	1	7.7%	At-Risk
Jefferson	13	1	7.7%	Transitional
Meigs	12	2	16.7%	Distressed
Monroe	12	2	16.7%	At-Risk
Morgan	20	3	15%	Distressed
Muskingum	15	2	13.3%	Transitional
Noble	13	0	0%	At-Risk
Perry	15	2	13.3%	At-Risk
Pike	13	2	15.4%	Distressed
Scioto	17	3	17.6%	Distressed
Washington	15	1	6.7%	Transitional

Note. Type of Appalachian County, data obtained from website developed by ARC, 2016.

The counties for the study were selected based on information from the Appalachian Regional Commission (2016) that has categorized the Appalachian counties in Ohio into three groups based on socioeconomic indicators: distressed, at-risk, and transitional. In order to better answer the first research question, the amount of low birth weights and the rate of low birth weights were considered for the counties by the groups distressed, at-risk, and transitional. The number of low birth weights in each group of Appalachian counties was determined as well as the rate. The distressed counties in Appalachia, Ohio that were selected for this study, which included Athens, Meigs, Morgan, Pike, and Scioto, had the highest rate (15.8%) of low birth weight. The transitional counties selected for this study including Coshocton, Guernsey, Jefferson, Muskingum, and Washington (8.6%) had the lowest rate of low birth weights, as shown in Table 5.

Table 5

Low Birth Weights per Type of Appalachian County in Ohio

Type of Appalachian County	Number of Low birth weights	Total Number of Respondents	Rate of Low birth weights
Distressed	12	76	15.8%
At-Risk	7	67	10.4%
Transitional	6	70	8.6%

ACE.

The exposure to ACE was measured by using questions 18-31 on the questionnaire. According to the data received, 38.3% reported one or more exposures to ACE. This is substantially higher than the 26% that report exposure to ACE in the general population of Ohio (America's Health Rankings, 2017), as shown in Table 6. 15.4% of the study sample reported one exposure to ACE while 3.8% of the sample reported exposure to five or more ACEs. The average of number of ACE exposures reported was 1.3 with a standard error of .149.

Table 6

Number of ACE Exposures in Sample of Women in Appalachia, Ohio

Number of Exposures	Percent of the Sample
0	61.7%
1	15.4%
2	10.9%
3	6.4%
4	1.9%
5	3.8%

The types of ACE fall into five different categories, which include poor home life, emotional abuse, neglect, physical abuse and sexual abuse (CDC, 2016). The type of ACE, in addition to the amount, were determined by respondent's answers to questions 18-31 of the questionnaire. Poor home life was defined as divorced parents, members of the household being in prison, depressed or having committed suicide. It also included adults in the household having drinking problems or drug problems. Emotional abuse included questions about how others made them feel, if they were talked down to, or if someone continually made fun of them. Neglect included having someone to take them to the doctor, cook for them, and make sure they had clean clothes. Physical abuse included someone hitting the respondent or members of their family on a regular basis. Sexual abuse included the respondent being forced to touch someone, someone touching them inappropriately, or sex of any kind (consensual or not) during childhood.

Poor home life was the most reported types of ACE, with 32.7% of respondents reporting exposure. The questionnaire developed by the CDC and used in this study asks respondents if families were divorced, separated, or they had an unstable home life, which were used to determine if respondents were exposed to poor home life. The next most reported ACE was physical abuse, with 16.5% of the sample reporting exposure, followed by neglect, with 8.6% of the sample reporting exposure. Sexual abuse was the least reported ACE, with 2.6% of the sample reporting exposure to this ACE. In the case of sexual abuse, all those that reported it also reported exposure to five or more ACEs, with all of these respondents also reporting physical abuse and poor home life in childhood, as shown in Table 7. Of the 23% that reported two or more exposures to ACE, 87% reported a poor home life.

Table 7

Types of ACE by Percentage in the Sample

Types of ACE	Percentage of sample
Poor Home life	32.7%
Emotional Abuse	5.7%

Neglect	8.6%
Physical Abuse	16.5%
Sexual Abuse	2.6%

Questions 18-31 of the ACE questionnaire were used for determining type of exposure to ACE in the respondents. The ACE that respondents reported being exposed to most was living in a household with separated parents or a depressed individual, at 40.1% and 36.0% respectively. The next most reported ACEs was living in a household where they were exposed to alcohol and witnessing a female figure in their life being physically abused, at 24.8% and 22.0% respectively, as shown in Figure 3. Questions falling into the category of sexual abuse received the lowest number of positive responses, for a total of 2.6% (5 respondents) of the sample. Figure 3 is a graphic representation of the percentage of respondents that answered positively to the corresponding ACE. Questions 18 and 19 of the questionnaire were not used in scoring of the number of exposures as stated in instructions by the CDC (2016), but were used for tracking or correlative purposes. The CDC (2016) indicates that there have been many research studies completed using the questionnaire that have found a strong correlation between poor home life, living with depressed persons, or living in a separated family environment with increased rates of exposure to ACE. This was supported by findings in this study, where 87% of those that answered that they lived in a separated family situation, had divorced parents, or were living with depressed people also reported that they were exposed to additional ACEs.

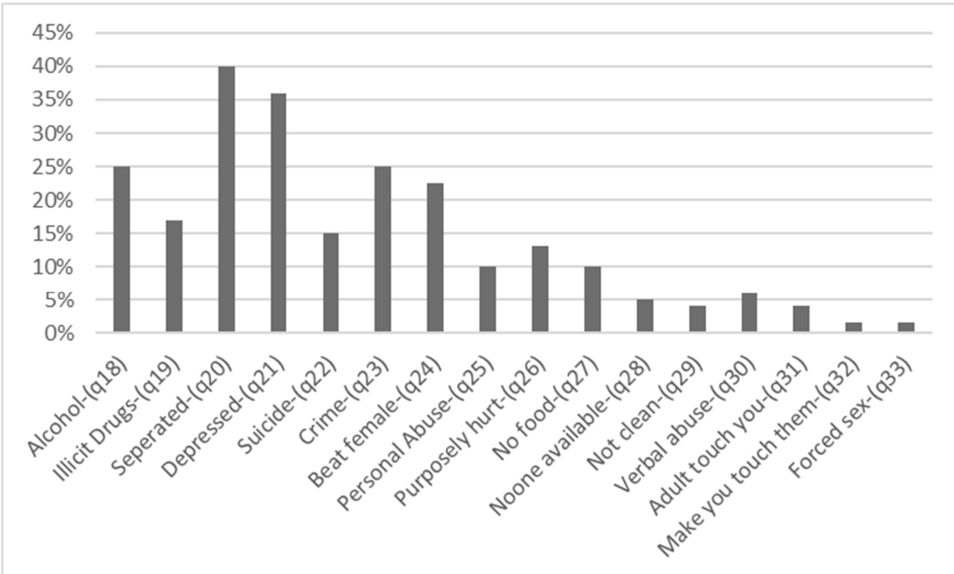

Figure 3. ACE Exposures for Respondents in Appalachia, Ohio by Question

The rate of ACE exposure of each Appalachian Ohio county was determined and compared to the type of Appalachian county, as shown in Table 8. The lowest rate of exposure to ACE was in Coshocton county, with only two individuals reporting exposure to ACE at a rate of 15.4%. The highest rate of exposure to ACE was found in Meigs County, with a total of 9 and a rate of 66.7% of the respondents stating they had some exposure to ACE. Meigs is defined as a distressed Appalachian county (ARC, 2016). When looking at the other four distressed Appalachian counties that were selected, they too had higher rates of exposure to ACE, with the lowest rate of exposure to ACE reported in a distressed county belonging to Scioto at a rate of 41.2%. When the counties were examined by their categorical groupings transitional, at-risk, and distressed in terms of ACE exposure, it was found that distressed counties had higher rates of exposure to ACE than at-risk and transitional counties. In fact, the rate of exposure to ACE nearly doubled in distressed counties as opposed to transitional counties, as shown in Table 9.

Table 8

Number and Rate of Respondents Exposed to ACE in Selected Appalachian County

County	Number of Respondents	Number of Respondents Exposed to ACE	Rate of Respondents exposed to ACE	Type of Appalachian County
Athens	14	9	64.3%	Distressed
Coshocton	13	2	15.4%	Transitional
Guernsey	14	3	21.4%	Transitional
Highland	13	7	53.8%	At-Risk
Jackson	13	4	30.8%	At-Risk
Jefferson	13	5	38.5%	Transitional
Meigs	12	8	66.7%	Distressed
Monroe	12	4	33.3%	At-Risk
Morgan	20	10	50.0%	Distressed
Muskingum	15	5	33.3%	Transitional
Noble	13	3	23.1%	At-Risk
Perry	15	5	33.3%	At-Risk
Pike	13	7	53.8%	Distressed
Scioto	17	7	41.2%	Distressed
Washington	15	5	33.3%	Transitional

Note. Type of Appalachian County came from data obtained from information on the website developed by ARC, 2016.

Table 9

ACE Exposure of Respondents per Category of Appalachian County in Ohio

Type of Appalachian County	Number of Exposures	Total Number of Respondents	Rate of ACE Exposure
Distressed	41	76	53.9%
At-Risk	25	67	37.3%
Transitional	20	70	28.6%

The type of ACE exposure was examined per county. Rates were determined to compare exposure from one county to another as the counties had varying number of respondents. Exposure to poor home life was seen in all 15 counties, while sexual abuse and emotional abuse was seen in 5 and 10 counties respectively. Of the 5 counties where sexual abuse was reported, 4 were categorized as distressed counties. Emotional abuse was reported in all 5 distressed counties, as well as being reported in 2 at-risk counties and 3 transitional counties. Physical abuse was the second most reported ACE, and was reported in 13 out of 15 of the counties including all distressed counties. Neglect was reported in 9 of the 15 counties, with neglect being reported in all but 1 of the distressed counties. The overall average among counties for respondents reporting an exposure to poor home life was 35%. 14.3% of the respondents reported physical abuse. The average rate of exposure to neglect, sexual abuse, and emotional abuse was reported in 10.2%, 3.4%, and 7.1% of the respondents respectively as shown in Table 10.

Table 10

Rate of Exposure per County According to ACE Category

County	Poor Home Life	Physical Abuse	Neglect	Sexual Abuse	Emotional Abuse	Type of Appalachian County
Athens	64.3%	35.7%	50.0%	7.1%	14.3%	Distressed
Coshocton	15.4%	7.7%	0.0%	0.0%	7.7%	Transitional
Guernsey	14.3%	0.0%	7.1%	0.0%	0.0%	Transitional
Highland	46.2%	23.1%	7.7%	0.0%	0.0%	At-Risk
Jackson	30.8%	15.4%	23.1%	0.0%	0.0%	At-Risk
Jefferson	30.8%	15.4%	0.0%	0.0%	7.7%	Transitional
Meigs	58.3%	25.0%	16.7%	25.0%	16.7%	Distressed
Monroe	33.3%	25.0%	0.0%	0.0%	8.3%	At-Risk
Morgan	50.0%	15.0%	10.0%	5.0%	10.0%	Distressed
Muskingum	33.3%	6.7%	6.7%	0.0%	0.0%	Transitional
Noble	15.4%	0.0%	0.0%	0.0%	15.4%	At-Risk
Perry	20.0%	13.3%	20.0%	0.0%	0.0%	At-Risk
Pike	53.8%	7.7%	0.0%	7.7%	7.7%	Distressed
Scioto	35.3%	11.8%	11.8%	0.0%	11.8%	Distressed
Washington	26.7%	13.3%	0.0%	6.7%	6.7%	Transitional

Low Birth Weight and ACE

In total, 212 respondents were selected from the 266 respondents based on exclusion criteria, with 82 of these respondents indicating some exposure to ACE and the remaining 130 not reporting any exposure to ACE. As stated previously, 25 respondents indicated that they delivered low birth weight babies, 12 of which reported exposure to ACE, as shown in Table 11. Almost half (48%) of the mothers that stated they had a low birth weight baby were exposed to ACE. This accounted for 14% of the total number of mothers that stated they were exposed to ACE. The remaining 52% of the mother's that reported low birth weight deliveries reported that they had not been exposure to ACE, which accounted for 10% of the total number of mothers giving birth that had not been exposed to ACE.

Table 11

Exposure to ACE and Low Birth Weight Deliveries in Appalachia, Ohio

Exposure to ACE		Number of Low birth weights	Rate of Low Birth Weight	Percentage of Low birth weight Deliveries
Yes	82	12	14%	48%
No	130	13	10%	52%

There were 25 respondents that reported low birth weight deliveries, which is shown broken down by county in Table 4. The range for number of respondents exposed to ACE per county was 0-2. Of the 25 respondents that reported low birth weight deliveries, 12 also reported exposure to ACE. 7 of the respondents were from distressed counties, 4 were from at-risk counties, and only one was from a transitional county. Muskingum County was the only transitional county to have a respondent that reported low birth weight delivery and exposure to ACE, as seen in Table 12.

Table 12

Number of Low Birth Weight Respondents Exposed to ACE per County

County	Number of Low birth weights	Number of Low Birth Weight Respondents Exposed to ACE	Rate of Low birth weight Respondents Exposed to ACE	Type of Appalachian County
Athens	2	1	50.0%	Distressed
Coshocton	1	0	0.0%	Transitional
Guernsey	1	0	0.0%	Transitional
Highland	2	1	50.0%	At-Risk
Jackson	1	1	100.0%	At-Risk
Jefferson	1	0	0.0%	Transitional
Meigs	2	1	50.0%	Distressed
Monroe	2	1	50.0%	At-Risk
Morgan	3	1	33.3%	Distressed
Muskingum	2	1	50.0%	Transitional
Noble	0	0	0.0%	At-Risk
Perry	2	1	50.0%	At-Risk
Pike	2	2	100.0%	Distressed
Scioto	3	2	66.7%	Distressed
Washington	1	0	0.0%	Transitional

Note. Type of Appalachian County came from data obtained from the website developed by ARC, 2016.

The type of ACE was also considered specifically in those reporting low birth weight deliveries, as seen in Table 13. All respondents that reported having a low birth weight delivery and reported exposure to ACE also reported a poor home life. The next most reported ACE exposure category was physical abuse, reported in 8 of the 12 (67%) respondents considered. The only transitional county to have had a respondent report both a low birth weight delivery and exposure to ACE did not report physical, emotional, or sexual abuse, as the exposure to ACE that was reported was a poor home life. Neglect, sexual abuse, and emotional abuse were reported by 3 of the 12 respondents at a rate of 25%.

Table 13

Rate of Exposure in Respondents Reporting Low Birth Weight Deliveries per County According to ACE Category

County	Poor Home Life	Physical Abuse	Neglect	Sexual Abuse	Emotional Abuse	Type of Appalachian County
Athens	100.0%	100.0%	100.0%	0.0%	0.0%	Distressed
Coshocton	0.0%	0.0%	0.0%	0.0%	0.0%	Transitional
Guernsey	0.0%	0.0%	0.0%	0.0%	0.0%	Transitional
Highland	100.0%	100.0%	0.0%	0.0%	0.0%	At-Risk
Jackson	100.0%	100.0%	0.0%	0.0%	100.0%	At-Risk
Jefferson	0.0%	0.0%	0.0%	0.0%	0.0%	Transitional
Meigs	100.0%	100.0%	0.0%	100.0%	0.0%	Distressed
Monroe	100.0%	100.0%	0.0%	0.0%	100.0%	At-Risk
Morgan	100.0%	100.0%	100.0%	100.0%	0.0%	Distressed
Muskingum	100.0%	0.0%	0.0%	0.0%	0.0%	Transitional
Noble	0.0%	0.0%	0.0%	0.0%	0.0%	At-Risk
Perry	100.0%	0.0%	0.0%	0.0%	0.0%	At-Risk
Pike	100.0%	50.0%	0.0%	50.0%	0.0%	Distressed
Scioto	100.0%	50.0%	50.0%	0.0%	50.0%	Distressed
Washington	0.0%	0.0%	0.0%	0.0%	0.0%	Transitional

Note. Type of Appalachian County came from data obtained from website developed by ARC, 2016.

Assumptions

Assumptions made in the collection and statistical analysis of data included that the data supplied by ODH to the researcher were accurate and fell within the parameters that were designated. It was also assumed that the data collected from the respondents were accurate and truthful, and that each respondent resided in an Appalachian county in Ohio during their childhood. It is assumed that since the data were collected from three different types of Appalachian Counties in Ohio, as defined by ARC (2016), that this is reflective of the larger Appalachian population. Secondary data were used for comparisons and to better define the

Appalachian sample in this study, which it is assumed that this data obtained from America's Health Rankings was statistically accurate and representative of the population.

There were also assumptions made in the statistical analysis of the survey data. It is assumed that the instruments developed and provided by the CDC (2016), were reliable and valid for use with the sample that was studied. As the instrument was a questionnaire, it was subject to bias, particularly social desirability bias and recall bias, due to the nature of the questions involved. Respondents may have answered questions based on desires of acceptance by society rather than actual events. In addition, the questionnaire looked at events occurring in the respondent's childhood, which a respondent's memory of what happened may have not been reflective of the actual event.

The questionnaire was self-administered and the entire study was anonymous, which served to reduce the bias as much as possible by offering protection of the respondent's identity. In addition, the questionnaire only asked if events occurred, not specific details of the events. This would reduce recall bias among the respondents. While steps were taken to reduce the amount of bias that impacted results, answers provided by the respondents may have been effected by bias and therefore not a representative sample of the Appalachian Ohio child bearing population. In the case of recall bias, it was likely minimized as Pinto et al. (2014) completed a study involving the impact of recall bias on research involving ACE. They found that recall bias did not impact the integrity of the respondent's answers.

It is assumed that there were no significant outliers in the data that could have negatively impacted results. The category of county, birth weight, and the number of exposures were analyzed using SPSS and box plots. The normality of this information was also analyzed using kurtosis and skewness. The homogeneity of this information was analyzed in SPSS using Leven's test. As the results of these statistical tests showed no concerns, the data are thought to satisfy assumptions of normality, homogeneity, and have no outliers. As stated previously, there was no missing data which would impact the results of the study.

Statistical Analysis Findings

RQ1: What is the difference between county of residence in Appalachian maternal populations in relation to ACE?

$H_0 1$: There is no difference between county of residence in Appalachian maternal populations in relation to ACE.

$H_A 1$: There is a difference between county of residence in Appalachian maternal populations in relation to ACE.

The questionnaires were color coded prior to being mailed and the data were grouped by county on return. The county then became a variable in statistical analysis. The questionnaire was used to determine if the mother was exposed to ACE and the county in which the mother resided. Exposure to ACE and county of residence were both simplified to categorical variables, and a chi-square test was performed to analyze the data. As one would expect natural variation between counties, which was seen, the counties were divided into three groups based on socioeconomic indicators: distressed, at-risk, and transitional.

Grouping the counties by the ARC (2016) defined categories of distressed, at-risk, and transitional gave a better understanding to the variation of exposure to ACE in women aged 18-34 among the counties of Appalachia, Ohio. Descriptive statistics demonstrated that a higher percentage of respondents in distressed counties of Appalachia, Ohio were exposed to ACE as opposed to those in transitional counties. Prevalence rates were determined by calculating the total number of respondents that identified exposure to one or more ACE in each county as well as the total number of respondents from each county. The counties are broken down by classification in Table 14.

Table 14

Classification of Selected Counties in Appalachia, Ohio

Distressed	At-Risk	Transitional
Athens	Highland	Coshocton
Meigs	Jackson	Guernsey
Morgan	Monroe	Jefferson
Pike	Noble	Muskingum
Scioto	Perry	Washington

The sum of both total number of respondents and total number of respondents reporting exposure to ACE was determined by adding these numbers from each county within the category. This resulted in a total number of respondents and a total number of those exposed to ACE in distressed counties, at-risk counties, and transitional counties. The total number of exposures was divided by the total number of respondents for each of these three groups. The result was a prevalence rate showing more exposure in distressed counties at 53.9% then in at-risk counties (37.3%) or transitional counties (28.6%).

The chi-square test of independence was performed to examine the relationship between category of county of residence and exposure to ACE, with the data shown in Table 15. The significance level for in the chi-square test was found to be .006, which is less than the p of .05. This allowed for the null hypothesis to be rejected. Based on these results, there was a difference in exposure to ACE depending on what category of Appalachian county the respondent was from. The degrees of freedom were 2 and the Cramer's V was .318 out of a maximum of 1. This indicates a moderate relationship between exposure to ACE and category of county of residence in Appalachia, Ohio.

Table 15

Chi-Square Cross Tabulation for Category of County and Exposure to ACE

Category of County	Exposure		Total (N=)	Test Statistic χ^2	Significance
	Yes	No			
Distressed	41 (54%)	35 (46%)	76		
At-Risk	25 (38%)	41 (62%)	66		
Transitional	20 (29%)	50 (71%)	70		
Total	86 (41%)	127 (59%)	212	8.81	0.006

RQ2: What is the association between maternal exposure to ACE and increased risk of low birth weight infants in Appalachian populations?

$H_0$2: There is no association between maternal exposure to ACE and low birth weight infants in Appalachia.

H_A2: There is an association between maternal exposure to ACE and low birth weight infants in Appalachia.

The questionnaire was used to determine if the mother had a low birth weight delivery and was exposed to ACE. As these were both simplified to categorical variables, a chi-square test was performed to analyze the data. 82 respondents reported exposure to ACE, with 12 of these individuals also reporting a low birth weight delivery, which was calculated as 14.6% of the total number of respondents reporting exposure to ACE. Of the remaining 130 that reported no exposure to ACE, 13 (10%) of these individuals reported a low birth weight delivery.

A chi-square analysis was completed on ACE exposure and low birth weight using the categorical data that were collected. Table 16 shows the cross tabulation. The significance level was found to be .211, with a degree of freedom of 1, indicating that the null hypothesis should be accepted. As a result, the data demonstrates no statistically significant relationship found between low birth weight delivery and exposure to ACE in Appalachia, Ohio. The Cramer's V was found to be .070, which also shows no real effect of the between the variables. This would mean that exposure to ACE had little effect on low birth weight deliveries in Appalachia, Ohio.

Table 16

Chi-Square Cross Tabulation for Low birth weight and Exposure to ACE

Low birth weight	Exposure		Total (N=)	Test Statistic χ^2	Significance
	Yes	No			
Yes	12 (48%)	13 (52%)	25		
No	74 (40%)	113 (60%)	188		
Total	86 (41%)	126 (59%)	212	2.14	0.211

RQ3: What is the difference in the impact of types of ACE on birth weight in the Appalachian population?

$H_0$3: There is no difference in the impact of types of ACE on birth weight in an Appalachian population.

H_A3: There is a difference in the impact of types of ACE on birth weight in an Appalachian population.

The questionnaire was used to determine if the type of ACE exposure had an impact on low birth weight offspring. As these were both simplified to categorical variables, a chi-square test was performed to analyze the data. The analysis showed there was a statistically significant relationship between the independent variable of type of ACE exposure and low birth weight deliveries in Appalachia, Ohio. The exposure that was most often associated with low birth weight was determined to be poor home life. The data that resulted from the analysis is in Table 17 in the cross tabulation. There were 5 degrees of freedom and the significance level was found to be .000, indicating that the null hypothesis was rejected and the type of ACE exposure impacts low birth weight deliveries. This means that one type of ACE could impact low birth weight rate more than others. Poor home life was seen in 8 of the 12 that reported low birth weight and ACE exposure. The Cramer's V was found to be .388 indicating a moderate relationship between type of ACE exposure and increase risk of low birth weight.

Table 17

Chi-Square Cross tabulation for Types of ACE and Low Birth Weight

Low birth weight	No Exposures	Home life	Physical	Neglect	Sexual	Emotional	Total (N=)	Test Statistic χ^2	Sig.
Yes	13 (52%)	12 (48%)	8 (32%)	3 (12%)	3 (12%)	3 (12%)	25		
No	113 (60%)	55 (29%)	27 (14%)	15 (8%)	2 (1%)	9 (5%)	187		
								23.3	0.000

After the results of initial data analysis in answering the research questions, it became apparent that there were other points to consider, such as a more complex relationship between county of residence, exposure to ACE, and low birth weight that might exist. As a result, a log-linear analysis was completed using the variables low birth weight, category of county, and ACE exposure. The Chi-Square likelihood ratio of this was .641 with a degree of freedom of 3 and a significance level of .887, indicating that the there was no statistically significant relationship found between category of county of residence, low birth weight, and ACE exposure.

Summary

In summary, the null hypothesis for the first and the third null hypothesis were rejected, with the second null hypothesis being accepted. This indicates that while exposure to ACE may not impact risk of low birth weight deliveries as stated in research question two, the data and analysis indicated that there was a significant relationship found between ACE exposure and category of Appalachian county in Ohio, resulting in rejection of the first null hypothesis. As the third null hypothesis was also rejected, data showed that where respondents reported exposure to ACE, there was a significant relationship between poor home life and risk of low birth weight. In addition, a log-linear regression analysis of data was completed to see if there was any association between low birth weight, category of county, and exposure to ACE. No statistically significant relationship was found however, using the present data. This information has been summarized in Table 18.

Table 18

Summary of Data Analysis and Hypothesis Testing

Hypothesis	Dependent Variable	Independent Variable	Statistical Test	Significance	Hypothesis Outcome
$H_0$1: There is no difference between county of residence in Appalachian maternal populations in relation to ACE.	Exposure to ACE	Category of county of residence	Chi-Square	.006	Rejected
H_A1: There is a difference between county of residence in Appalachian maternal populations in relation to ACE.	Exposure to ACE	Category of county of residence	Chi-Square	.006	Accepted

$H_0$2: There is no association between maternal exposure to ACE and low birth weight infants in Appalachia.	Exposure to ACE	Birthweight of offspring	Chi-Square	0.211	Accepted
H_A2: There is an association between maternal exposure to ACE and low birth weight infants in Appalachia.	Exposure to ACE	Birthweight of offspring	Chi-Square	0.211	Rejected
$H_0$3: There is no difference in the impact of types of ACE on birth weight in an Appalachian population.	Type of ACE exposure	Birthweight of offspring	Chi-Square Log-linear regression	0.000	Rejected
H_A3: There is a difference in the impact of types of ACE on birth weight in an Appalachian population.	Type of ACE exposure	Birthweight of offspring	Chi-Square Log-linear regression	0.000	Accepted

In Chapter 5, there will be a more in-depth discussion of the meaning the results in terms of advancing the field of knowledge in both maternal health and Appalachian health, with reference to the LCA. Limitations pertaining to the study will also be discussed. Recommendations will be given for future research with respect to these limitations. Finally, social implications of the study will be discussed in hopes of future research in this area.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

Purpose

The purpose of this study was to quantitatively examine the association between maternal exposure to ACE and adverse birth outcomes such as low birth weight. Confounding variables were controlled for by screening and eliminating respondents with a history of diabetes, heart or cardiovascular disease, and complicated obstetrical histories, as these can impact birth outcomes. Respondents were also screened for behavioral risk factors such as smoking, drinking, and illicit drug use while pregnant. The population of Appalachia, Ohio is largely homogenous, which helped to control for demographics such as race, as well as SES. Age was controlled for setting parameters of the study for women between 18-34 in initial requests for information from ODH.

Nature of Study

A cross-sectional design was used to better understand the relationship between maternal exposure to ACE and low birth weight incidence in a population. Research to date has not considered what role maternal exposure to ACE may have on birth weight of offspring. In addition, little has been researched in terms of low birth weight and the impact on Appalachians populations. A chi-square analysis was used by Braveman et al (2010) and Chung et al. (2010) for trend analysis in populations and odds ratios to predict the likelihood of factors affecting adverse birth outcomes in a population. Because of the nature of the questionnaire and the categorical data received, a chi-square analysis was completed to determine any significance between low birth weight and ACE exposure in the Appalachian Ohio population.

Summary of Findings

This study used respondents from 15 different counties in Appalachia, Ohio. These counties were categorized into three groups based on socioeconomic indicators as defined by ARC (2016): distressed, at-risk, and transitional. The counties were grouped into three categories defined by ARC to better understand these relationships if they were found. A total of 899 packets containing the questionnaires were mailed out in two separate mailings of 446 and 453 with response rates of 30.9% and 28% respectively. The overall response rate for the study during the 10-week data collection period was 29.7%. There was a total of 266 questionnaires returned between the two mailings, of which 54 were removed from the sample due to not meeting screening and the predefined exclusion criteria. 94% of the sample identified themselves as white, 93% indicated that they graduated from high school, and 68% were married. This was similar to statistics found in the populations of surrounding regions and the state of Ohio (America's Health Ranking, 2017).

In terms of behavioral risk factors, 39.5% stated they smoked, only 11% claimed to smoke while pregnant. The percentage of women smokers is lower in the general population the state of Ohio (26.3%) than in the study sample; however, more people throughout the state reported smoking while pregnant (16%) than those in the sample (America's Health Rankings, 2017). The same was true for drinking, with the sample reporting 34% on a normal basis and 0% while pregnant, while Ohio women reported 20.6% on a normal basis and 7.8% reported drinking while pregnant. Illicit drug use was lower in the sample than in the population both outside of gestation and while pregnant.

Low birth weight was reported in 25 women, which was 12% of the selected sample from Appalachia, Ohio. This was higher than the 8.5% found in the general population of the Ohio (America's Health Ranking, 2017). Of the sample counties, those that were categorized as distressed had the highest average rate of low birth weight, at 15.8% of the respondents from distressed counties. In addition, of the 25 respondents who reported low birth weight in the sample, 12 were identified as being from distressed counties, meaning that 48% of the low birth weights reported were from distressed counties. At-risk counties had lower rates of birth rate at 10.4% and transitional counties had even lower rates of birth rate reported at 8.6% which was comparable to the state's rate of 8.5% (America's Health Ranking, 2017).

ACE exposure was measured by the questionnaire as well, with 38.3% of the sample reporting exposure to at least one ACE as defined by the CDC. This was higher than 26.5% exposure to ACE in the state of Ohio overall (America's Health Rankings, 2017). The most reported type of exposure was poor home life, which included factors such as divorce of a parent, suicide of a parent or guardian, imprisonment of someone in the home, depression of someone in the home, and the use of alcohol or drugs by someone in the home (CDC, 2016). Of those that reported ACE, 16.5% reported physical abuse, while only 2.6% reported sexual abuse.

ACE exposure was also examined by county of residence. This was accomplished by using the categorization of distressed, at-risk, and transitional for the counties in the study. The highest rate of ACE exposure was found in Meigs (66.7%), which is a distressed county. 53.9% of the respondents from distressed counties were identified as being exposed to one or more ACEs. This is high compared to the 37.3% and 28.6% reported in at-risk and transitional counties respectively.

The impact of ACE exposure on low birth weights was also examined in this study. Of the 25 low birth weights reported, 12 also reported exposure to ACE and 13 reported no exposure to ACE. While the rate of low birth weights was higher in those exposed to ACE (14.6%) than those that were not exposed to ACE (10%), the rates were close and statistical analysis was needed to understand any significant relationships. The type of ACE exposure was also considered in terms of impact on low birth weight. In all the respondents that reported a low birth weight delivery and exposure to ACE, they all identified as having a poor home life. The second most reported type of ACE exposure in those reporting a low birth weight delivery was physical abuse.

In terms of statistical analysis, there was a significant difference between category of county of residence and maternal exposure to ACE, as the distressed counties were more likely to be exposed to ACE. The significance level of the chi-square test was found to be $p = .006$, lower than the set $p =. 05$. The Cramer's V was found to be .318, which shows a moderate relationship between exposure to ACE and category of residence. Based on these findings, $H_0 1$ was rejected and the alternate hypothesis was accepted. There is a difference in ACE exposure rates based on category of county of residence.

A significant relationship was also found in the chi-square analysis of type of ACE exposure and likelihood of low birth weight of offspring, with poor home life impacting respondents more than the other types of ACE exposure. The significance was .000 with a Cramer's V of .388, indicating a moderate relationship between type of ACE exposure and low birth weight in Appalachia, Ohio. Based on these findings, $H_0 3$ was rejected and the alternate hypothesis accepted. It was found that different types of ACE exposure had impacted risk of low birth weight in varying amounts, with not all respondents reporting low birth weight deliveries and exposure to the same ACE.

A significant relationship was not found between low birth weight delivery and ACE exposure, as the significance in the chi-square analysis was p=.211 and the Cramer's V .070, indicating no significant relationship between the two variables. While a greater percentage of those exposed to ACE reported low birth weight, based on the statistical analysis for RQ2, it was determined that the null hypothesis had to be accepted. This meant that there was no statistically significant association between low birth weight and ACE exposure of the mother.

Interpretation of Findings

This study used the ACE questionnaire developed by the CDC to determine if there was a relationship between exposure to ACE and low birth weight in Appalachia, Ohio. The study also determined if there were Appalachian counties in Ohio that had higher exposure rates of ACE. In addition, the type of ACE exposure was examined in terms of impact on birth weight.

Research Question 1

What is the difference between county of residence in Appalachian maternal populations in relation to ACE?

In terms of exposure to ACE, there has been wide variation among populations and samples in studies. Smith, Gotman, and Yonkers (2016) suggest that over 72% of people may be impacted by exposure to ACE in some way, where 40% were reported to have been exposed to ACE in the original Kaiser sample (CDC, 2016) and 28% were reported to be exposed in other studies conducted by the CDC (2016).

This wide variation could be accounted for by differences in geography, as it has been found that rural regions of the United States may be at a greater risk to be exposed to ACE than more urban counterparts, as Sprang et al. (2013) estimated that over 44% of the sample studied in rural populations were exposed to 3 or more ACE. The variation is not found only on a national level, but at the state level as well. For instance, Sacks et al. (2014) suggested that Ohio has an ACE exposure rate of 36%, while other sources say the exposure rate is 26% (America's Health Rankings, 2017).

This variation was considered in the formation of the first research question. This study considered rate of ACE exposure specifically in an Appalachian Ohio female population to determine if there were differences from the state exposure rate and differences among the counties themselves. The rate of ACE exposure was considered individually in counties first, with rates of exposure ranging from 15.4% to 66.7%. This provided evidence that there was considerable variation in ACE exposure among the Appalachian counties sampled. To determine if there were any trends associated with this, the counties were clustered into groups according to their classification by ARC (2016) based on socioeconomic factors. The clusters have been identified in Table 15 in Chapter 4.

After the counties were considered in the groups of distressed, at-risk, and transitional, a more definitive pattern emerged. Of the respondents that reported from distressed counties in Appalachia, Ohio, 53.9% of those respondents were exposed to ACE. This was larger than the rate of exposure found in at-risk counties (37.3%) and transitional counties (28.6%). The chi-square results indicated a significance level of p=.006, where p<.05 was to be considered statistically significant. This indicates that there was a significant relationship between exposure to ACE and the category of the county of residence. Distressed counties are defined as counties that rank in the lowest 10% of the nation in terms of unemployment rates, per capita market income, and poverty rates (ARC, 2016). The statistical analysis showed that respondents coming from distressed communities had a higher rate of exposure to ACE.

The Cramer's V was found to be .318, suggesting a moderate effect occurs between category of Appalachian Ohio county and exposure to ACE. Based on these results, $H_0 1$ was rejected as a difference was found in clusters of the sample in terms of ACE exposure. Ohio's ACE exposure rate is estimated to be 26%-36% of the population (America's Health Rankings, 2017; Sacks et al., 2014). The rate of exposure in distressed counties was much higher, while the rate in transitional counties was comparable to state exposure rates. Based on this, there is evidence to support the alternative hypothesis that ACE exposure rates differ depending on category of county in Appalachia, Ohio and those living in distressed counties are more likely to be exposed to ACE than the rest of the population in Ohio, including other counties in Appalachia, Ohio. Taking this further, the data here could suggest that those in lower socioeconomic settings have increased risk of ACE exposure, similar to findings of Seng et al. (2011) who found that populations in low SES communities were more likely to be exposed to child abuse and suffer PTSD.

Research Question 2

What is the association between maternal exposure to ACE and increased risk of low birth weight infants in Appalachian populations?

A number of researchers have provided evidence that there is an increased risk of low birth weight in rural and Appalachians communities. Yao et al. (2012) studied the Appalachian population specifically and found higher rates of infant mortality and lower birth weight in Appalachia as opposed to non-Appalachian communities. Statistics show that as a region, infant mortality is higher in Appalachia than in non-Appalachia, with rates of 5.97 compared to 6.73 out of 1000 live births respectively (Henry J Kaiser Foundation, 2016). In addition, when comparing low birth weight rates between counties in Ohio, non-Appalachian counties show rates of 7.10% and 6.10% whereas Appalachian counties had rates of 9.7% and 9.3%.

The rates of low birth weight were considered in all counties individually and then in the three separate groups as defined by ARC (2016). 25 respondents out of 212 respondents reported low birth weight deliveries, or 12% of the total number of respondents. This is higher than the 8.5% rate of low birth weight deliveries reported for Ohio (America's Health Ranking, 2017). When considered individually by county, the rate of low birth rate ranged from 0% to 17.6%, with a median of 13.3%. This indicates that there is an increased likelihood of low birth rate in Appalachian Ohio counties and supports findings like that of Kent et al. (2013), Lisonkova et al. (2011), Braveman et al. (2010), and Yao et al. (2012). When counties were separated into the predefined ARC categories, the distressed counties had a higher rate of low birth rates than at-risk or transitional counties. This agrees with the findings of Garcia-Subirats et al. (2011), who found that people in low SES communities are more likely to have adverse birth outcomes.

As the rates of low birth weight and ACE exposure were both found to be higher in the sample than statistics provided by previous research, the study considered the relationship between low birth weight rates and ACE exposure in Appalachian Ohio. Of the 212 respondents that were chosen, 82 reported some form of ACE, which was 38% of the sample. 12 of these individuals, a rate of 14%, reported low birth weight deliveries in addition to ACE exposure. The rate of those reporting low birth weight births that had not been exposed to ACE was 10%. Based on descriptive statistics alone, this would suggest evidence that ACE exposure causes increased rates of low birth weight deliveries in Appalachia, Ohio counties.

However, when a chi-square statistical analysis was completed on the variables low birth weight and maternal ACE exposure, no statistically significant relationship was found, as a p=.211 and a Cramer's V of .070 was determined, suggesting little to no effect of one variable on the other. With these results, the $H_0 2$ was accepted, with statistical evidence supporting the statement that there is no association between maternal expose to ACE and low birth weight rates in Appalachia, Ohio counties. While the number of respondents reporting low birth weight deliveries in the sample was higher than in the general population, it was still a relatively small number of individuals. This could have impacted the results, which could have led to the lack of statistical evidence to support rejection of the null hypothesis and acceptance of the alternative hypothesis.

Research about stress and adverse birth outcomes have yielded varied results. Where Class et al. (2013) completed a study that demonstrated a strong association between stress from violence and traumatic events felt in preconception and a greater likelihood of adverse birth outcomes such as low birth weight, Bussières et al. (2015) has shown that the impact of maternal stress is small on adverse birth outcomes. Research specifically targeting ACE has also yielded mixed results, with Christiaens et al. (2015) finding that stress from ACEs were associated with increased preterm birth, while Wosu et al. (2015) completed a meta-analysis indicating that the relationship between abuse in childhood and adverse birth outcomes for women were unclear. In addition to the ambiguity found in research about the impact of ACE on maternal health, there has admittedly been little research completed in this area with the need for more (Wosu et al., 2015). Considering this, the findings of this study agreed with the literature that currently exists. There was no statistically significant association between ACE exposure and low birth weight, however the population should be studied more due to the results of the descriptive statistics and the low number of reported low birth weights in the sample.

Research Question 3

What is the difference in the impact of types of ACE on birth weight in the Appalachian population?

ACE exposure may take the form of poor home life, physical abuse, neglect, sexual abuse or emotional abuse (CDC, 2016). As all of these may impact birth outcomes differently, it is important to understand their impacts singularly, as one may impact birth outcomes more than the others. Seng et al. (2011) found that women that suffered from child abuse had offspring weighing less than those not exposed, supporting evidence that physical abuse impacts birth weight. Kingston et al. (2012) found that poor home life and low family cohesion impacted prenatal stress and birth outcomes significantly, although other forms of ACE were not considered. However, when Wosu et al. (2015) completed a meta-analysis on sexual abuse and birth outcomes, the relationship between child sexual abuse and low birth weight was unclear.

In order to provide further knowledge about the impact that different types of ACE may have on maternal health, a breakdown analysis of the specific types of ACE was completed per county. Exposure to poor home life was seen in all 15 counties, which supports Kingston et al.'s (2012) findings that lack of social cohesion was prevalent in communities. Physical abuse was seen in 13 of the 15 counties including all the distressed counties, with the other types of abuse reported in some of the counties to a lesser extent. Of the five counties where sexual abuse was reported, four were categorized as distressed counties. As it appears that distressed counties were impacted by all types of ACE, this coincided with findings of Logan-Greene et al. (2014), who found that lower SES populations were impacted by ACE exposure at increased rates.

Report of exposure to ACE was also examined specifically in the respondents that reported low birth weight. 12 respondents reported low birth weight deliveries and exposure to ACE. All 12 respondents reported poor home life, with some reporting exposure to additional types of ACE. 67% reported physical abuse, however no respondents from transitional counties reported physical abuse. Neglect, sexual abuse, and emotional abuse were reported in 25% of the respondents that reported ACE exposure and low birth weight deliveries, again no one in a transitional county reported this type of ACE exposure. This further supports the findings that poor home life is a frequently reported ACE (Kingston et al., 2012). In addition, not only does it show that those in lower SES communities have a greater chance of exposure to ACE like Logan-Greene et al. (2014) found, but that the number of exposures per person and severity of exposure increases, with physical abuse being found only in distressed communities with lower SES.

Statistical analysis in the form of a chi-square analysis that was completed on the type of ACE exposure and low birth weight delivery yielded statistically significant results. This led to the rejection of $H_0 3$ and acceptance of the $H_A 3$, types of ACE exposure impact low birth weight differently. The significance level was found to be p=.000, with a Cramer's V of .388 indicating a moderate relationship between low birth weight and types of maternal ACE exposure. The results of this study supported what was found by Kingston et al. (2012), that poor home life impacts low birth weight deliveries. Unfortunately, much like the results of Wosu et al. (2015), the findings of this study provide little clarity as to the impacts of other ACE exposures because they were reported so infrequently.

Limitations

This study relied on information provided through a self-administered survey. As a result, it should be considered that the results could have been impacted by bias. The nature of the questions could have created a social desirability bias within the respondents (Stuart & Grimes, 2009). In fact, the Appalachian population is largely untrusting of outsiders (Esch & Hendryx, 2011), another potential for bias. If the sample did not trust the researcher's intentions, they could have potentially not answered accurately on questionnaires. This means that respondents could have not been truthful about exposure to ACE or risky behavior while pregnant because of their concern of how society would view them. While respondents were informed that the survey was completely anonymous and all information was kept confidential, they still may have not answered truthfully. In addition, as the questionnaire is largely based on events that happened in childhood, recall bias could have impacted the results. This could have meant that respondents forgot about certain exposures in their past, which would have decreased the number of respondents reporting ACE exposure. However, as stated before, work by Pinto et al. (2014) suggest that recall bias is minimalized in studies concerning ACE exposure.

This study also looked at respondents from only 15 counties of the 32 Appalachian counties in Ohio. This was done in efforts to better understand trends within categories of counties in

Appalachia, Ohio. This study relied on information from ARC (2016) to determine the type of county selected for the study. It was assumed that the indicators used by ARC were consistent and truly define a county for what it is. However, these counties may not have been representative of other counties in Appalachia, Ohio. As far as generalizability, it should be considered that this study only looked at low birth weight and exposure to ACE in one state of Appalachia and that results may vary drastically in other states.

Another limitation of study is the percentage of the sample that reported low birth weight. Low birth weight was reported in 8.5% deliveries in Ohio (American's Health Ranking, 2017), and was found to be higher in the Appalachian counties. As there were only 25 people reporting low birth weight, this made it difficult to identify any trends or realize any true impact of ACE on low birth weight. While no statistically significant relationships were found between ACE exposure and low birth weight in this study, this may have been due to the small sample size and was a basis for recommendation of future study.

Cross-sectional design does not allow for direct control of variables, including many confounding variables (Campbell & Stanley, 1963), an inherent weakness of this type of study design. This study accounted for many of the confounding variables through using a largely homogeneous population, the Appalachian population. This was based on assumptions that the data provided by resources such as America's Health Rankings (2017) and the Henry J. Kaiser Foundation (2016) were true and accurate. The study was also based on information from ARC (2016), whose depiction of the population is that they are largely of the same SES, educational levels, racial, and ethnic backgrounds. In this aspect, many potential confounding variables were controlled. In addition, health screening questions in the beginning of the instrumentation were used to eliminate respondents based on predefined exclusion criteria for potential confounding concern, such as those with complicated obstetrical history or diabetes.

Recommendations

ACE's are traumatic and often violent in nature (CDC, 2016). ARC (2016) uses three socioeconomic indicators to define Appalachian counties. The counties meeting distressed county criteria in this study were ranked in the bottom 10% socioeconomically in the nation. This would cause a disparity to be felt, especially in Ohio where neighboring counties are not distressed and improving their socioeconomic standing. As the distressed counties selected for this study in Appalachia, Ohio were found to have higher rates of ACE exposure, more research should be completed to understand the relationships between the two. The disparity of socioeconomic indicators in the area could be increasing levels of exposure to ACE, which would be in line with Wilson and Picket (2010) who wrote about the increase in violence due to disparities felt in communities. In addition, study of the exposure rate of ACE in relationship to populations should be carried out in other Appalachian areas as well including all categories of counties as defined by ARC (2016) to provide further evidence of possible interaction between disparity and increase risk of exposure to ACE in Appalachia.

In terms of ACE exposure and low birth weight, higher rates of low birth weight were found in those that had exposure, even though no significant statistical evidence was found to support rejection of $H_0 2$. This could have been due to the limitation identified as a relatively low number of people reported low birth weight, 12% of the sample. With this low number, it may have been difficult to determine if there was a relationship between the variables or not. To discern this, it is recommended that the survey be given to more respondents, with a larger sample of both those that have been exposed and those that have not. With an increase in sample size, this may provide evidence in the form of statistical analysis of the effect of ACE exposure on low birth weight deliveries.

As there was a significant relationship found between types of exposure and low birth weight delivery in the Appalachian women of this study, it would improve knowledge of the maternal health field if this association were further investigated. This study found a moderate effect between types of ACE exposure and low birth weight, with poor home life reported in all respondents that were exposed to ACE and had a low birth weight delivery. Further investigation regarding types of ACE exposure and the individual impacts they each have on low birth weight deliveries would give more insight into maternal health.

The research questions and results for the study led to further investigation of a more complex relationship between county of residence, exposure to ACE, and low birth weight. While the log-linear regression that was completed yielded no statistically significant results with a significance level of .887, it is recommended that this relationship be further examined. There was a moderate effect between ACE exposure and county of residence, which could be examined in a larger sample with a greater number of low birth weight deliveries to determine if in fact there is a relationship between ACE exposure, county of residence, and low birth weight deliveries.

As poor home life appeared to be the most reported ACE, it is recommended that more research be completed to find out the extent of impact on maternal health. The research to date concerning poor home life as an ACE is concerned with determining prevalence in populations (Kingston et al., 2012) and has not yet studied the impact on specific health outcomes. With the current research in agreement that poor home life is rather prevalent, especially in areas with low SES, further research on the impact that it has on a community's health would be beneficial. Taking this one step further, studying aspects of health in relation to poor home life in the Appalachian setting where a variety of SES environments already exist, may provide information to improve current knowledge and health interventions aimed at improving population health.

Implications

This study found a statistically significant relationship between category of Appalachian county of residence and exposure to ACE. It also found a statistically significant relationship between low birth weight deliveries and the specific ACE exposure poor home life. There are many implications for social change and further research based on this and the limitations found in current research.

Positive Social Change

While there were some limitations to the study and not all null hypotheses were rejected, the results of the study still provided a more in depth understanding about ACE exposure and Appalachia, which worked at filling a current knowledge gap in the literature. With this said, the study has also provided information for further defining health aspects of the Appalachian community, as less research currently exists on this population as opposed to non-Appalachian counterparts. Findings here showed a difference at the county level in terms of risk of exposure to ACE in Appalachia, Ohio. This could be taken into consideration and used as support for policy development and improved health interventions in regard to maternal health in Appalachia. As there are Appalachian communities in 13 states, this study could also provide stimulus for future studies in other states or data to support changes in health interventions in these areas.

As the study uses the LCA, insights about programs to improve maternal health could be used to also address increased rates of chronic disease in populations or even to reduce rates of chronic disease. Chronic disease burden is often higher in Appalachia areas than in non-Appalachian areas (Esch & Hendryx, 2011). The higher rates of chronic disease mean more medical bills, which adds to the financial burden in already distressed areas and to the disparity that already exists between areas. As this study has recommended further investigation of ACE exposure in Appalachian populations, results obtained by the study could help to inform the direction of future spending, as a marked difference between prevalence of ACE exposure was found between counties in the same state.

Both state and Appalachian agencies should be motivated by these results to action and use them as the basis for further study. A marked difference between counties was found in ACE exposure rate. The counties where exposure is increased should be concerned, and with the support of the state and other Appalachian agencies such as ARC, they should work on developing ways to address this exposure rate. As changes in economic status may take years, it is important for the distressed areas to consider ways to address the increased risk of ACE now. This could be through further analysis of the populations and development of more targeted interventions to reduce ACE exposures. As Pies et al. (2012) demonstrated, this should go a long way in improving population health of the communities.

While this study is focused on Appalachian populations, the findings have potential to impact populations on a global level. As Appalachian populations are largely considered rural, concepts investigated in this study could be used to support further studies in rural areas. Rural populations are often impacted by low SES, as distressed counties in Appalachian Ohio are. It stands to reason that they may also be more at risk for exposure to ACE as found in other studies (Kingston et al., 2012) and supported by this study. The data, relationship between variables, insight into rural populations, and best practices identified through this study should be shared and discussed with policymakers of rural or Appalachian areas, allowing the findings to impact polices at all level of government and in many populations.

Recommendations for Practice

Kent et al. (2013) and Kim and Saada (2013) suggest that interventions that have reduced levels of preterm birth and low birth weight in a number of populations, may not be reaching rural areas that are more isolated as their rates of these are considerably higher. Hendryx et al. (2014) stressed the importance of considering the complex myriad of risk factors that are population specific when considering low birth weight deliveries. Mersky et al. (2013) called for further study of ACE, specifically on the populations that are impacted most by it, which in this study was found to be those in the most distressed counties of Appalachia, Ohio. This study found that the maternal population in some counties in Appalachia were more exposed to ACE than other counties. In addition, this study also found that poor home life is the ACE most associated with low birth weight deliveries.

Based on findings in this study and on the fact that the literature discussed above suggest that interventions are not making it to or not working in rural areas, it is vital that better attempts be made to reduce disparity and implement interventions targeting Appalachian women of child bearing years. With better interventions targeting poor home life, ACE exposure in areas where it is prevalent could be reduced. The information found in the literature review for this study and the data of the study itself support the need for interventions to reduce low birth weight and on reducing ACE exposure in distressed counties. Public health interventions should be developed to address the disparities between counties. If successful, these interventions could reduce the rate of low birth weight deliveries, which would reduce infant mortality and improve health indices for the communities in question. Focus should be on the specific counties impacted the most, the distressed counties that were identified with the serious problems of low birth weight and ACE exposure. Local and state health agencies should ensure that interventions are reaching these populations in order to see the most drastic improvement on population health.

The findings in this study support further action in Appalachia, Ohio and other Appalachian areas, especially in the most distressed counties. There was a difference in exposure to ACE found, which becomes the responsibility of the research community to investigate further and the responsibility of the state and local community to address with interventions as increased exposure to ACE has been related to a number of poor health outcomes later in life (Pies et al., 2011).

Conclusion

In conclusion, this study found that women living in distressed counties in Appalachia, Ohio are more likely to be exposed to ACE and more likely to have low birth weight deliveries. In addition, of those reporting ACE and low birth weight deliveries, poor home life was identified as the most reported ACE exposure. These results provided insight into an understudied population as well as provided sound evidence that there is increased concern for ACE exposure and low birth weight disparity among communities. While the study did not conclusively provide evidence that there is an association between low birth weight and mother's exposure to ACE, it did provide evidence that in more distressed counties the association may exist. Further research should be completed using a larger population to determine if there is indeed a relationship between low birth weight and ACE exposure, as this study had a sample of only 25 women that reported low birth weight. Considering these findings and the literature review completed for this study, there is an abundance of support for improving interventions targeting distressed counties in Appalachia to improve maternal health.

This study has advanced the knowledge of the ACE, maternal health, and the impact of these on Appalachian communities. While data were not found to support all initial alternative hypotheses, the study did conclusively show that there was a greater risk of exposure to ACE in distressed communities. It also showed that exposure to poor home life impacted low birth weight more than other types of ACE exposure. It is critical that this knowledge be used by the scientific community to study the relationships further and by the public health community to develop more targeted health interventions for populations that are in most need. In doing so, improvements can be made in population health over the course of generations, and a reduction in poor health outcomes in Appalachia will be realized.

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Appendix A: Infant Mortality Rate Table

Table 19

Infant Mortality Rates

Country	Status	Infant Mortality Rates (per 1,000 live births)
Japan	Developed Country	2.13
Sweden	Developed Country	2.6
South Korea	Developed Country	3.93
Canada	Developed Country	4.71
Serbia	Developing Country	6.16
United States	Developed Country	6.17
Chile	Developing Country	7.02

*Rates per 1,000 live births
Note. Data from CIA, (nd).

Appendix B: Infant Mortality Rates for the United States

Table 20

Infant Mortality Rates in the United States

Region, State, or County	Description	Infant Mortality Rate (per 1,000 live births)	Low Birth Rate (percent of low birth weight live births, > 2,500)
Non-Appalachia	Region	5.97	
Appalachia	Region	6.73	
Ohio	State	4-11; overall 7.7	4.9%-11.5%; overall 8.7%
West Virginia	State	6-16; overall 8	6.4-13.4%
New Hampshire	State	4.5-5.7; overall 5	5.9%-8%; overall 6.8%
Delaware	non-Appalachian Ohio	4	7.10%
Geauga	non-Appalachian Ohio	5.9	6.10%
Muskingum	Appalachian Ohio	8.4	9.70%
Scioto	Appalachian Ohio	9	9.30%

* Rates per 1,000 live births
Note. Data from Henry J. Kaiser Foundation, 2016.

Appendix C: Economic Status of Appalachian Counties in Ohio

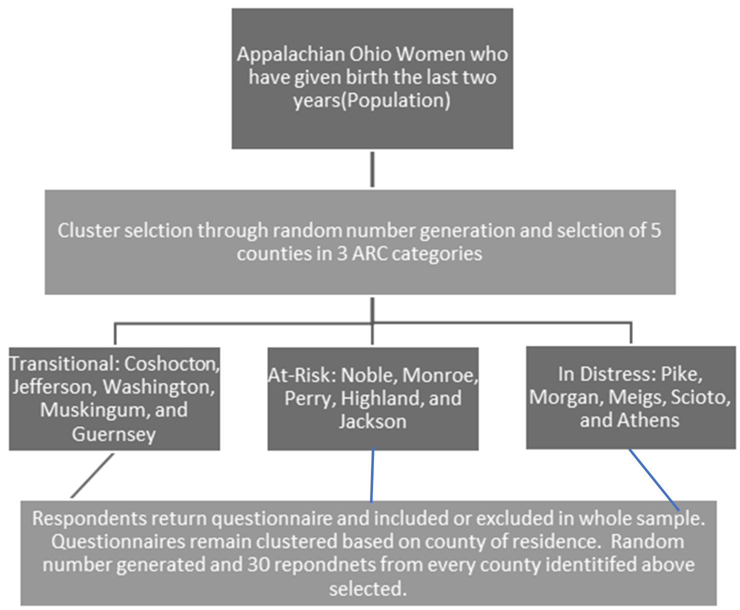
Table 21

Appalachian Counties in Ohio by Economic Status

County	Economic Status	County	Economic Status
Adams	Distressed	Jefferson	Transitional
Ashtabula	At-Risk	Lawrence	Transitional
Athens	Distressed	Mahoning	Transitional
Belmont	Transitional	Meigs	Distressed
Brown	Transitional	Monroe	At-Risk
Carroll	Transitional	Morgan	Distressed
Clermont	Transitional	Muskingum	Transitional
Columbiana	Transitional	Noble	At-Risk
Coshocton	Transitional	Perry	At-Risk
Gallia	Transitional	Pike	Distressed
Guernsey	Transitional	Ross	Transitional
Harrison	Transitional	Scioto	Distressed
Highland	At-Risk	Trumbull	Transitional
Hocking	Transitional	Tuscarawas	Transitional
Holmes	Transitional	Vinton	Distressed
Jackson	At-Risk	Washington	Transitional

Note. Data from Appalachian Regional Commission, 2016.

Appendix D: Sampling Process



Appendix E: Research Cover Letter

Maternal Health Study

Do something for future generations, be a part of an important maternal health research study.
The research is being conducted by Kristen Dickerson, MPH, RN. The purpose of the study is to understand how trauma in childhood impacts birth of offspring in your community.
If you can answer yes to the following, you may be eligible:

- Between the ages of 18 and 34 when you gave birth
- Lived in one of the following counties in Ohio childhood to be in the study: Adams, Ashtabula, Athens, Belmont, Brown, Carroll, Clermont, Columbiana, Coshocton, Gallia, Guernsey, Harrison, Highland, Hocking, Holmes, Jackson, Jefferson, Lawrence, Mahoning, Meigs, Monroe, Morgan, Muskingum, Noble, Perry, Pike, Ross, Scioto, Trumbull, Tuscarawas, Vinton, or Washington.
- No significant medical or obstetrical history such as high-risk pregnancy, severe high blood pressure, diabetes, or heart disease as diagnosed by a physician
- Gave birth to a child weighing less than 5 pounds 8 ounces
- Drug, tobacco, and alcohol free during pregnancy

Benefits to participating include being a part of helping future babies have better outcomes in your community and a greater understanding of good maternal health. There are no risks to participating in the study and participating is easy.

Participation should take less than 10 minutes and includes:

- Reading informed consent
- Completing questionnaire
- Mailing it back in using the stamped self-addressed envelope

This is a completely anonymous study and the questionnaire will not be shared with anyone. All information is treated as confidential and will not be shared.

If you have any questions now or at any time during the process of your part in the study, please contact me at (740) 297-0085.

Thank you for your participation and effort to make our communities better for our children!

Appendix F: Consent Form

You are invited to take part in a research study about maternal health and childhood trauma. The researcher is inviting women who gave birth between the ages of 18-34 who have had a child in the last two years and lived in one of the following counties in Ohio during childhood to be in the study: Adams, Ashtabula, Athens, Belmont, Brown, Carroll, Clermont, Columbiana, Coshocton, Gallia, Guernsey, Harrison, Highland, Hocking, Holmes, Jackson, Jefferson, Lawrence, Mahoning, Meigs, Monroe, Morgan, Muskingum, Noble, Perry, Pike, Ross, Scioto, Trumbull, Tuscarawas, Vinton, or Washington. Your name was obtained through the use of public data provided by Ohio Department of Health. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Kristen Baker Dickerson, who is a doctoral student at Walden University.

Background Information:
The purpose of this study is to understand the impact of childhood trauma on maternal health and birth weight of offspring.

Procedures:
If you agree to be in this study, you will be asked to:

- Complete the questionnaire that should take less than 10 minutes.
- Mail responses back in a self-addressed envelope. **Please do not include a return address or your name anywhere in order to protect your privacy.**
- Data collection for purposes of this study is one time only, no further action is required.

Here are some sample questions:

1. During the first 18 years of your life, were you ever beaten more than the occasional spanking?
2. During the first 18 years of your life, did any adult ever purposely hurt you in some way?
3. During the first 18 years of your life, did any parent, step-parent, or other adult in your life touch you in an unwanted sexual way?

Voluntary Nature of the Study:
This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind later. You may stop at any time.

Risks and Benefits of Being in the Study:
Being in this type of study involves minimal risk to the participant, with mild fatigue or stress being the only discomforts. This study should not pose much risk to your safety or wellbeing. However, there are some challenging questions in the questionnaire that could potentially bring on a significant amount of stress or bring back bad memories. If at any time you experience any undue stress or feel that the questionnaire is becoming psychologically taxing, please contact Six

Counties main office at (740) 454-9766. They are licensed to provide counseling service and will assist you in finding help within your county.

The benefits to the study include a greater understanding of maternal health and ability to take part in helping the future health of your community. There are no gifts associated with this research project.

Privacy:
Any information you provide will be kept confidential. Please do not include your return address on the envelope or your name anywhere on the survey as this will help to provide you privacy. This ensures that there is no way of the research administrator knowing who completed the questionnaire.

The surveys will be kept in a locked cabinet, and electronic data files will be kept on a password-protected computer and on a flash drive in the locked cabinet for 5 years, as required by Walden University.

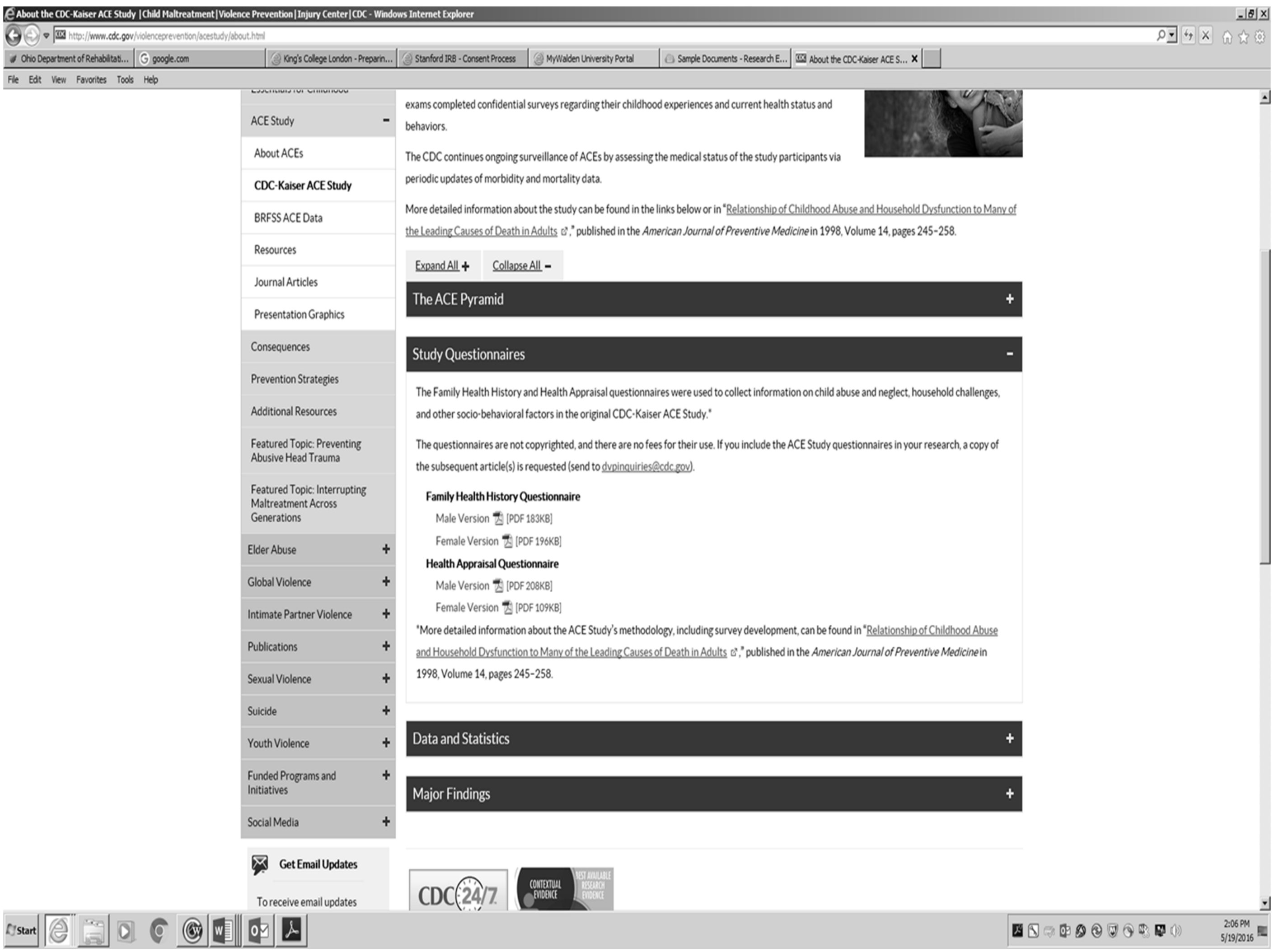
Contacts and Questions:
You may ask any questions you have now. Or if you have questions later, you may contact me via phone (740-297-0085) or email (kristen.baker2@waldenu.edu). For assistance in finding counseling services, contact Six Counties at (740) 454-9766. If you want to talk privately about your rights as a participant, you can call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is 612-312-1210. Walden University's approval number for this study is 03-28-17-0073884 and it expires on 03/27/2018.

Please keep this consent form for your records.

Obtaining Your Consent

If you feel you understand the study well enough to make a decision about it, please indicate your consent by returning a completed survey.

Appendix G: Consent to Use Instrumentation



About the CDC-Kaiser ACE Study | Child Maltreatment | Violence Prevention | Injury Center | CDC - Windows Internet Explorer

http://www.cdc.gov/violenceprevention/acestudy/about.html

Ohio Department of Rehabilitati... | google.com | King's College London - Preparin... | Stanford IRB - Consent Process | MyWalden University Portal | Sample Documents - Research E... | About the CDC-Kaiser ACE S...

File Edit View Favorites Tools Help

ACE Study
About ACEs
CDC-Kaiser ACE Study
BRFSS ACE Data
Resources
Journal Articles
Presentation Graphics
Consequences
Prevention Strategies
Additional Resources
Featured Topic: Preventing Abusive Head Trauma
Featured Topic: Interrupting Maltreatment Across Generations
Elder Abuse
Global Violence
Intimate Partner Violence
Publications
Sexual Violence
Suicide
Youth Violence
Funded Programs and Initiatives
Social Media

Get Email Updates
To receive email updates

exams completed confidential surveys regarding their childhood experiences and current health status and behaviors.

The CDC continues ongoing surveillance of ACEs by assessing the medical status of the study participants via periodic updates of morbidity and mortality data.

More detailed information about the study can be found in the links below or in "Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults," published in the *American Journal of Preventive Medicine* in 1998, Volume 14, pages 245–258.

Expand All + Collapse All −

The ACE Pyramid

Study Questionnaires

The Family Health History and Health Appraisal questionnaires were used to collect information on child abuse and neglect, household challenges, and other socio-behavioral factors in the original CDC-Kaiser ACE Study.*

The questionnaires are not copyrighted, and there are no fees for their use. If you include the ACE Study questionnaires in your research, a copy of the subsequent article(s) is requested (send to dvpinquiries@cdc.gov).

Family Health History Questionnaire
Male Version [PDF 183KB]
Female Version [PDF 196KB]

Health Appraisal Questionnaire
Male Version [PDF 208KB]
Female Version [PDF 109KB]

*More detailed information about the ACE Study's methodology, including survey development, can be found in "Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults," published in the *American Journal of Preventive Medicine* in 1998, Volume 14, pages 245–258.

Data and Statistics

Major Findings

2:06 PM 5/19/2016

Note. Authorization to use questionnaire from the CDC website (2016).

Appendix H: Instrumentation

Adapted from CDC Health Appraisal Questionnaire and Family Health Survey Female Version

Please complete to the best of your ability and memory. This is a survey that will ask questions about your current status as well as historical questions based on your childhood. Some of the questions may be difficult to answer. This survey is confidential, and there is no way of identifying you from the answers given as there is no identifiable information. Please circle or write the answer that best describes you. If at any time you experience any stress due to the nature of the questions, please contact Six Counties counseling services at (740) 454-9766 and they will provide guidance for help.

1. Were you between the ages of 18-34 when you gave birth?
    a. Yes
    b. No
2. Did you give birth in 2014 or 2015?
    a. Yes
    b. No
3. Did the child you gave birth to then weigh less than 5 pounds 8 ounces (2,500g)?
    a. Yes
    b. No
4. Have you ever had a highly complicated pregnancy or delivery as diagnosed by a physician?
    a. Yes
    b. No
5. Did you reside in an Appalachian county in Ohio or a county in Southeastern Ohio during your childhood including Adams, Ashtabula, Athens, Belmont, Brown, Carroll, Clermont, Columbiana, Coshocton, Gallia, Guernsey, Harrison, Highland, Hocking, Holmes, Jackson, Jefferson, Lawrence, Mahoning, Meigs, Monroe, Morgan, Muskingum, Noble, Perry, Pike, Ross, Scioto, Trumbull, Tuscarawas, Vinton, or Washington?
    a. Yes
    b. No
6. Are you of Mexican of Hispanic descent?
    a. Yes
    b. No
    c. Do not wish to answer
7. What is your race? (Please select all that apply)
    a. Asian
    b. Black
    c. American Indian
    d. White
    e. Other
    f. Do not wish to answer
8. Have you ever smoked?
    a. Yes

   b. No
9. Did you smoke while pregnant?
   a. Yes
   b. No
10. Do you have or have you ever been diagnosed with any of the following: High blood pressure, heart disease, stroke, or diabetes?
   a. Yes
   b. no
11. Do you drink alcohol?
   a. Yes
   b. No
12. Did you drink while you were pregnant?
   a. Yes
   b. No
13. Do you use street drugs?
   a. Yes
   b. No
14. Did you use street drugs while pregnant?
   a. Yes
   b. No
15. Did you graduate high school?
   a. Yes
   b. no
16. Are you employed and able to pay most bills?
   a. Yes
   b. No
17. Are you married?
   a. Yes
   b. No

The following questions are meant to decide what exposure if any you had to adverse childhood experiences. These questions are to be answered based on your life from the ages of 0-18.

18. During the first 18 years of your life, did you live with anyone who had a problem with drinking or was considered an alcoholic?
   a. Yes
   b. No
19. During the first 18 years of your life, did you live with anyone who used street drugs?
   a. Yes
   b. No
20. During the first 18 years of your life, were your parents ever separated, divorced, or unmarried and living in separate places?
   a. Yes
   b. No

21. During the first 18 years of your life, did you live with anyone that was depressed or mentally ill?
    a. Yes
    b. No
22. During the first 18 years of your life, did anyone in your household attempt or commit suicide?
    a. Yes
    b. No
23. During the first 18 years of your life, did anyone in your house commit a serious crime or go to prison?
    a. Yes
    b. No
24. During the first 18 years of your life, did any male figure ever abuse your mother or stepmother to include, hitting, throwing things, biting, kicking, or threatening them with a knife or a gun?
    a. Yes
    b. No
25. During the first 18 years of your life, were you ever beaten more than the occasional spanking?
    a. Yes
    b. No

26. During the first 18 years of your life, did any adult ever purposely hurt you in some way?
    a. Yes
    b. No
27. During the first 18 years of your life, did you ever go without food?
    a. Yes
    b. No
28. During the first 18 years of your life, was there someone available to take care of you, as in take you to the doctor, cook for you, take care of you when you were ill?
    a. Yes
    b. No
29. During the first 18 years of your life, did people in your house call you names, say mean things, or make you feel bad about yourself?
    a. Yes
    b. No
30. During the first 18 years of your life, did you wear clean clothes and take baths regularly?
    a. Yes
    b. No
31. During the first 18 years of your life, did any parent, step-parent, or other adult in your life touch you in an unwanted sexual way?
    a. Yes
    b. no
32. During the first 18 years of your life, did any parent, step-parent, or other adult in your life make you touch them in an unwanted sexual way?
    a. Yes

   b. No

33. During the first 18 years of your life, did a parent step-parent, or adult living in your home actually have sexual intercourse with you (oral, anal, or vaginal)?
    a. Yes
    b. No

Thank you for your time!

This concludes the questionnaire. Please place you completed questionnaire in the self-addressed, stamped envelope that was provided for you and place it in the mail.

Appendix I: Operationalization of Variables

Table 22

Operationalization of Variables

Variable	Source	Measure	Description of derived variables
Independent Variables			
Exposure to ACE	Questionnaire- Questions 18-33	Interval (Nominal)	To be grouped into 5 categories: 0 exposures, 1 exposure, 2-3 exposures, 4 exposures, 5 or more exposures Also grouped into those exposed and those not exposed
Age	Questionnaire- Question 1	Interval	
Race/Ethnicity	Questionnaire - Question 6-7	Nominal	
County of birth/residence (for both mother and child)	Vital Statistics Color coding by return envelope for questionnaire	Nominal	Grouped by ARC definitions on the basis of economic development: Distressed, at-risk, transitional
Education	Questionnaire- Question 15	Ordinal	
SES	Questionnaire- Question 16	Ordinal	
Dependent Variables			
Birth weight of offspring	Vital Statistics Questionnaire- question 3	Interval (Nominal)	To be grouped into 2 categories: babies weighing > 2500 g, babies weighing ≤ 2500 g.
Medical History	Questionnaire- questions 8-14	Nominal	
Obstetrical History	Family Health History Questionnaire- Questions 4	Interval	
Drug abuse	Questionnaire- Questions 13-14	Ordinal	

Appendix J: Research Questions and Statistical Tests

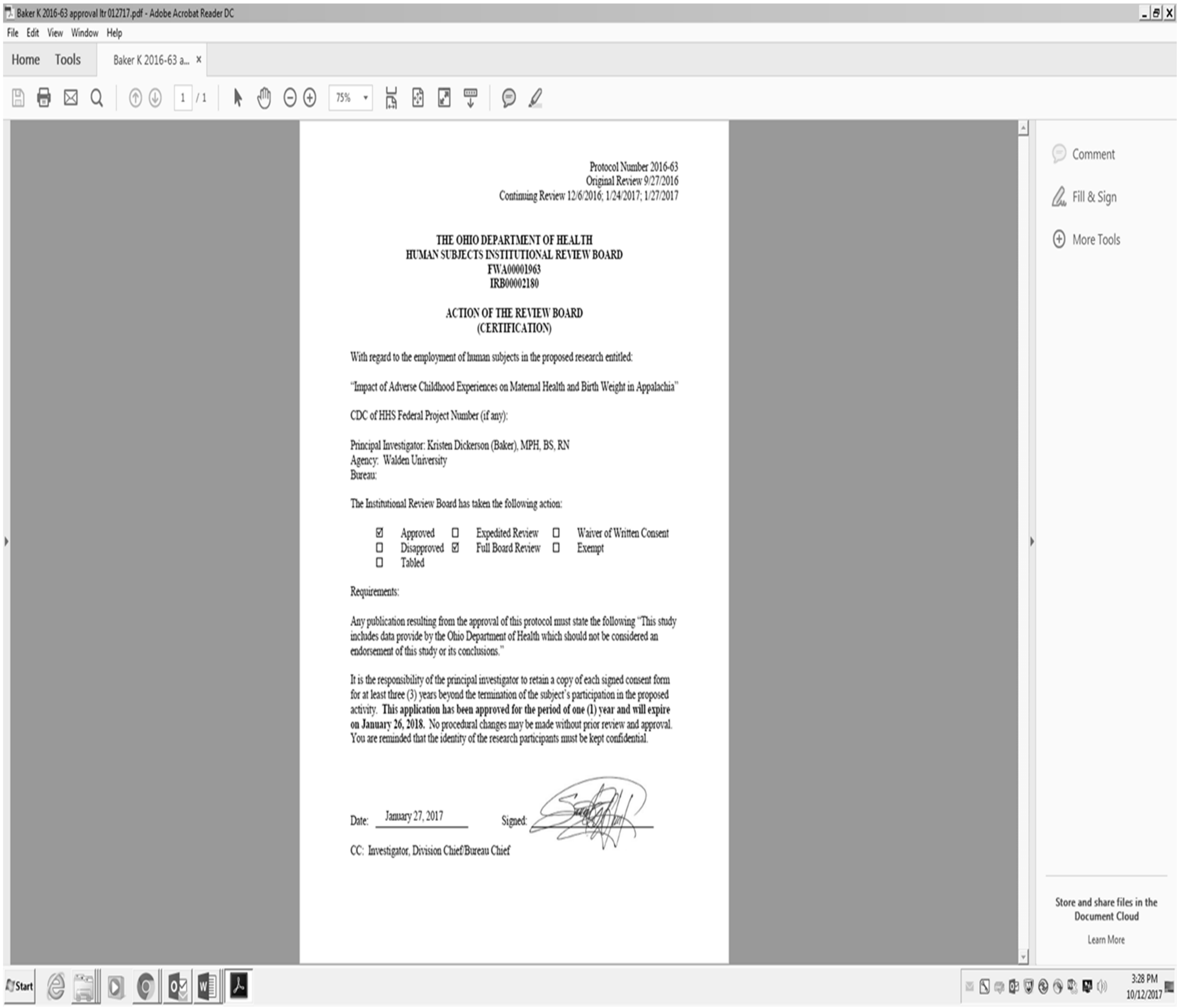
Table 23

Research Questions and Associated Statistical Tests

Research Question	Variables	Associated Survey questions	Statistical Tests
What is the difference between county of residence in Appalachian maternal populations in relation to ACE?	Independent: Category of County of residence Dependent: Exposure to ACE	Color code for county; Questions 18-31	Chi-Square
What is the association between maternal exposure to ACE and increased risk of low birth weight infants in Appalachian populations?	Independent: Exposure to ACE Dependent: Birth weight of offspring	Questions 3; Questions 18-31	Chi-Square
What is the difference in the impact of types of ACE on birth weight in the Appalachian population?	Independent: Exposure to specific types of ACE, determined through breakdown of FHH questionnaire Dependent: Birth weight of offspring	Questions 3; Questions 18-23	Chi-Square Log-linear regression

*Confounders and exclusion from the study are determined by questions 1-2 and 4-17.

Appendix K: Ohio Department of Health Protocol Approval Letter



Protocol Number 2016-63
Original Review 9/27/2016
Continuing Review 12/6/2016; 1/24/2017; 1/27/2017

THE OHIO DEPARTMENT OF HEALTH
HUMAN SUBJECTS INSTITUTIONAL REVIEW BOARD
FWA00001963
IRB00002180

ACTION OF THE REVIEW BOARD
(CERTIFICATION)

With regard to the employment of human subjects in the proposed research entitled:

"Impact of Adverse Childhood Experiences on Maternal Health and Birth Weight in Appalachia"

CDC of HHS Federal Project Number (if any):

Principal Investigator: Kristen Dickerson (Baker), MPH, BS, RN
Agency: Walden University
Bureau:

The Institutional Review Board has taken the following action:

- ☑ Approved ☐ Expedited Review ☐ Waiver of Written Consent
- ☐ Disapproved ☑ Full Board Review ☐ Exempt
- ☐ Tabled

Requirements:

Any publication resulting from the approval of this protocol must state the following "This study includes data provide by the Ohio Department of Health which should not be considered an endorsement of this study or its conclusions."

It is the responsibility of the principal investigator to retain a copy of each signed consent form for at least three (3) years beyond the termination of the subject's participation in the proposed activity. **This application has been approved for the period of one (1) year and will expire on January 26, 2018.** No procedural changes may be made without prior review and approval. You are reminded that the identity of the research participants must be kept confidential.

Date: January 27, 2017 Signed:

CC: Investigator, Division Chief/Bureau Chief

Note. Approval letter for protocol obtained from ODH IRB.