

12-20-2013

An Evaluation of Pregnancy-associated Morbidity among Georgia's USDA Designated Food Deserts, 2009-2010

Yonte Burnam
Georgia State University

Dajun Dai
Georgia State University

Lisa Casanova
Georgia State University

Follow this and additional works at: http://scholarworks.gsu.edu/iph_theses

Recommended Citation

Burnam, Yonte; Dai, Dajun; and Casanova, Lisa, "An Evaluation of Pregnancy-associated Morbidity among Georgia's USDA Designated Food Deserts, 2009-2010." Thesis, Georgia State University, 2013.
http://scholarworks.gsu.edu/iph_theses/307

This Thesis is brought to you for free and open access by the School of Public Health at ScholarWorks @ Georgia State University. It has been accepted for inclusion in Public Health Theses by an authorized administrator of ScholarWorks @ Georgia State University. For more information, please contact scholarworks@gsu.edu.

AN EVALUATION OF PREGNANCY-ASSOCIATED MORBIDITY AMONG
GEORGIA'S USDA DESIGNATED FOOD DESERTS, 2009-2010

by

Yonté Oterra Burnam
B.S., GEORGIA STATE UNIVERSITY, 2012

A Thesis Submitted to the Graduate Faculty of Georgia State University in Partial
Fulfillment of the Requirements for the Degree

MASTER OF PUBLIC HEALTH

ATLANTA, GEORGIA
30302

ABSTRACT

YONTÉ BURNAM

An Evaluation of Pregnancy-associated Morbidity among Georgia's USDA Designated Food Deserts, 2009-2010

(Under the direction of Dr. Lisa Casanova, Faculty Member)

Objective: To assess the affect of pregnant women residing in a USDA designated food desert on the development of pregnancy-associated morbidities

Results: Living in a USDA food desert is not significantly associated with the development of pregnancy-associated morbidity [OR=0.973; CI: 0.835-1.134; p-value=0.728]. Backward stepwise regression showed all proposed potential confounders were significantly associated with the development of pregnancy-associated morbidity. These potential confounders include maternal age, regular exercise routine or previous diagnosis of diabetes or hypertension (p-values < 0.02).

Conclusion: Residing in a USDA designated food desert is not associated with the development of pregnancy-related morbidity. This analysis suggests other sociodemographic risk factors, such as maternal age or exercise routine, as indicators of morbidity rather than food accessibility.

INDEX WORDS: Pregnancy associated morbidity, pregnancy complications, maternal health, women's health, food availability, food access, food environment

An Evaluation of Pregnancy-Associated Morbidity among Georgia's USDA
Designated Food Deserts, 2009-2010

By: Yonté Oterra Burnam

Approved:

Dr. Lisa Casanova
Committee Chair

Dr. Dajun Dai
Faculty Member

Date

Author's Statement Page

In presenting this thesis as a partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, to copy from, or to publish this thesis may be granted by the author or, in her absence, by the professor under whose direction it was written, or in his/her absence, by the Associate Dean, School of Public Health. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involve potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential financial gain will not be allowed without written permission of the author.

Signature of Author

Acknowledgements

I would like to thank my thesis advisors Drs. Lisa Casanova and Dajun Dai for their continued guidance throughout the course of this project. I would also like to thank Ms. Nicole Kosacz and Ms. Madhubanti Chatterji for graciously working with me and supplying the necessary data for this analysis. I want to send my warm appreciation to my parents for their everlasting love and support throughout my journey through academia.

Notice of Borrowers Page

All theses deposited in the Georgia State University Library must be used in accordance with stipulations prescribed by the author in the preceding statement.

The author of this thesis is:

Student's Name: Yonté Burnam

Street Address: 314 Lakeview Way

City, State, and Zip Code: Jonesboro, GA 30238

The Chair of the committee for this thesis is:

Professor's Name: Dr. Lisa Casanova

Department: Environmental Health

College: School of Public Health

Georgia State University

P.O. Box 3995

Atlanta, Georgia 30302-3395

Users of this thesis who not regularly enrolled as students at Georgia State University are required to attest acceptance of the preceding stipulation by signing below. Libraries borrowing this thesis for the use of their patrons are required to see that each user records here the information requested.

NAME OF USER ADDRESS DATE TYPE OF USE

Name of User	Address	Date	Type of Use Examination only for Copying

Yonté Burnam

314 Lakeview Way
Jonesboro, GA 30238
Email: yburnam1@gmail.com

Education

- M.P.H. **Georgia State University**, Atlanta, GA 08/12 – 12/13
Epidemiology
GPA: 4.0
- B.S. **Georgia State University**, Atlanta, GA 08/08 – 05/12
Biological Science
GPA: 3.2

Experience

- Georgia Department of Public Health**, Atlanta, GA 01/13 – 08/13
Influenza Surveillance Intern
- Managed and analyzed data from the U.S. Outpatient Influenza-like Illness Surveillance Network for state influenza reports
 - Developed and distributed a monthly newsletter to all Georgia health districts
 - Assisted state epidemiologists in confirmation of fatal influenza cases often using Epic Systems
- National B Virus Resource Center**, Atlanta, GA 02/10 - 08/13
Laboratory Assistant
- Performed immunological assays while maintaining experimental integrity
 - Accepted and handled packages containing time sensitive biological agents
 - Maintained cellular viability of multiple cell lines for the purposes of research

Projects/Presentations

- Georgia State Undergraduate Research Conference,** Atlanta, GA 03/12
- *Macacine herpesvirus 1 Inhibition of Pro-inflammatory Responses in Human Foreskin Fibroblast*
- National B Virus Resource Center,** Atlanta, GA 02/10 - 08/13
- *Differential Pro-inflammatory Responses of Human Foreskin Fibroblast and Rhesus Macaque Fibroblast in Response to Macacine herpesvirus 1 Infection*
 - *Phosphorylation of Phosphoinositide 3-Kinase in Response to Glycoprotein D of B Virus*

Research Experience

- National B Virus Resource Center,** Atlanta, GA 08/12 - Present
- Graduate Research Assistant**
- Collaborate with other researchers to develop research proposals and accomplish research goals
 - Assist senior researchers in the preparation of federal grant applications
 - Perform intense literature reviews to aid in the development of experimental designs
 - Pending SRA clearance for Level-4 Biological Safety Laboratories

Table of Contents

ACKNOWLEDGEMENTS	IV
LIST OF TABLES	VII
LIST OF FIGURES	VIII
CHAPTER I - INTRODUCTION	9
CHAPTER II - REVIEW OF THE LITERATURE	11
CHAPTER III - METHODS AND PROCEDURES	18
<i>DATA SOURCE</i>	18
<i>STUDY SAMPLE</i>	18
<i>MEASUREMENT OF GEORGIA'S FOOD DESERTS</i>	19
<i>DEFINITIONS OF OUTCOMES</i>	19
<i>STATISTICAL METHODS</i>	20
CHAPTER IV – RESULTS	21
CHAPTER V - DISCUSSION AND CONCLUSION	31
<i>DISCUSSION</i>	31
<i>LIMITATIONS OF THE STUDY</i>	33
<i>CONCLUSION</i>	34
REFERENCES.....	35

LIST OF TABLES

Table 1. Description of study participants ($n=3,584$)

Table 2. Bivariate logistic regression of the association of pregnancy-associated morbidity and various risk factors.

Table 3. Stepwise backwards elimination of the association of pregnancy-associated

LIST OF FIGURES

Figure 1. Spatial Distributions of USDA food deserts in Georgia

Figure 2. Spatial Autocorrelation of Pregnancy-Associated Morbidity in Georgia, 2009-2010

Chapter I - Introduction

Whether food is made available to an individual plays a key role in the development of healthy eating habits and ultimately health outcomes. Poor nutrition has been linked to the development of poor health outcomes. The consumption of healthy food items becomes especially important before and during the early months of pregnancy (Comstock S, 2012). Research in the fields of nutrition and health has established that consuming vegetables and fruits daily has a protective effect against the development of many chronic illnesses (Beaulac J, 2009; Shaw, 2006). The development of chronic diseases such as diabetes, cardiovascular disease, or hypertension during pregnancy can lead to various complications during pregnancy. These complications can cause long-term health effects for both the mother and child (Huda S, 2010; Jensen D, 2005; Kuklina E, 2009; Kuklina & Callaghan, 2011).

In recent decades the prevalence of obesity among American women has steadily risen (Huda S, 2010). As of 2008, the World Health Organization estimates there are 300 million obese women worldwide (WHO, 2013). According to the National Heart Lung, and Blood Institute, individuals with a body mass index (BMI) greater than 30 kg/m² are obese (Chu S, 2008). It is estimated that approximately 30% of all women of reproductive age in the United States are obese. Obese individuals are at a greater risk of developing comorbidities (Morland K, 2006). Huda and colleagues attribute the growing number of obese Americans to significant changes in the dietary content of Americans that began in the early 1980s. Huda et al. also cites the rising rates in obesity and

prevalence of adverse maternal and perinatal outcomes as sources of an increased burden on the U.S. healthcare system and, consequently, economic costs (Huda S, 2010).

Morland and colleagues cite that the United States spend an estimated \$110 billion on treatment for obesity or complications of obesity (Morland K, 2006).

Food deserts are defined as geographical areas where there exists poor access to healthy and affordable foods. The United States Department of Agriculture (USDA) defines a food desert as an area where 33% or more of residents live more than one mile from the nearest supermarket in an urban area or more than ten miles from the nearest supermarket in a rural area. A supermarket is defined as any food store with at least 50 employees (USDA, 2012). As of 2010, the USDA estimated a total number of 29.7 million people living in the United States were living in a food desert (Ploeg M, 2012). In previous literature, researchers have classified food deserts using various methods. These methods include analyzing average distances between residences and supermarkets, density of food markets by population, food availability or quality, and pricing of food items (Beaulac J, 2009). Although some researchers do not accept the idea that availability of food varies by geographic region, there is evidence to support the existence of food deserts in the United States (Beaulac J, 2009; Eckert, 2011).

The purpose of this study is to analyze the potential association between living in a food desert and developing a severe adverse pregnancy outcome such as gestational hypertension, gestational diabetes, or experiencing labor pre-term from 2009-2010 in Georgia women.

Chapter II - Review of the Literature

Food Availability, diet and health outcomes

Many factors, including environmental, social, and economic factors, interact to affect one's lifestyle and risks for developing certain health outcomes (Morland K, 2006; Powell L, 2007). The availability, or lack thereof, of healthy and affordable food choices plays a major role in the health of an individual (Beaulac J, 2009; Eckert, 2011; Morland K, 2006; Ploeg M, 2012; Powell L, 2007; Shaw, 2006). Recent studies on nutrition and health have begun to focus on food deserts and how the spatial location of food stores in relation to populations can affect the health of individuals residing in that community (Horowitz C, 2004; Morland K, 2006; Powell L, 2007). Supermarkets are known to offer a wider range of healthier food choices compared to smaller non-chain food stores or convenience stores (Horowitz C, 2004). Larger food stores are more likely to keep food items in stock. Individuals who live in proximity to larger food stores are more likely to consume more fruits and vegetables, have more healthful eating habits, and less likely to be obese (Morland K, 2006).

The lack of healthy diet choices has been proposed as a contributor to the varying burden from health disparities that exists between communities. Studies show accessibility of healthy affordable foods varies greatly between populations in the United States and the socioeconomic status of the majority of the community within an area is a reliable predictor of levels of food access (Beaulac J, 2009; Powell L, 2007). According

to Powell et al. (2006), low-income urban communities have fewer large food stores compared to middle-income urban areas. Rural areas have a smaller number of large supermarkets compared to urban areas. Large disparities in food availability exist in African-American communities when compared to their white counterparts (Eckert, 2011; Powell L, 2007). This association exists even when controlling for differences in income, race, and urban/rural classifications (Powell L, 2007). These findings provide evidence for the theory that low socioeconomic status serves as a risk factor for low food accessibility.

Although evidence exist to support the effects of food availability on health, a growing number of neighborhoods in the United States have experienced an increase in the number of fast-food establishments and a decrease in the number of retail stores offering fresh fruits and vegetables in that same area. Morland et al. (2006) proposes this as a major contributor to individuals' eating habits. It has been established that convenience greatly affects a person's food choices. Individuals living in areas with a high number of convenience stores and fast food restaurants will most likely use these food stores instead of travelling further distances in order to shop at a larger supermarket which may offer a wider range of healthier food options (Morland K, 2006). These communities often consist of a high number of low-income families and a high minority population, especially African-Americans (Eckert, 2011).

Maternal morbidity

Maternal morbidity encompasses any condition, either physical or psychological, which when aggravated by pregnancy, results in negative outcomes to a woman's health

(Callaghan W, 2008). Although maternal death is rare in the United States, Callaghan and others concluded from data encompassing the years 1991-2003 that 5 out of every 1000 pregnancies suffered a severe complication during a delivery hospitalization (Callaghan W, 2008). In the United States, a large proportion of this pregnancy-associated morbidity is due to the development of chronic diseases before and during pregnancy.

In 2010, chronic diabetes occurred at a rate of 7.0 per 1,000 live births while gestational diabetes occurred at a rate of 44.2 per 1,000 live births. Pregnancy-related hypertension occurred in 43.4 per 1,000 live births ("Maternal Morbidity and Mortality," 2012). Although the overall rate of pregnancy-associated non-delivery hospitalizations has declined in recent years, large disparities in hospitalization rates due to maternal morbidities have been observed between individuals based on age, race, and payment source (Bennett T, 1998). For example, African-American women are 1.5 times more likely than their White counterparts to be hospitalized during pregnancy. Self paying women are two times more likely to be hospitalized than women with private insurance and younger women are also at a higher risk for antenatal complications than older women (Bacak S, 2005; Bennett T, 1998).

Obesity and maternal complications

Obesity during pregnancy has been associated with severe maternal morbidity and greater than half of all women who died as a result of complications during pregnancy were overweight or obese (Huda S, 2010). There is growing evidence that maternal obesity is linked to an increased risk of obesity and diabetes in the offspring. Obese women are also at a greater risk of having a pregnancy that results in miscarriage or fetal

malformation (Simmons, 2011). Some researchers theorize environmental factors play a key role in the development of life-long eating habits. Some of these factors include access to fresh produce, the increasing number and availability of fast-food restaurants (Eckert, 2011; Morland K, 2006).

Women who do not consume healthy foods on a daily basis are more likely to be overweight or obese. In comparison with women of normal body mass index (BMI < 24.99 kg/m²), obese women are more likely to develop serious medical complications (Dennedy, 2010). Obesity has been shown to positively correlate with many long-term complications in both the mother and child, including the development of Type 2 diabetes, high blood pressure, and birth defects (Huda S, 2010). Chu et al. resulted that higher BMI was associated with higher risk for cesarean section, as well as, diabetes mellitus, gestational diabetes, and hypertensive disorders (Chu S, 2008). Obesity has also been associated with pregnancies resulting in longer hospital stays.

Maternal weight gain often confounds the relationship between obesity and the development of pregnancy related complications (Simmons, 2011). Weight gain during pregnancy is natural and healthy; however weight gain of more than 4-5 kg of fat is considered excessive (Huda S, 2010). A 2005 study of 481 obese Danish women found that women who gained 10-14.9 kg during their pregnancies had a 3.6 fold increase in risk for the development of hypertension and a 2.8 fold increase in the risk of preterm labor as compared to women who gained less than 5.0 kg during pregnancy. The risk for both hypertension and preterm labor increased with increasing gestational weight gain (Jensen D, 2005).

Huda and colleagues suggest obese women gain weight differently than lean women during pregnancy. Lean women tend to gain weight in the trunk and thighs while obese women tend to gain weight in more central regions of the body. These central regions are comprised of mostly subcutaneous saturated fat stores (Huda S, 2010). Ethnicity has been shown to play a key role in the deposition of fat stores in the body and the ratio of fat to lean muscle can vary with race. Insulin resistance, a risk factor for the development of gestational diabetes, is associated with weight gain in the trunk (Simmons, 2011).

Hypertension and maternal complications

Hypertensive disorders during pregnancy are ranked among the top causes of maternal associated morbidities in the U.S. (Visser V, 2013). Approximately 5-10% of all pregnancies are complicated by these disorders (Kuklina E, 2009). Preexisting hypertension, gestational hypertension, and preeclampsia are hypertensive disorders that commonly affect pregnancy outcomes. They could also lead to the development of many severe maternal complications (Kuklina E, 2009). Gestational hypertension is defined as having a diastolic blood pressure of 95 mmHg or above. Preeclampsia is defined as having a diastolic blood pressure of 90 mmHg or above along with proteinuria. Proteinuria is the presence of more than 300 mg of protein in the urine (Visser V, 2013). According to Kuklina and others (2010), from the year 1998 to 2006 the rate of hypertensive disorders per 1,000 delivery hospitalizations increased from 67.2 to 83.4. The highest increase observed was among those hospitalizations with patients suffering from chronic hypertension (Kuklina E, 2009).

Women whom suffer from pregnancy-related hypertensive disorders are at a greater risk of developing cardiovascular disease later in life. Visser et al. (2013) showed that women with hypertensive disorders during pregnancy were also at higher risk of developing chronic hypertension than women who did not suffer from gestational hypertension (Visser V, 2013).

Gestational diabetes mellitus and maternal complications

Gestational diabetes mellitus (GDM) is characterized by glucose intolerance and is first diagnosed between weeks 24 and 28 of a woman's pregnancy. It is estimated that GDM occurs in 7% of all pregnancies in the United States (Dennedy, 2010). GDM is diagnosed in women with fasting plasma glucose levels of ≥ 92 mg/dL or < 126 mg/dL. GDM has been associated with a higher risk for pregnancy outcomes such as preterm deliveries, still births, and clinical neonatal hypoglycemia. Women diagnosed with GDM are also more likely to develop hypertensive disorders and require cesarean sections upon delivery (Deveer R, 2013) According to Dennedy and colleagues, the prevalence of GDM would decrease by at least 50% in the absence of obesity (Dennedy, 2010).

Deveer and colleagues (2013) performed a prospective randomized control trial to assess the effects of diet on various pregnancy outcomes among women diagnosed with GDM. A treatment group was given professional nutritional advice on managing their dieting during the course of their pregnancies while the control group was left to determine the best diet choices without the intervention. Researchers observed marked differences in the pregnancy outcomes between the two groups of women. The intervention group presented significantly different outcomes than the control group

including, on average, a lower infant birth weight and lower total maternal weight gain (Deveer R, 2013). According to a study conducted by the National Institutes of Health, obese women are at a greater risk of having babies with congenital heart defects (NIH 2010). Deveer et al. concluded a timely diagnosis and management of GDM is essential in order to improve health outcomes among pregnant women. It is especially critical for women with GDM to partake in nutritional therapy during pregnancy to ensure positive health outcomes (Deveer R, 2013). This may be particularly difficult if these women reside in a food desert.

This paper will specifically focus on pregnancy-associated morbidities that develop as a direct result of the diet of the pregnant woman. The aim of this analysis is to identify trends relating to various pregnancy-related complications among Georgia's communities, which lack an adequate access to quality produce.

Chapter III - Methods and Procedures

Data Source

The Pregnancy Risk Assessment Monitoring System (PRAMS) is a nation-wide surveillance program funded by the Centers for Disease Control and Prevention. The PRAMS questionnaire was developed to analyze trends of maternal behaviors during and after pregnancies resulting in live births in the United States. This population based stratified sample consist of data on approximately 1,300 – 3,400 deliveries from each participating state annually. Individual state health departments are responsible for collecting data from its residents who participate in the survey. Women are initially contacted via a mailed questionnaire. If a response is not received within a designated timeframe, subjects are contacted via phone by the local health department ("PRAMS Questionnaires," 2012). Responses completed by new mothers can be used to describe various behaviors, attitudes, and experiences occurring during pregnancy. Details of the study design and methodology are available through the CDC's website ("Pregnancy Risk Assessment Monitoring System-Reproductive Health," 2012).

Study Sample

All live births in which a birth certificate was issued were included in the study population of the Pregnancy Risk Assessment System ("Pregnancy Risk Assessment Monitoring System-Reproductive Health," 2012). A total of 5,469 live births were included in the study population used in this analysis. Each birth occurred in the state of Georgia from 2009-2010. Of the total study population, 34% of women contacted did not

to participate. Women who did not participate in the PRAMS survey either refused to participate (5.0%) or did not respond (29.1%). All women who completed the PRAMS questionnaire were included in this study. A total of 3,584 pregnancies were included in this analysis.

Measurement of Georgia's Food Deserts

This analysis used data collected from the USDA's Food Environment Atlas dataset. The independent variable, living in a food desert, was dichotomized and analyzed based on those individuals having low access to a supermarket. In an urban area, an individual residing more than one mile away from the nearest supermarket was classified as having low accessibility. In a more rural area, an individual living more than 20 miles from the nearest supermarket was classified as having low accessibility. A supermarket was defined as any food store with greater than 50 employees.

In this analysis, counties were used as a proxy for neighborhoods. The food desert variable was constructed by calculating the percentage of residents per county living in an area with low access to affordable and fresh produce. As defined by the USDA, an area is classified as a food desert if more than 33% of residents are considered as having low accessibility to fresh and affordable foods. This variable was calculated for each of Georgia's 159 counties (USDA, 2012).

Definitions of Outcomes

A dichotomous variable was created for pregnancy-associated morbidity. Pregnancy associated morbidity was defined as any pregnancy in which the woman

experienced gestational hypertension, preeclampsia, gestational diabetes, or preterm labor as an outcome. Of the pregnancies included in this analysis, 3,544 could be classified based on pregnancy-associated morbidities. Approximately 1.5% of women were missing outcome data.

Statistical Methods

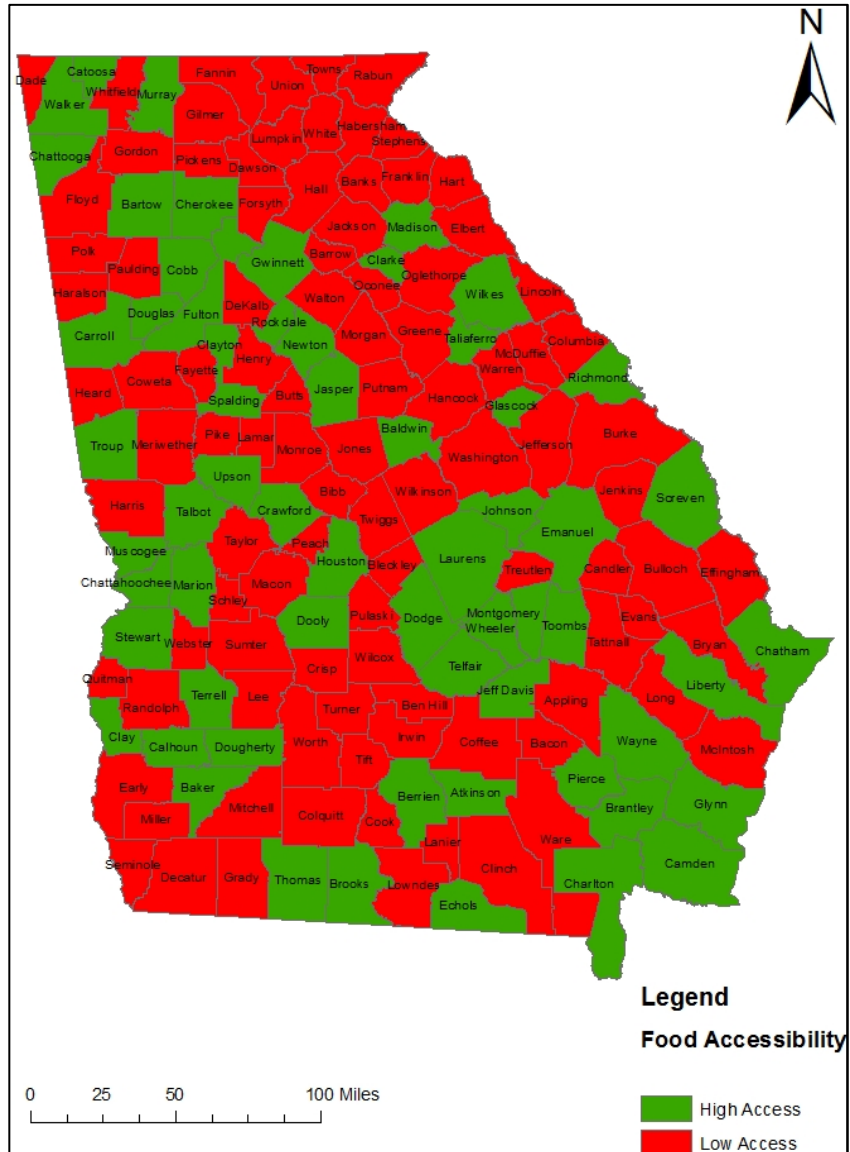
Bivariate analyses were performed to analyze the relationships of various sociodemographic factors and pregnancy-associated morbidity. Those associations found to be significant at a 5% significance level were treated as potential confounders of the relationship between food access and pregnancy-associated morbidity. A multivariate logistic regression was used to assess the main association between food deserts and morbidity while adjusting for potential confounding variables. All analyses were conducted using SAS 9.3 or ArcMap 10.1 (ESRI, 2011; Little R, 2011).

Chapter IV – Results

Descriptive Summary Statistics

Of the 3,589 study participants who reported county of residence, 58.29% lived in a food desert as defined by this analysis. Figure 1 visually displays the spatial locations of food deserts in Georgia. The majority of food deserts were found to be located in rural counties of Georgia.

Figure 1. Spatial Distributions of USDA food deserts in Georgia



Note: USDA food deserts are defined as areas of low food access or areas where greater than 33% of residents had low accessibility to a supermarket (USDA, 2012).

Table 1 shows the distribution of demographic variables in the 3,584 pregnancies included in the analysis. The average age was 26 years old. By ethnicity, each county was

made up, on average, of 46.91% Whites and 41.73% Black/African-American. In regards to education level, 22.15% of the study population did not have a high school degree, while 25.47% of respondents reported completing a college degree program or higher. However, the majority (29.73%) of participants report having earned less than \$10,000 in the year preceding their pregnancies.

Characteristic	n	%
Maternal Age (years)		
Less than 19	438	12.22
20-24	1024	28.57
25-29	882	24.61
30-34	730	20.37
35-39	394	10.99
40-44	105	2.93
45+	11	0.31
Maternal Race		
White	1660	46.76
Black/African-American	1482	41.75
Other	408	11.49
Maternal Education		
Less than high school	769	22.23
High school graduate	1141	32.98
Some college	672	19.42
College degree or more	878	25.38
Maternal Annual Income		
<\$10,000	900	29.89
\$10,000-\$14,999	381	12.85
\$15,000-\$19,999	270	8.97
\$20,000-\$24,999	222	7.37
\$25,000-\$34,999	272	9.03
\$35,000-\$49,999	273	9.07
≥\$50,000	693	23.02
Insurance Type		
Private	1293	36.86

Public	759	21.64
Military	150	4.28
Self Pay	85	2.42
No Insurance	1221	34.81
Pregnancy-Associated Disease		
Risk Factors		
Pre-pregnancy exercise 3+ days per week	1169	32.75
Diabetes	415	11.63
Hypertension	482	13.51
Residence Status		
Urban	2328	64.96
Rural	1256	35.04

Of those reporting insurance type, 36.77% report having private insurance while similarly 34.86% report having no insurance. Approximately one-third of all women in the study population reported exercising 3 or more days per week before their pregnancies. On average, 11.62% of women reported a diabetes diagnosis before pregnancy while 13.46% reported a diagnosis of high blood pressure. At the time of analysis, 64.96% of the study population classified themselves as living in an urban area while the remaining 35.04% lived in rural areas.

Table 2. Multivariate logistic regression of the association of pregnancy-associated morbidity and various risk factors

Risk Factor	<i>n</i>	Adjusted OR	(95% CI)	P-value
Maternal Age (years)				
*Less than 19	431	1.00		
20-24	1013	1.32	(1.035-1.678)	0.024
25-29	874	1.63	(1.279-2.090)	< 0.001

30-34	722	1.60	(1.242-2.062)	<0.001
35-39	389	1.91	(1.436-2.546)	<0.001
40-44	104	1.68	(1.082-2.607)	0.020
45+	11	1.91	(0.572-6.364)	<i>ns</i>
Maternal Race				
*White	1647	1.00		
Black/African-American	1465	0.99	(0.854-1.139)	<i>ns</i>
Other	399	0.91	(0.724-1.137)	<i>ns</i>
Maternal Education				
Less than high school	758	0.86	(0.701-1.046)	<i>ns</i>
High school graduate	1127	0.91	(0.760-1.091)	<i>ns</i>
Some college	665	1.04	(0.850-1.281)	<i>ns</i>
*College degree or more	872	1.00		
Maternal Annual Income				
*< \$10,000	885	1.00		
\$10,000-\$14,999	379	0.96	(0.752-1.223)	<i>ns</i>
\$15,000-\$19,999	268	0.79	(0.593-1.040)	<i>ns</i>
\$20,000-\$24,999	222	1.25	(0.933-1.682)	<i>ns</i>
\$25,000-\$34,999	268	0.95	(0.718-1.248)	<i>ns</i>
\$35,000-\$49,999	269	0.82	(0.619-1.082)	<i>ns</i>
≥ \$50,000	686	0.80	(0.651-0.978)	0.03
Insurance Type				
*Private	1280	1.00		
Public	752	1.01	(0.842-1.216)	<i>ns</i>
Military	148	1.17	(0.833-1.656)	<i>ns</i>
Self Pay	84	1.07	(0.685-1.677)	<i>ns</i>
No Insurance	1206	0.90	(0.768-1.061)	<i>ns</i>
Marital Status				
*Not Married	1609	1.00		
Married	1933	0.91	(0.794-1.041)	<i>ns</i>
Exercise				
*No	2376	1.00		

Yes	1154	0.73	(0.629-0.838)	< 0.001
Pre-pregnancy Diabetes				
*No	3119	1.00		
Yes	410	1.26	(1.021-1.547)	0.031
Pre-pregnancy Hypertension				
*No	3055	1.00		
Yes	475	1.81	(1.488-2.195)	< 0.001

Note: *Denotes reference categories; Adjusted odds ratios are presented with 95% confidence intervals and p-values to display statistical significance; 675 observations were not included in this analysis because of missing responses to these descriptive variables; *ns* denotes non-significant results at 95% confidence levels; Significant results are highlighted.

A bivariate analysis was performed to identify potential confounders of the association between living in a USDA food desert and developing pregnancy-associated morbidities. Those variables found to be significant were included in the final analysis as potential confounders of the relationship between food accessibility and pregnancy-associated morbidities. These were the age of the mother ($P < 0.03$), diabetes before pregnancy ($P = 0.031$), and high blood pressure before pregnancy ($P < 0.001$). These factors were all positively associated with experiencing pregnancy-associated morbidities. On the contrary, maternal annual total income above \$50,000 ($P = 0.03$) and exercising at least three times a week prior to becoming pregnant ($P = 0.031$) had protective effects against developing complications during pregnancy.

Multivariate regression analyses were then performed to assess the relationship between the dichotomous variable, living in a food desert, and the development of a pregnancy-associated morbidity. The variables previously identified as potential confounders of this relationship were re-evaluated independently using a stepwise backward elimination procedure. Those variables that change the main association by more than 10%, when dropped, were deemed significant to the relationship between food availability and the development of pregnancy-associated morbidities.

Living in a food desert was not associated with the development of pregnancy-associated morbidities (P=0.728). Table 3 presents the corresponding odds ratios and confidence intervals for the remaining elements which all proved significant for the development of pregnancy-associated morbidities.

Table 3. Stepwise backwards elimination of the association of pregnancy-associated morbidity and living in a food desert

Risk Factor	Odds Ratio	95% CI	P-value	Percent Change
Food Desert	0.973	(0.835-1.134)	0.728	
Maternal Age	0.968	(0.831-1.127)	0.673	-0.51
Maternal Annual Income	0.958	(0.822-1.115)	0.577	-1.54
Diabetes	0.975	(0.838-1.134)	0.743	0.21
High Blood Pressure	0.971	(0.834-1.131)	0.710	-0.21
Exercise	0.981	(0.842-1.143)	0.810	0.82

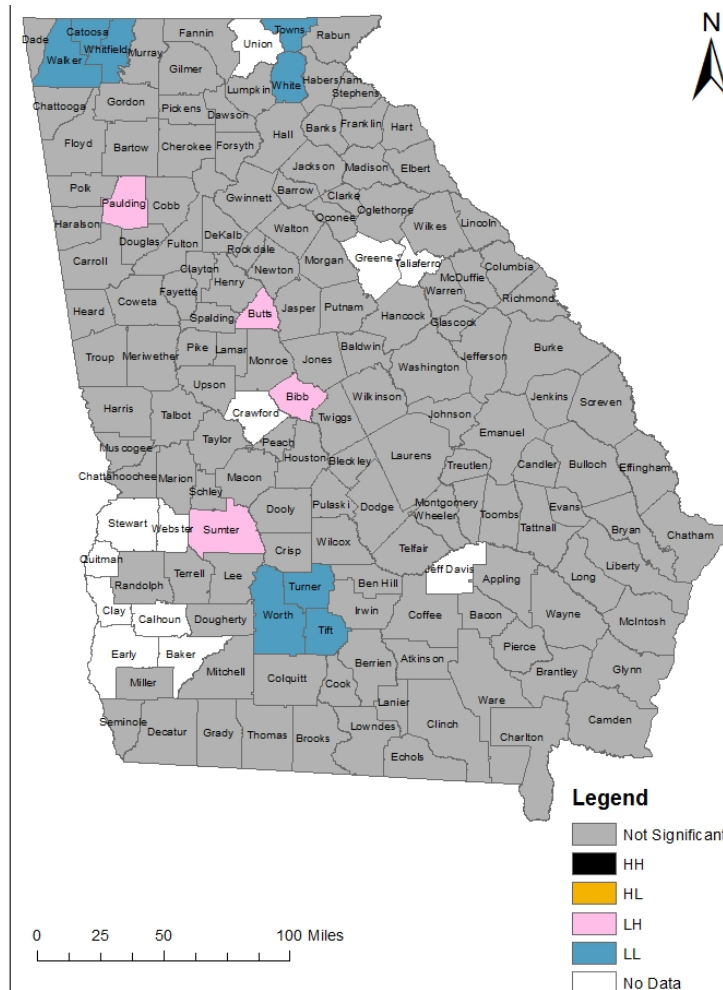
Note: The main association is highlighted; Unadjusted odds ratios are presented with 95% confidence intervals and p-values to display statistical significance of the association once the corresponding variable is eliminated.

Based on the results of the stepwise elimination, no one confounder proved independently significant to the main association between food accessibility and

pregnancy-associated morbidities. The corresponding percent change in the odds ratio once each variable was eliminated is evidence to this fact. The results of this stepwise backwards elimination procedure provide support that all of the confounders listed in Table 3 may interact in order to effect the main association.

ArcGIS was used to assess the clustering of pregnancy-associated morbidity in Georgia using local Moran's *I*. To further assess the spatial locations of hot spots of pregnancy-associated morbidity events in Georgia, Anselin's local indicators of spatial autocorrelation (LISA) statistic was performed. The LISA statistic measures the similarity of the counts of pregnancy-associated morbidity between adjacent areas. A clustering is a region with many areas with uncommonly high or low values. Figure 2 displays the spatial locations of hot spots of pregnancy-associated morbidity among USDA designated food deserts in Georgia in 2010.

Figure 2. Spatial Locations of Hot Spots of Pregnancy-Associated Morbidity in Georgia, 2009-2010



Note: LH indicates areas with a lower number of residents experiencing a pregnancy-associated morbidity as compared to neighboring counties. LL indicates neighboring areas which both exhibit a low number of residents experiencing a pregnancy-associated morbidity as compared to other counties. Those counties labeled as not significant have

no difference in the number of pregnancy-associated morbidity events as neighboring counties.

Figure 2 presents evidence of the non-significant differences in pregnancy-associated morbidity events in Georgia. Most counties do not have significant differences in the number of morbidity events as compared to their neighboring counties. Counties shown in pink are those that have a significantly lower number of residents suffering from pregnancy-associated morbidities as compared to neighboring counties. These counties were also designated as areas of high access to fresh and affordable foods (Figure 1). Counties shown in blue are areas with a significantly lower numbers of residents suffering from pregnancy-associated morbidities. These counties were all designated as food deserts in this analysis (Figure 1). These observations, if seen statewide, would have served as evidence of the relationship between food availability and the development of adverse pregnancy outcomes.

Chapter V - Discussion and Conclusion

Discussion

A number of previous studies have established a clear association between poor nutrition and the development of poor health outcomes, including food accessibility in relation to chronic diseases such as diabetes, cardiovascular disease, and hypertension (Eckert, 2011; Morland K, 2006; Ploeg M, 2012; Powell L, 2007; Shaw, 2006). The lack of fresh produce in a community of people can lead to adverse health outcomes that may be identified in clusters of individuals residing in that community. However, not many studies have been performed to determine the effects of food availability on pregnancy outcomes.

This study used a representative sample of women who gave birth in the state of Georgia from 2009-2010 to determine if specific adverse pregnancy outcomes were associated with living in a food desert from 2009-2010 as defined by the United States Department of Agriculture. These pregnancy-associated morbidities include preeclampsia, gestational hypertension, preterm labor, and gestational diabetes. This analysis presents findings from the PRAMS database, a statewide cross sectional study.

The incidence of pregnancy-associated morbidity among the Georgia women giving birth from 2009-2010 was 39.16% in this analysis. This value is consistent with previous literature. Studies indicate approximately 25% of pregnant women received primary diagnoses for preterm labor, nausea, vomiting, genitourinary complications, hypertensive disorders, or hemorrhage. Diagnosis for preterm labor accounts for 30% of

those diagnoses alone (Bacak S, 2005). Another study found 18% of deliveries associated with pregnancy-associated discharge codes (Bennett T, 1998).

This study determined there is no association with living in a food desert and developing adverse pregnancy outcomes [OR=0.973; CI: 0.835-1.134; p-value=0.728]. This study found a significant association between a mother experiencing gestational diabetes or gestational hypertension while living in a food desert [OR: 1.26; 95% CI: (1.021-1.547); p-value = 0.031] and [OR: 1.81; 95% CI: (1.488-2.195); p-value <0.001], respectively. This is consistent with previous literature. Ahern et al. (2011) concluded there was a clear association between food availability and health outcomes. They specified food access as a key determinant of the development of adverse health outcomes, especially in metropolitan areas (Ahern M, 2011). As further support of the findings of this analysis, Nash et al. (2013) concluded food access and availability does not influence the diet quality of a woman during pregnancy (Nash D, 2013). Our study provides further evidence for Nash et al.'s conclusions.

The results of the Anselin's local indicators of spatial autocorrelation (LISA) statistic served as evidence of the random distribution of pregnancy-associated morbidities among Georgia's counties. The spatial analysis performed in this study yields evidence that food deserts and pregnancy-associated morbidity may be a random phenomenon and not associated with certain factors of the communities in which they are located. This conclusion is based on the theory that neighboring or adjacent features are more related to one another than those that are located further apart. If Georgia's counties, which neighbor each other, have similar risk factors, which promote morbidities relating

to pregnancy, then events of pregnancies with adverse outcomes would be spatially clustered. Since the spatial analysis of these events yielded they were randomly dispersed, it has been concluded that the geographic location of pregnancy-associated morbidities is random and may not be associated with the spatial locations of food deserts or any other risk factors.

Limitations of the Study

Several limitations of this analysis must be considered when attempting to interpret the results. First, this analysis was based on the responses received from a cross-sectional study. The analysis of cross-sectional studies hinders the inference of causality from any associations made. Information on both the dependent and independent variables was collected at the same time through a single questionnaire. This makes it impossible to determine the temporal relationship between the two variables.

The results of this analysis depend heavily on the validity of the derived constructs. The method used to define the food availability construct may hinder the analysis of the association as well as the interpretation of results. The food availability data obtained from the USDA was based on the residents' access to food within a specific census tract. In order to compare rates of pregnancy-associated morbidity among areas with low food access, aggregation of census tracts to county level data was necessary. This may have reduced the accuracy of the estimated strengths of the associations assessed during this analysis.

Finally, in a number of Georgia's counties, there were fewer than 10 observations from 2009-2010. In order to increase the total number of observations per county more data from previous years of the PRAMS survey must be analyzed. The low numbers of mothers from each county negatively influenced the statistical power of the analysis.

Conclusion

This study concludes there is no association between living in a food desert and the development of pregnancy-associated morbidity. On the contrary, other sociodemographic factors may play a key role in the development of adverse pregnancy outcomes among mothers living in Georgia. This analysis provides evidence for the existence of food deserts in Georgia and should serve as a basis for implementing programs aimed at increasing the availability of fresh and affordable foods to the Georgia's residents whom reside in them.

References

- Ahern M, Brown C, and Dukas S. (2011). A national study of the association between food environments and county-level health outcomes. *The Journal of Rural Health, 27*, 367-379. doi: 10.1111/j.1748-0361.2011.00378
- Albrecht, S. S., Kuklina, E. V., Bansil, P., Jamieson, D., Whiteman, M. K., Kourtis, A. P., . . . Callaghan, W. M. (2010). Diabetes Trends Among Delivery Hospitalizations in the US, 1994-2004. *Diabetes Care, 33*(4), 768-773. doi: Doi 10.2337/Dc09-1801
- Bacak S, Callaghan W, Dietz P, and Crouse C. (2005). Pregnancy-associated hospitalizations in the United States, 1999-2000. *American Journal of Obstetrics and Gynecology, 192*, 592-597. doi: 10.1016/j.ajog.2004.10.638
- Beaulac J, Kristjansson E, and Cummins S. (2009). A systematic review of food deserts, 1966-2007. *Preventing Chronic Disease, 6*(3).
- Bennett T, Kotelchuck M, Cox C, Tucker M, and Nadeau D. (1998). Pregnancy-associated hospitalizations in the United States in 1991 and 1992: A comprehensive view of maternal morbidity. *American Journal of Obstetrics and Gynecology, 178*(2), 346-354.
- Callaghan W, MacKay A, and Berg C. (2008). Identification of severe maternal morbidity during delivery hospitalizations, United States, 1991-2003. *American Journal of Obstetrics and Gynecology, 199*, 133.e131-133.e138. doi: 10.1016/j.ajog.2007.12.020
- Chu S, Bachman D, Callaghan W, Whitlock E, Dietz P, Berg C, O'Keefe-Rosetti M, Bruce C, and Hornbrook M. (2008). Association between obesity during pregnancy and increased use of health care. *The New England Journal of Medicine, 358*, 1444-1453.
- Comstock S, Pound L, Bishop J, Takahashi D, Kostrba A, Smith S, and Grove K. (2012). High-fat diet consumption during pregnancy and the early post-natal period leads to decreased alpha cell plasticity in the nonhuman primate. *Molecular Metabolism, 10-22*. doi: 10.1016/j.molmet.2012.11.001
- Dadelszen P, Payne B, Li J, Ansermino M, Pipkin F, ... and Magee L. (2011). Prediction of adverse maternal outcomes in pre-eclampsia: development and validation of the fullPIERS model. *Lancet, 377*, 219-227. doi: 10.1016/S0140-6736(10)61351-7
- Dennedy, M. Dunne, F. (2010). The maternal and fetal impacts of obesity and gestational diabetes on pregnancy outcome. *Best Practice & Research Clinical Endocrinology & Metabolism, 24*, 573-589. doi: 10.1016/j.beem.2010.06.001
- Deveer R, Deever M, Akbaba E, Enguin-Ustun Y, Aydogan P, ... and Mollamahmutoglu L. (2013). The effect of diet on pregnancy outcomes among pregnant with abnormal glucose challenge test. *European Review for Medical and Pharmacological Sciences, 17*, 1258-1261.

- Dozier A, Brownell E, Guido J, Yang H, Howard C, ... and Lawrence R. (2013). Adapting the pregnancy risk assessment monitoring survey to enhance locally available data: Methods. *Maternal Child Health Journal*. doi: 10.1007/s10995-013-1350-6
- Eckert, J. Shetty, S. (2011). Food systems, planning and quantifying access: Using GIS to plan for food retail. *Applied Geography*, 31, 1216-1223. doi: 10.1016/j.apgeog.2011.01.011
- ESRI. (2011). ArcGIS Desktop Release 10. Redlands, GA: Environmental Systems Research Institute.
- Gulmezoglu A, Say L, Betran A, Villar J, and Piaggio G. (2004). WHO systematic review of maternal mortality and morbidity: Methodological issues and challenges. *BMC Med Res Methodol*, 4(16). doi: 10.1186/1471-2288-4-16
- Gulmezoglu, A. M., Say, L., Betran, A. P., Villar, J., & Piaggio, G. (2004). WHO systematic review of maternal mortality and morbidity: methodological issues and challenges. *BMC Med Res Methodol*, 4, 16. doi: 10.1186/1471-2288-4-16
- Horowitz C, Colson K, Herbert P, and Lancaster K. (2004). Barriers to buying healthy foods for people with diabetes: Evidence of environmental disparities. *American Journal of Public Health*, 94(9), 1549-1554.
- Huda S, Brodie L, and Sattar N. (2010). Obesity in pregnancy: Prevalence and metabolic consequences. *Seminars in Fetal & Neonatal Medicine*, 15, 70-76. doi: 10.1016/j.siny.2009.09.006
- Jensen D, Ovesen P, Beck-Nielsen H, Molsted-Pedersen L, Sorensen B, and Damm P. (2005). Gestational weight gain and pregnancy outcomes in 481 obese glucose-tolerant women. *Diabetes Care*, 28(9), 2118-2122.
- Jillcott S, Keyserling T, Crawford T, McGuirt J, and Ammerman A. (2011). Examining associations among obesity and per capita farmer's markets, grocery stores/supermarkets, and supercenters in US counties. *Journal of the American Dietetic Association*, 111(4), 567-572. doi: 10.1016/j.jada.2011.01.010
- Kuklina E, Ayala C, and Callaghan W. (2009). Hypertensive disorders and severe obstetric morbidity in the United States. *Journal of Obstetrics and Gynaecology*, 113(6), 1299-1306.
- Kuklina, E., & Callaghan, W. (2011). Chronic heart disease and severe obstetric morbidity among hospitalisations for pregnancy in the USA: 1995-2006. *BJOG*, 118(3), 345-352. doi: 10.1111/j.1471-0528.2010.02743.x
- Little R, Milliken G, Stroup W, and Wolfinger R. (2011). SAS Introduction to mixed modeling. Cary, NC.
- . Maternal Morbidity and Mortality. (2012). In W. s. H. USA (Ed.), *Health Status-Reproductive and Maternal Health*.

- Maxwell, Seely E and Cynthia. (2007). Chronic Hypertension in Pregnancy. *Journal of the American Heart Association*, 115, e188-e190. doi: 10.1161/circulationaha.106.636472
- Morland K, Roux A, and Wing S. (2006). Supermarkets, other food stores, and obesity: The atherosclerosis risk in communities study. *American Journal of Preventive Medicine*, 30(4), 333-339. doi: 10.1016/j.amepre.2005.11.003
- Nash D, Gilliland J, Evers S, Wilk P, and Campbell M. (2013). Determinants of diet quality in pregnancy: Sociodemographic, pregnancy-specific, and food environment influences. *Journal of Nutrition Education and Behavior*, 1-8. doi: 10.1016/j.jneb.2013.04.268
- Ploeg M, Breneman V, Dutko P, Williams R, Snyder S, Dicken C, and Kaufman P. (2012). Access to affordable and nutritious food: updated estimates of distance to supermarkets using 2010 data. *ERS Report Summary*. Retrieved September 21, 2013
- Powell L, Slater S, Mirtcheva D, Bao Y, and Chaloupka F. (2007). Food store availability and neighborhood characteristics in the United States. *Preventive Medicine*, 44, 189-195. doi: 10.1016/j.ypmed.2006.08.008
- PRAMS Questionnaires. (2012). Retrieved 14 April, 2012, from <http://www.cdc.gov/prams/Questionnaire.htm>.
- Pregnancy Risk Assessment Monitoring System-Reproductive Health. (2012). Retrieved 14 April, 2013, from <http://www.cdc.gov/prams/>.
- Salihu H, Adamu Y, Aliyu Z, and Aliyu M. (2004). Pregnancy-associated morbidity in Northern Nigeria. *Journal of Obstetrics and Gynaecology*, 24(4), 367-371. doi: 10.1080/01443610410001685457
- Shaw, Hillary. (2006). Food deserts: Towards the development of a classification. *The Power of Geography*, 88(2), 231-247.
- Simmons, David. (2011). Diabetes and obesity in pregnancy. *Best Practice & Research Clinical Obstetrics and Gynaecology*, 25, 25-36. doi: 10.1016/j.bpobgyn.2010.10.006
- USDA. (2012). Food Environment Atlas Documentation. *United States Department of Agriculture*.
- Visser V, Hermes W, Franx A, Koopmans C, Pampus M, Mol B, and Groot C. (2013). High blood pressure six weeks postpartum after hypertensive pregnancy disorders at term is associated with chronic hypertension. *Pregnancy Hypertension: An International Journal of Women's Cardiovascular Health*, 1-6. doi: 10.1016/j.preghy.2013.07.002
- WHO, World Health Organization. (2013). *Obesity and overweight: Fact sheet*. (311). Geneva: WHO Retrieved from <http://www.who.int/mediacentre/factsheets/fs311/en/index.html>.
- WM, Kuklina EV and Callaghan. (2010). Chronic heart disease and sever obstetric morbidity among hospitalisations for pregnancy in the USA: 1995-2006.

Journal of Obstetrics and Gynaecology, 118, 345-352. doi: 10.1111/j.1471-0528.2010.02743.x

Your food environment atlas. (2010). Retrieved October 6, 2013, from <http://www.ers.usda.gov/foodatlas/>.

(Ahern M, 2011; Albrecht et al., 2010; Bacak S, 2005; Beaulac J, 2009; Bennett T, 1998; Callaghan W, 2008; Chu S, 2008; Comstock S, 2012; Dadelszen P, 2011; Denedy, 2010; Deveer R, 2013; Dozier A, 2013; Eckert, 2011; Gulmezoglu A, 2004; Gulmezoglu, Say, Betran, Villar, & Piaggio, 2004; Horowitz C, 2004; Huda S, 2010; Jensen D, 2005; Jillcott S, 2011; Kuklina E, 2009; Kuklina & Callaghan, 2011; Little R, 2011; "Maternal Morbidity and Mortality," 2012; Maxwell, 2007; Morland K, 2006; Nash D, 2013; Ploeg M, 2012; Powell L, 2007; "PRAMS Questionnaires," 2012; "Pregnancy Risk Assessment Monitoring System-Reproductive Health," 2012; Salihu H, 2004; Shaw, 2006; Simmons, 2011; Visser V, 2013; WHO, 2013; WM, 2010; "Your food environment atlas," 2010)