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Influential factors in fruit and vegetable consumption among low-income U.S. women

By

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Doctor of Philosophy

Epidemiology

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By

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An abstract of
A dissertation submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
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Abstract

Influential factors in fruit and vegetable consumption among low-income U.S. women
By Tiffany Lynn Stallings

Consumption of fruits and vegetables (F&V) is below recommended amounts in the United States and intake is generally lower among low-income individuals. Previous research has indicated that recipients of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) had higher F&V intake than WIC non-recipients with similar incomes (≤185% of the Poverty Index Ratio (PIR)). Other studies found WIC recipients who participated in the Farmers' Market Nutrition Program (FMNP) increased F&V intake and learned nutrition competencies. This dissertation included three analyses that examined factors influencing F&V consumption and the nutrition environment among low-income women.

The first analysis used data from the Infant Feeding Practice Study II to examine variation in F&V intake by WIC participation/poverty status (e.g. WIC recipients/ ≤185% of PIR, WIC non-recipients/≤185% of PIR, and >185% of PIR) among pregnant and postpartum women using Kruskal-Wallis tests and logistic regression. In general, F&V intakes were found to be lowest among NonWIC/≤185% PIR and only prenatal vegetable consumption varied by WIC/PIR ($p=0.04$). Additionally, postnatal F&V intake was higher among breastfeeding than non-breastfeeding women (fruit: $p<0.0001$; vegetable: $p=0.006$).

The second analysis used data from the Emory WIC FMNP study to examine influences of the FMNP on F&V intake and nutrition knowledge and competencies using bivariate analyses and logistic regression. Study participants received WIC food vouchers and nutrition education, and the FMNP group received $30 of F&V coupons. Nutrition knowledge and F&V intake did not significantly vary by FMNP group. Over 50% of FMNP participants reported learning new F&V competencies and these participants increased F&V consumption ($p=0.03$).

The third analysis also used data from the Emory WIC FMNP study to explore the agreement between perceived and actual nutrition environment measures of F&V availability, quality, and affordability/price using kappa statistics and sensitivity/specificity. All agreements were poor (kappa values<0.3).

My study findings of higher F&V intake among WIC recipients could support increased efforts to inform WIC non-recipients/≤185% of PIR that they may meet remaining eligibility requirements for WIC benefits. Also, the Emory WIC FMNP study results could support WIC-led nutrition education programs to teach nutrition competencies and the nutrition environment.

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Chapter 1: Importance of Fruit and Vegetable Intake

The following literature review describes the importance of F&V consumption, F&V recommendations, and the epidemiology of low F&V consumption in the U.S. and Georgia. The primary outcomes for Projects 1 and 2 of this dissertation are the F&V intake of low-income, African American mothers and preschool-age (2-5 years) children in the metro-Atlanta area. The primary outcome for Project 3 is the F&V consumption of pregnant and postpartum women in a national sample. Therefore, this literature review on F&V intake and its importance applies to and is referred to in all three dissertation projects.

1) Importance of Fruit and Vegetable Intake

Section 1) describes the importance of fruit and vegetable consumption by discussing chronic diseases associated with low F&V intake including cancer, cardiovascular diseases, Type II diabetes, and obesity. The relationship between childhood and adult obesity are discussed as are chronic diseases attributable to obesity. The economic costs of these chronic diseases associated with low F&V consumption are described also.

a) Chronic Diseases Associated With Low Fruit and Vegetable Consumption

Fruit and vegetable intake is low in the United States and Georgia with approximately one-quarter of adults consuming five or more servings of fruits and vegetables per day [1-4] and only 14.0% daily consuming both two or more fruits and three or more vegetables. [2] Low fruit and vegetable consumption has been associated with an increased risk for certain types of cancer, cardiovascular diseases, Type II diabetes, and obesity.[5-7] One study found that the risk of a major chronic disease (cancer, cardiovascular disease, or non-traumatic death) among Nurses' Health Study (NHS) participants and Health Professional's Follow-up Study (HPFS) participants to be nearly significant at 0.95 (95% CI: 0.89 – 1.01) for those in the highest quintile of F&V intake compared to the lowest quintile .[8] Further, the World Health Report 2003 estimated that worldwide almost 2.7 million lives per year, 31% of ischemic heart disease deaths, and 11% of stroke deaths could be prevented if there was adequate fruit and vegetable intake.[7] Chronic disease incidence and mortality and the association of chronic disease and F&V intake for the following chronic diseases: cancer, cardiovascular diseases, Type II diabetes, and obesity will be discussed below.

i) Cancer

Cancer is the second leading cause of death in the United States.[9] A total of 1,529,560 new cases of cancer are expected to be diagnosed among Americans and 569,490 cancer deaths are expected in 2010.[9] In Georgia, cancer is the second leading cause of death with an estimated incidence of 40,480 diagnosed cancers and 15,570 cancer deaths in 2010.[9,10] Cancer incidence and mortality rates per 100,000 adjusted to the 2000 U.S. standard population of cancers found to be associated with F&V intake for the overall U.S and Georgia populations are summarized in Table 1 below.

Table 1 Estimates of Cancer Incidence and Mortality for Cancer Sites Found to be Associated with F & V Intake, 2010				
	United States		**Georgia**	
Cancer Site	**Incidence**	**Mortality**	**Incidence**	**Mortality**
Oral Cavity and Pharynx	36,540	7,880	NA	NA
Esophagus	16,640	14,500	NA	NA
Lung and Bronchus	222,520	157,300	6,280	4,620
Stomach	21,000	10,570	NA	NA
Colon	102,900	51,370	3,840	1,430
Rectum	39,670	NA		
Bladder	70,530	14,680	1,470	NA
Cervix	12,200	4,210	390	NA
Ovary	21,880	13,850	NA	390
Breast	209,060	40,230	6,130	1,100

Source: [9]

Cancer and F&V Consumption

There is evidence of F&V intake decreasing the risk of cancer.[5,7,11-13] One study reported that there was twice the risk of most cancers among individuals with low versus high F&V consumption after control for potential confounders.[11] Glade et al., stated that "diets containing substantial and varied amounts of vegetables and fruits will prevent 20% or more of all cases of cancer."[12] Another estimate of the percentage of cancers that could be prevented by higher F&V intake was not as strong and ranged from 5-12%.[7]

Cancers of the mouth and pharynx, esophagus, lung, stomach, colon and rectum, bladder, and cervix have shown associations with F&V intake.[5,7,11,13,14] Protection from cancers of the colon and rectum were found among those with higher vegetable intake.[5] Fruit intake had a decreased risk for cancers of the esophagus, oral cavity, and larynx.[11] A review examined 13 ecologic studies, nine cohort studies, and 115 case-control studies of all cancer sites and found a protective effect of F&V intake on epithelial cancers (alimentary and respiratory tracts).[13] Another review found significant protective effects for hormone-related cancers of the cervix, ovary, endometrium, and breast.[11]

Dose-response effects of increasing F&V intake provide additional support for F&V intake preventing cancer.[5] Although carotenoids have been identified as preventive for cancer, there has not been clear results indicating the specific constituents in fruits and vegetables that prevent cancer.[14] A review found that leafy green vegetables, cruciferous vegetables, carrots, broccoli, lettuce, and citrus fruits in studies found that 70% or more of them demonstrated a protective effect against cancer.[13] Further, raw or fresh fruits and vegetables were found to be related to decreased cancer risks in 87% of the studies examining raw F&V.[13]

More recent studies examining the effect of fruit and vegetable intake and cancer have not been as definitive as previous research. For example, Koushik et al. found that there was not a strong relationship between overall colon cancer and F&V consumption.[15] Additionally, a recent meta-analysis reported that case-control studies yield stronger results than prospective studies on the protective effect of F&V intake and risk for cancer.[16]

ii) Cardiovascular Diseases

CVDs are the leading cause of death in the U.S. with 2006 prevalence estimates of 81.1 million and mortality of 831,100.[17] Prevalence estimates in the U.S. for specific CVDs include: CHD 17.6 million, stroke 6.4 million, high blood pressure 74.5 million, and high total cholesterol ≥ 200 mg/dL 102.2 million.[17] Morality estimates in the U.S. for specific CVDs include: CHD 425,400, stroke 137,100, and high blood pressure 56,600.[17]

Similar to the U.S., CVDs are the leading cause of death in Georgia.[18] Compared to all the states, the District of Columbia, and Puerto Rico, Georgia ranks among the highest death rates for CVDs (41st) and stroke (43rd), but not for CHD (12th).[17] The death rates for CVD and stroke in 2006 were 288.8 and 51.4 per 100,000 which reflect 28.2% and 33.6% decreases since 1996.[17] In 2007, one-third of all deaths (32%; 21,389) were attributable to CVD.[18]

Further, 30% of Georgia adults have been told they have high blood pressure and 37% for high cholesterol.[18] Three-fourths of Georgia adults do not meet the total (≥ 5/day) F&V recommendations, less than a quarter (23%) participate in leisure time physical activity, and approximately 1 in 4 (27%) are considered obese.[18]

Cardiovascular Diseases and F&V Consumption

High F&V intake has been associated with a decreased risk of cardiovascular diseases (CVD) in most studies.[8,19,20] For example, among NHS and HPFS participants, those with high F&V consumption (highest quintile ≥ 8 servings/day) had a significant decreased relative risk of 0.88 (95% CI: 0.81 – 0.95) for CVDs compared to those in the lowest F&V intake quintile (<1.5 servings/day).[8] Additionally, a significant relationship was shown between intake of fruit, green leafy vegetables, and F&V containing Vitamin C and CVDs.[8] There was a statistically significant trend ($p<0.001$) in lower CVD risk as the number of F&V servings increased.[8] A review of cohort, case-control, and ecological studies examining F&V intake and CVD found more research indicates a weak protective effect from F&V for coronary heart disease (CHD) while a strong protective effect for stroke.[20]

iii) Type II Diabetes

In 2006, prevalence estimates of physician-diagnosed adult diabetes (Type I and Type II) in the U.S. were 17.2 million.[17] Approximately 1.6 million were incident cases and 63.2 million were estimated to have prediabetes (≥100mg/d fasting plasma glucose < 126 mg/dl and ≥ 140mg/dl oral glucose tolerance test < 200 mg/dl).[17,21]

Type II diabetes has been traditionally diagnosed in adults 40 years of age and older; however Type II diabetes has been increasing in recent years among younger adults and children.[22] Many of these youth with Type II diabetes are overweight or obese and have a family history of diabetes.[22] From 2002-2003, the SEARCH study identified approximately 3,700 incident Type II diabetes cases among youth participants .[23] Although Type II diabetes is very rare in children less than 10 years of age, the incidence rates among 10-19 year old youth were higher with Type II rates among African Americans approximately 20 per 100,000/year.[23]

Diagnosed diabetes in Georgia has followed national trends with the prevalence increasing from 7.7% in 2001 to7.8% in 2005 to 10.1% in 2007.[24,25] Death rates due to diabetes were higher among African Americans than Whites and among males compared to females with the highest proportion of premature deaths due to diabetes among African American males (53.7%) compared to White females (23.6%).[24]

Type II Diabetes and F&V Consumption

Comparison of the median intake of total F&V from the 1st quintile (2.5 servings/day) to the 5th quintile (> 10 servings/day) indicate that women in the highest quintile had a significantly lower risk of Type II diabetes (RR = 0.77 (95% CI: 0.65 – 0.92)) adjusting for age, smoking status, and total calories ($p<0.001$).[26] A similar relationship was found for intake of total fruit (RR = 0.71 (95% CI: 0.60-0.84)), green leafy vegetables (0.68 (0.57 – 0.79)), and dark yellow vegetables (0.63 (0.52 – 0.76)).[26] However, when models were adjusted for age, smoking, total calories, alcohol use, BMI, exercise, history of hypertension, history of high cholesterol, and family history of diabetes, the relationships with fruits and vegetables were no longer statistically significant.[26] Further, among African American youth with Type II diabetes more than 80% consumed less than five servings of F&V/day.[27]

iv) Obesity

(1) Obesity Definition and Body Mass Index

Obesity is a general term used to describe an excess of adipose tissue or body fat.[28] Due to the complexity of measuring adipose tissue, economical and quick scientific techniques to estimate body fat such as Body Mass Index (BMI), skinfold thickness, circumference of the waist, ratio of waist-to-hip circumference have been developed along with more technologically advanced methods such as magnetic resonance imaging (MRI) and ultrasound.[29]

In particular, BMI is a calculated number using an individual's weight and height or stature in comparison to a healthy weight for that specific height or stature.[29] Adult (>20 years of age) BMI equals the weight (kg) divided by the height squared (m^2) or weight (lb.) divided by height squared (in^2) then multiplied by 703.[30] BMI calculations for children and adolescents use the 2000 Centers for Disease Control and Prevention (CDC) Growth Charts and measurements are more precise (weight to the nearest ¼ pound and height to the nearest 1/8 inch) and also incorporate the child's birth date, date of measurement, and sex.[31] BMI is calculated for infants and young children under two years of age by assessing weight-for-length measures.[32] Ranges of

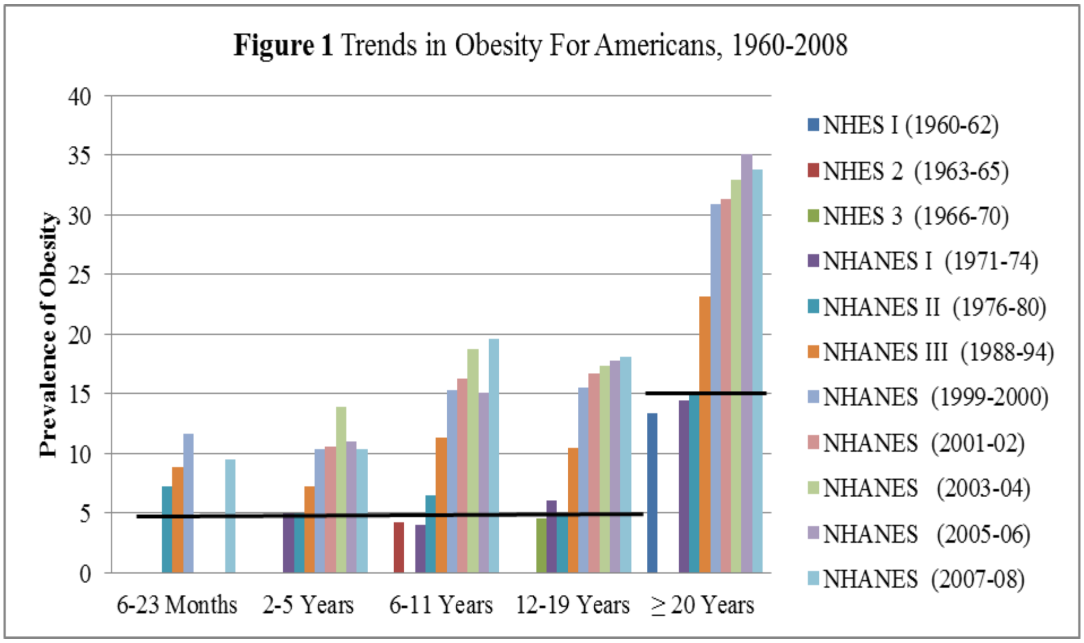
BMI correspond to standard weight descriptions of underweight, healthy weight, overweight, and obese. [33] Table 2 describes methods for describing BMI categories for males and females by age.[30,31]

Table 2 BMI Categories by Age					
		BMI Category			
Age	**Method**	**Underweight**	**Healthy Weight**	**Overweight**	**Obese**
2 to 20 years	Percentile Range	< 5th percentile	≥ 5th percentile to < 85th percentile	≥ 85th percentile to < 95th percentile	≥ 95th percentile
>20 years	BMI Numerical Range	< 18.5	18.5 to 24.9	25.0 to 29.9	≥ 30.0

Source: [30,31]

(2) Prevalence of Obesity

The prevalence of obesity in the United States has increased since 1980 in both adults and children as shown in Figure 1.[34,35] From 1960 to 1980, approximately 14% of adults and 6% of children were considered obese.[28,35] However, from 1980 to 2000 there were large statistically significant differences in nearly all age groups.[28,36,37] During the same two decades, Figure 1 shows how adult obesity doubled from 15.0% from 1976-80 to 30.9% from 1999-2000. Similarly, childhood obesity doubled among preschoolers (2-5 years) (5.0% to 10.4%) and children (6-11 years) (6.5% to 15.3%) and tripled among adolescents (12-19 years)(5.0% to 15.5%). The black horizontal lines on Figure 1 indicate the *Healthy People 2010* target goals for prevalence of childhood obesity at 5% and 15% for adults.[38] The prevalence of obesity was at these target levels before 1980, but is currently well above these targets.



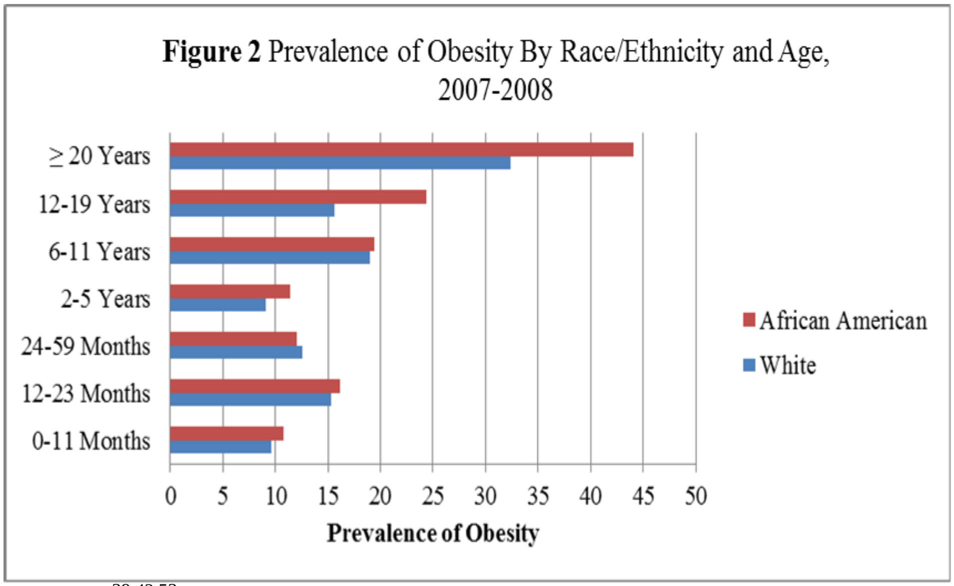
Sources: [34,35,39-41]

Since 2000, the prevalence of obesity has remained high at ≥ 30% among adults, 17% for children and adolescents (6-19 years), and 11% for preschool age (2-5 years).[35,42] More recent reports since 2000 have indicated another period of relatively small increases in BMI among both adults, adolescents, and preschool-age children and possibly another stable period of obesity prevalence (Figure 1).[36,39,40,42,43] However, one systematic review predicted by linear regression models that by 2015, the prevalence of obesity will be 40.8% in adults 20 years of age or older, 23.6% among adolescents aged 12-19 years, 22.7% among children aged 6-11 years.[44] This report predicted that the highest prevalence of all gender/age/race/ethnicity groups will be for non-Hispanic African American females at 62.5%.[44]

The prevalence of adult obesity in Georgia had a three-fold increase from 1991 (9.2%) to 2008 (27.3%).[45-47] Data on the prevalence of childhood obesity in Georgia is not as available as for adults. The 2001 Georgia Youth Tobacco Survey, 2005 Oral Health Screening, and 2003 and 2007 Georgia Student Health Surveys have collected obesity data on Georgia children aged 6-17 years. From 2001 to 2007, the prevalence of obesity among Georgia middle school children increased from 13.4% to 15% and from 11.2% to 14% among high schoolers.[48,49] In 2005, nearly one-quarter (24%) of third graders were considered obese in Georgia.[50]

The Pediatric Nutrition Surveillance System (PedNSS) provides obesity statistics for Georgia children from birth to <5 years of age for children enrolled in the WIC program. WIC recipients are low-income and at nutritional risk and they may not be representative of all Georgia children in this age group, however 31% of all Georgia residents <5 years of age are enrolled in WIC.[51] The prevalence of obesity among child (2-5 years of age) WIC recipients in Georgia as collected by PedNSS increased significantly from 9.4% in 1998 to 12.4% in 2003 and to 14.8% in 2008.[52] From 1998 to 2008, there was an average percentage point increase per year of about half-a percent (0.60% from 1998-2003 and 0.48% from 2003-2008).[52]

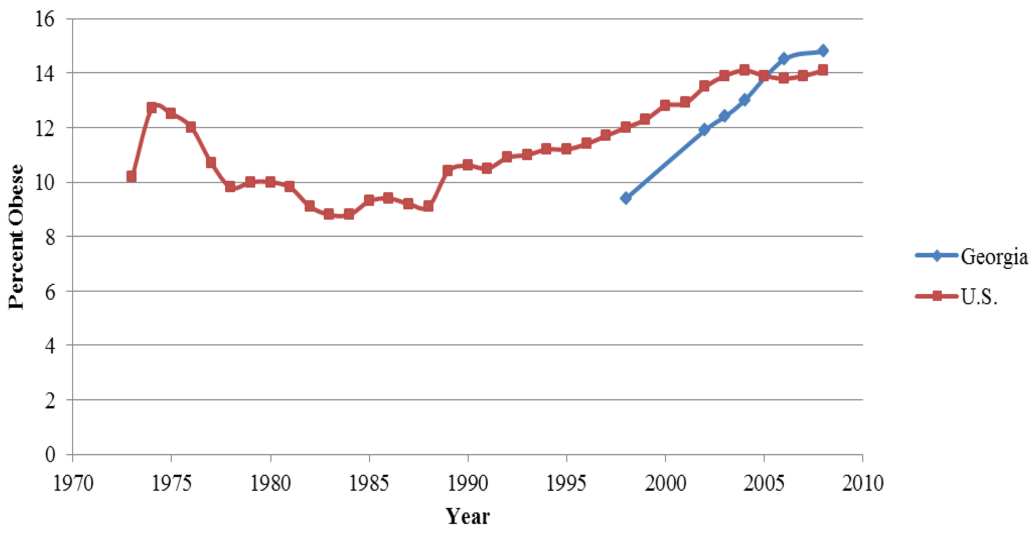
The prevalence of obesity is high in the United States as shown in Figure 2, but it is more elevated among minority racial/ethnic groups, especially African Americans, and low-income individuals.[36,40,44,45] For example, 2009 BRFSS data indicated that 26.4% of Whites were obese compared to 38.7% of African Americans and 29.3% of Hispanics.[4] Figure 2 illustrates the how prevalence of obesity is higher among African Americans in nearly all age groups, especially for those ≥ 20 years of age.[39,42,53]



Sources: [39,42,53]

The prevalence of obesity in adults participating in the national Continuing Survey of Food Intakes by Individuals (CSFII 1994-1996) (N = 9,643) was 17.6% overall and stratification of income found that those with a lower income were significantly ($p < 0.01$) more obese (23.0%) than those with a higher income (16.6%).[54] Children and adolescents who were low-income were statistically significantly more likely to be overweight (OR = 1.3 (95% CI: 1.01 – 1.6)) compared to those who were middle-income.[55] One particular group of interest is low-income children (<5 years of age) who are WIC recipients. Figure 3 demonstrates that childhood obesity among all WIC recipients has steadily increased from 10.4% in 1989 to 14.1% in 2008 and among Georgia WIC recipients from 9.4% in 1998 to 14.8% in 2008.[47,56,57] The Georgia WIC recipients were less obese than the national WIC population until 2006 when Georgians surpassed the national estimate and have continued to remain above the national average (Figure 3).[47,56-58]

Figure 3 Trends in Obesity Among Low-Income, Preschool-Aged Children, U.S and Georgia



Sources: [47,52,56,57,59,60]

Obesity and F&V Consumption

Research assessing the association of F&V consumption and obesity has not been as conclusive as for cancer, CVDs, and Type II diabetes. It is believed that increased F&V intake may help in weight management by two main reasons: 1) F&V are high in fiber and water and low in fat and calories[61,62] and 2) F&V may replace foods high in fat and sugar.[62,63] For example, a year-long intervention study aimed at increasing F&V intake found that F&V consumption increased 3.41 (SD = 3.47) servings/day and the percentage of overweight adults decreased 12.01% (11.05).[64] Additionally, NHS data found that as F&V quintile increased (Median intake (servings/day) 1st quintile = 2.63, 3rd = 5.24, 5th = 9.30), the fiber intake increased (12g, 16g, 21g) and saturated fat decreased (24g, 22g, 20g).[65] This same study found nearly a 25% decrease in risk of becoming obese (OR = 0.76 (95% CI: 0.69 – 0.86)) for women who had the greatest increase in F&V consumption from 1984-1994 compared to women with the greatest decrease in consumption.[65]

Research on the relationship of childhood obesity and F&V intake has not indicated similar findings as for adult obesity. For example, a study including 9-14 year olds from 1996-1999 demonstrated that there was a null association between changes in BMI z-score and F&V intake for girls (β=0.002 (95% CI: 0.001, 0.003)) and for boys (β=0.000 (95% CI: -0.000, 0.001)).[66] A study of preschool age (2-5 years) low-income children in North Dakota found non-significant results for the association of F&V intake and weight change (Fruit: β = 0.49 (p-value: 0.17; Vegetable: 0.09 (0.02)).[67]

(3) Relationship of Childhood and Adult Obesity

Obesity among children and adolescents has been found to predict adult obesity.[68-72] The Bogalusa Heart Study found that among obese children, 84% became obese adults, whereas among healthy weight children, 7% became obese adults.[68,69] Another study reported that if a mother or father was obese when the child was < 18 years of age, the child was more likely to be obese as an adult than a child with non-obese parents.[72] Further, the child's obesity status before the age of six was predicted by the parent's obesity status.[72] In a review of longitudinal studies published from 1970 to 1992 about the association of childhood and adult obesity, approximately a third (range: 26 to 41%) of obese preschool children became obese adults and about half (range: 42 to 63%) of obese school-aged children became obese adults.[71] The Bogalusa Heart Study found that as adult BMI increases, childhood BMI increases, especially at adult BMI ≥ 30 (obese) which is near childhood BMI percentile ≥ 95% (obese).[68] Further, childhood BMI percentiles were found to be statistically significantly and positively associated with adult risk factors including: total cholesterol, low-density lipoprotein (LDL) cholesterol, triglycerides, insulin, systolic blood pressure, and diastolic blood pressure and negatively associated with high-density lipoprotein (HDL) cholesterol.[68] Similar, but stronger, relationships were found for adult BMI and adult risk factors.[68]

(4) Chronic Diseases Attributable to Obesity

Increasing obesity in the U.S. among adults and children has also led to increases in chronic diseases related to being overweight and obese including: CVDs, Type II diabetes, certain types of cancer, joint problems, asthma, and sleep apnea.[22,46,69,73-75] Many of these diseases attributable to obesity are similar to those related to low F&V intake as previously described.

The number and percent of estimated new cancers attributable to obesity were 41,383 (3.2%) in 2002 and 84,501 (5.8%) in 2007with 33,966 (4.4%) among males and 50,535 (7.5%) among females [76,77]. Another study found that among cancer deaths from 1982-1998, 14% of them among men and 20% among women were attributable to overweight and obesity.[78] Obesity-attributed cancers include the following: among men and women: colorectal cancer, adenocarcinomas of the esophagus and gastric cardia, kidney; among men: cancers of the liver, pancreas, stomach; and among women: cancers of the breast, endometrium, uterus, kidney, cervix, pancreas, esophagus, gallbladder, breast, ovary, and non-Hodgkin's lymphoma.[76-79] Therefore, cancers that were similarly related to obesity and low F&V intake were cancers of the esophagus, stomach, colon and rectum, and cervix. There is little research on childhood cancers attributable to obesity and will therefore not be discussed.

The prevalence of CHD by weight classification among adult men and women with a BMI of 30.0 – 34.9 (Men: 16.0%, Women: 12.6%) was nearly double that of those considered normal weight with a BMI of 18.5-24.9 (Men: 8.84, Women: 6.9%).[80] Further, the estimated prevalence ratio of CHD comparing obese (BMI = 30.0 – 34.9) to normal weight individuals was 1.59 (95 %

CI: 1.17-2.11) for men and 1.58 (1.19-2.10) for women adjusting for age, race/ethnicity, and smoking status.[80] Another study found that the prevalence of heart disease was higher among participants of the 1994-1996 CSFII who were obese (male: 8.2%, female: 9.8%) compared to those who were normal weight (male: 7.3%, female: 5.7%) with a corresponding odds ratio of 1.4 (95% CI: 1.1 – 1.8) adjusting for age, race, gender, income, education, and smoking.[54]

Obese children have risk factors for cardiovascular diseases and since childhood obesity is highly associated with adult obesity, cardiovascular diseases may begin developing earlier in obese children. The Bogalusa Heart Study examined the following six cardiovascular disease risk factors: triglycerides, LDL cholesterol, HDL cholesterol, fasting insulin, systolic blood pressure, and diastolic blood pressure.[69] The Bogalusa Heart Study found that among children (5-17 years of age) who were considered obese, 70% had at least one of the six risk factors described in the previous statement, 39% had ≥ two risk factors, and 18% had ≥ three risk factors.[69] Similar statistically significant differences were found for the following cardiovascular risk factors: systolic blood pressure, diastolic blood pressure, high-density lipoproteins cholesterol, and triglycerides in the National Heart, Lung, and Blood Institute Growth and Health Study between obese and non-obese 9-18 year old girls.[70]

Among obese (BMI 30.0-34.9) adult women in the NHS, the relative risk of Type II diabetes was 20.1 (95% CI: 16.6 – 24. 4) compared to those with a BMI < 23.0.[81] The SEARCH for Diabetes in Youth Study found that among African American children aged 10-19 years with Type II diabetes, the majority were obese.[27] For example, approximately 85% of African American boys aged 10-19 years with Type II diabetes were obese, whereas among girls the percentage was higher among 10-14 year olds (nearly 90%) and lower among 15-19 year olds (nearly 75%).[27]

b) Economic Costs of Diseases and Conditions Associated With Low F&V Consumption

The economic costs of diseases/conditions associated with low F&V intake are high since cancer, CVDs (heart disease and stroke) and diabetes are among the top ten leading causes of death in the U.S.[82] Table 3 describes the total costs, direct medical expenses, and indirect lost productivity costs due to morbidity or mortality for cancer, CVDs, diabetes, and obesity for the U.S. and Georgia. Preventive, diagnostic, and treatment services comprise possible direct medical fees whereas morbidity and mortality expenses make up indirect costs.[83] Expenses associated with morbidity are defined as "the value of income lost from decreased productivity, restricted activity, absenteeism, and bed days" and mortality costs are "the value of future income lost by premature death."[83]

Table 3 Costs of Diseases/Conditions Associated with Low Fruit and Vegetable Consumption

		Costs ($ billion)		
Disease/Condition	**Year**	**Total**	**Direct**	**Indirect**
U.S.				
Cancer (1)	2010	263.8	102.8	161.0
CVD (2)	2010	503.2	324.1	179.1
Diabetes (3)	2007	174.0	116.0	58.0
Obesity (4)	2008	147.0	NA	NA
Georgia				
Cancer (5)	2004	4.6	2.9	1.7
CVD (6)	2007	11.2	NA	NA
Diabetes (7)	2006	5.1	1.8	3.3
Obesity (8)	1998-2000	2.1	NA	NA

Sources: (1)[9]; (2) [17]; (3)[23]; (4)[84]; (5)[10]; (6)[85]; (7)[86]; (8)[83,87]

One study estimated that medical costs in 1995 due to cancer were $47.4 billion and indirect expenses due to lost productivity because of disability were $14.3 billion of which diet-related costs for each cost were estimated to be \$14.2 and 4.3 billion respectively.[6] The majority of the CVD total expenses were for CHD (\$177.1 billion), hypertensive disease (\$76.6 billion), and stroke (\$73.7 billion).[17] One study estimated that medical costs in 1995 due to CHD, heart disease, stroke, and diabetes were \$85.3 billion and indirect expenses due to lost productivity due to disability were \$20.0 billion of which diet-related costs for each were estimated to be \$19.4 and 5.0 billion respectively.[6]

Obesity and its related health concerns result in direct and indirect medical costs and burden the health care system.[83,88,89] From 1996-1998, it was estimated that direct and indirect medical expenses attributable to obesity in the U.S. were \$26.8 billion and \$47.5 billion using two difference datasets: Medical Expenditure Panel Survey (MEPS) and National Health Interview Surveys (NHIS).[89] Among children, medical expenses associated with childhood obesity increased from \$125.9 million in 2001 to \$247.6 million in 2005.[90] Another study estimated that from 2002 to 2005, an additional \$14.1 billion was spent annually on direct medical fees attributable to obesity including: outpatient visits, prescription drugs, and emergency room visits.[91] A more recent report by Finkelstein et al. estimated that in 2008 the medical costs attributable to obesity were \$147 billion.[84]

Regarding obesity's impact on health care, obese individuals had longer lengths of hospital stays compared to healthy-weight individuals from 1971-1992.[88] As an individual's BMI increased above 18.5, their hospital length of stay increased by 60% (rate ratio 1.60 (95% CI 1.19-2.16)) for $30.0 \leq \text{BMI} < 35.0$ compared to $18.5 \leq \text{BMI} < 25.0$.[88] Hospitalizations among patients with an obesity diagnosis nearly doubled from 1999 to 2005[90] and from 2002 to 2005, outpatient visits attributable to childhood obesity increased 38.3%, drug prescriptions increased 29.7%, and emergency room visits increased 10.3%.[91]

In response to low fruit and vegetable intake in the U.S., the link between low fruit and vegetable intake and chronic disease, and the high medical costs of these chronic diseases, there has been increased attention on improving fruit and vegetable access, availability, and intake.

Fruit and Vegetable Recommendations and National Food and Nutrition Programs

The following section describes fruit and vegetable recommendations for Americans two years of age and older and for pregnant and postpartum women. The national food and nutrition programs that promote the recommendations such as "5 A Day - For Better Health" and "Fruit & Veggies – More Matters" are described.

c) "5 A Day For - Better Health"

The national "5 A Day – For Better Health" fruit and vegetable campaign that was initiated in 1991 was based on the "California 5 A Day – For Better Health" program that began in the late 1980s. From 1988 to mid-1991, the California Department of Health Services, funded by the National Cancer Institute (NCI), launched the "California 5 A Day - For Better Health" program to increase fruit and vegetable consumption among Californians.[92] The initiative chose to use five servings as the recommendation since this amount would: 1) provide a mixture of F&V of various types (all high in essential nutrients); 2) possibly take the place of higher fat and sugar foods; 3) be a reasonably achievable amount in the mind of the consumer; 4) follow other F&V recommendations; and 5) be a memorable amount.[5,92] The program implemented changes to the food system, increased public awareness through media and retail (supermarkets), and provided professional education.[92]

From 1989 to 1991, survey results indicated that White and African American Californian's total F&V intake increased by 0.3 servings (White: 3.7 to 4.0; African American: 4.0 to 4.3).[92] This change was largely due to increases in intake of vegetables and salad since fruit and juice consumption remained relatively constant.[92] Further, the program's messages about awareness, knowledge, beliefs, and attitudes about fruits and vegetables and their role in cancer prevention improved from 1989 to 1991.[92] For example, there was a statistically significant change (51% in 1989 to 65% in 1991) in the percentage who agreed that "what people eat or drink will make a difference in the chances of getting cancer."[92] However, the program appeared to have no impact on the percentage who knew five or more servings of F&V should be consumed daily for good health, which stayed constant at 23% from 1989 to 1991.[92]

In 1990, all Americans were estimated to consume an average of 3.27 servings/day and nearly 1 in 5 people (19%) ate five or more servings daily [5]. With the "California 5 A Day – For Better Health" program as an example, the NCI and Produce for Better Health Foundation (PBH) planned and launched a national program, "5 A Day – For Better Health", to increase fruit and vegetable consumption among all Americans.[5] Beginning in 1991, "5 A Day" messages and information about how F&V decrease risks for cancer and chronic diseases were disseminated by radio, television, newspaper, brochures, and presentations to the general public at supermarkets, restaurants, schools, health care settings, worksites, churches, and food assistance programs.[5] In 1993, states were invited to participate in the "5 A Day" campaign at the community level and Georgia was among the most active states in promoting "5 A Day" media messages.[5] In 1996, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) incorporated the "5 A Day" message into its nutrition education sessions and the Farmers' Market Nutrition Program (FMNP).[5]

The “5 A Day- For Better Health” had an initial budget of $27 million for the first five years and NCI provided additional funds for research including $18 million from 1992 to 1997 and an additional $9.6 million in 1997.[5] Findings from research on the “5 A Day” program indicated that the initiative’s messages have been received and understood by many Americans.[93] For instance, the “5 A Day” surveys found that awareness of the “5 A Day – For Better Health” program increased significantly from 2.0% to 17.8% from 1991 to 1997 with higher follow-up (1997) awareness among females, younger ages (18-34 years), Whites, and those with a high education level.[93] Further, the “5 A Day” program significantly increased how many people think they should consume at least five servings of F&V daily (1991: 7.7%; 1997: 19.2%).[93] Knowledge of the program’s F&V consumption recommendation was higher among females, middle aged (35-49 years), Whites, and higher education levels.[93]

Despite significant increases in awareness of the “5 A Day” program and F&V recommendations, fruit and vegetable intake slightly increased, but not significantly as shown in Table 4.[93] The average adult consumed 3.78 servings/day of F&V with 23.4% consuming five or more servings per day in 1991compared to 3.90 servings/day and 25.8% in 1997.[93] F&V intake increased more for females, young adults (19-34 years), Hispanics, those with more than high school education, and those with less than 130% poverty ratio index from 1991 to 1997 as shown in Table 4.[93]

Table 4 Changes in F & V Consumption From 1991 to 1997						
	Model-adjusted Mean (SE) Intake			**Model-adjusted Percentage Consuming ≥ 5 Servings/Day (Mean (SE))**		
	1991	**1997**	**P-value**	**1991**	**1997**	**P-value**
Total	3.78 (0.05)	3.90 (0.07)	0.12	23.38 (0.97)	25.77 (0.82)	0.047
Sex						
Male	3.45 (0.07)	3.53 (0.12)	0.56	18.06 (1.37)	19.65 (1.51)	0.42
Female	4.06 (0.07)	4.22 (0.06)	0.066	27.86 (1.12)	30.94 (1.17)	0.079
Age (years)						
18-34	3.54 (0.08)	3.84 (0.11)	0.033	19.16 (1.45)	23.20 (1.78)	0.071
35-49	3.73 (0.08)	3.80 (0.11)	0.586	23.35 (1.70)	25.32 (1.79)	0.417
50-64	3.94 (0.11)	3.86 (0.12	0.62	23.58 (2.54)	25.53 (1.73)	0.524
≥ 65	4.29 (0.12)	4.30 (0.12)	0.934	33.30 (3.18)	32.81 (2.46)	0.895
Race/Ethnicity						
White	3.75 (0.05)	3.88 (0.07)	0.125	22.66 (1.12)	25.45 (0.96)	0.046
African American	4.01 (0.13)	3.79 (0.14)	0.254	29.20 (2.32)	25.23 (2.62)	0.253
Hispanic	3.56 (0.12)	4.04 (0.22)	0.043	22.74 (2.43)	30.64 (3.58)	0.06
Education						
< High School	3.51 (0.13)	3.55 (0.14)	0.832	19.27 (2.65)	20.72 (2.89	0.701
High School	3.56 (0.08)	3.69 (0.11)	0.329	21.26 (1.56)	22.11 (1.81)	0.724
> High School	3.97 (0.06)	4.22 (0.08)	0.014	25.74 (1.38)	29.31 (1.19)	0.041
Poverty Index Ratio						
< 130%	3.61 (0.13)	3.90 (0.16)	0.122	20.66 (2.45)	29.07 (2.84)	0.017
130-300	3.63 (0.07)	3.82 (0.12)	0.122	21.45 (1.53)	24.03 (2.16)	0.306
> 300	3.97 (0.07)	3.97 (0.08)	0.977	25.89 (1.50)	26.19 (1.24)	0.874

Source: [93]

From 1994 to 2005, F&V intake decreased slightly from 3.42 times/day in 1994 (24.6% meeting total F&V (≥ 5 /day) recommendation) to 3.24 times/day in 2005 (25.0%).[3] There was a greater overall decrease among males (standardized change, -0.26 times/day) than females (-0.17 times/day), but significant increases in percentage points meeting recommendations among non-Hispanic African American women (+4.08), women aged 25-34 years (+3.65), and men aged 18-24 years (+3.71).[3]

d) *Healthy People 2010*

In 2000, the *Healthy People 2010* aimed to build on the trend of increasing F&V consumption with the following objectives[38]:

Objective 19-5: "Increase the proportion of persons aged 2 years and older who consume at least two daily servings of fruit" with a target of 75%

Objective 19-6: "Increase the proportion of persons aged 2 years and older who consume at least three daily servings of vegetables, with at least one-third being dark green or orange vegetables" with a target of 50%.

These objectives indicated how many of the servings should be fruits or vegetables with emphasis on specific-colored vegetables, whereas the "5 A Day" program focused on consumption of at least five total servings of fruits and vegetables daily

e) "Fruits and Veggies – More Matters"

In 2009, the national "5 A Day" campaign was replaced by "Fruits and Veggies – More Matters" with collaboration of the Centers for Disease Control (CDC) and PBH.[94] The CDC had begun updating the national F&V consumption campaign in October 2005 when the CDC became the primary agency heading the campaign.[3,95] The updates included the Healthy People 2010 objectives and the

expression of servings sizes in cups with half a cup equal to a serving size as stated in the *Dietary Guidelines for Americans* (January 2005).[38,95]

This new program follows in the previous "5 A Day - For Better Health" accomplishments and strives to continue to inspire Americans to consume more F&V of all forms (fresh, frozen, canned, dried, and 100% juice), and hopes to contribute to research on the importance of fruits and vegetables in reducing the risks for obesity and chronic diseases.[94] This initiative provides numerous online resources with nutrition education available to the general public including simple explanations of the benefits and importance of consuming F&V, lists of the F&V currently in season, tips on how to choose, store, and prepare F&V, and how to encourage children to eat more F&Vs.

Current fruit and vegetable recommendations stated in the "Fruits and Veggies – More Matters" campaign are more specific to sex, age-groups, physical activity levels, and pregnancy/breastfeeding status. Recommendations increase with increasing age and physical activity level and are similar or higher among males compared to females. Table 5 describes the F&V recommendations for males and females of various age-groups with increasing physical activity levels. "Less active" is defined as an average of less than 30 minutes of physical activity a day, "moderately active" is defined as an average of 30 to 60 minutes of physical activity a day, and "active" is defined as an average of more than 60 minutes of physical activity a day.[96] For instance, the daily recommendations are as follows for a female aged 19-50 years with a "moderately active" physical activity level: 2 cups of fruit (4 servings) and 3 cups of vegetables (6 servings) as shown in Table 5.[96]

Table 5 Fruit and Vegetable Recommendations					
		Fruit		**Vegetables**	
Sex	**Age (yrs)**	**Cups**	**Servings (1 serving = 1/2 cup)**	**Cups**	**Servings (1 serving = 1/2 cup)**
Less Active Activity Level					
Female	2 to 3	1	2	1	2
	4 to 8	1	2	1.5	3
	9 to 13	1.5	3	2	4
	14 to 18	1.5	3	2.5	5
	19 to 30	1.5	3	2.5	5
	31-50	1.5	3	2.5	5
	51+	1.5	3	2	4
Male	2 to 3	1	2	1	2
	4 to 8	1	2	1.5	3
	9 to 13	1.5	3	2.5	5
	14 to 18	2	4	3	6
	19 to 50	2	4	3.5	7
	51+	2	4	3	6
Moderately Active Activity Level					
Female	2 to 3	1	2	1.5	3
	4 to 8	1.5	3	2	4
	9 to 13	1.5	3	2.5	5
	14 to 18	2	4	2.5	5
	19 to 50	2	4	3	6
	51+	1.5	3	2.5	5
Male	2 to 3	1	2	1.5	3
	4 to 8	1.5	3	2	4
	9 to 13	1.5	3	3	6
	14 to 18	2	4	3.5	7
	19 to 30	2	4	3.5	7
	31+	2	4	3.5	7
Active Activity Level					
Female	2 to 3	1	2	1.5	3
	4 to 8	1.5	3	2.5	5
	9 to 13	2	4	3.5	7
	14 to 18	2.5	5	4	8
	19 to 50	2	4	3	6
	51+	2	4	3	6
Male	2 to 3	1	2	1.5	3
	4 to 8	1.5	3	2	4
	9 to 13	1.5	3	3	6
	14 to 18	2	4	3.5	7
	19 to 30	2.5	5	4	8
	31 to 50	2.5	5	4	8
	51+	2.5	5	3.5	7

Source: [96]

Examples of a one half-cup serving of common fruits include: half a large banana, 16 grapes, four large strawberries, one cantaloupe wedge and half a medium grapefruit.[97] One serving of common vegetables include: five broccoli florets, half a medium white or large sweet potato, six baby carrots, and half a large ear of corn.[97]

f) MyPyramid Plan for Moms

The MyPyramid Plan for Moms provides the recommended caloric intake and corresponding servings of fruits and vegetables for pregnant and breastfeeding women as shown in Table 6.[98] It is important that women's energy intake is adequate during pregnancy to support the developing fetus. While the energy intake is recommended to remain at non-pregnant levels in the 1st trimester of pregnancy (no increase in intake during 1st trimester), the energy intake is recommended to increase in the 2nd and 3rd trimesters.[98,99] For the average American woman who is 5 feet 4 inches tall and weighs 156 pounds before pregnancy, approximately 2 cups of fruit and 3 cups of vegetables should be consumed daily in the 1st trimester (2,400 total calories), 2 cups of fruit and 3.5 cups of vegetables (2,600 total calories) in the 2nd trimester, and 2.5 cups of fruit and 3.5 cups of vegetables (2,800 total calories) in the 3rd trimester as shown in Table 6.[98] Table 6 states the recommended caloric intake and fruit and vegetable servings for the average American woman.

If a woman is breastfeeding following pregnancy, her energy intake should remain increased as shown in Table 6 for the average American women. However, if she is not breastfeeding, her energy intake should be returned to pre-pregnancy levels. Thus, the fruit and vegetable recommendations are consistent with this lower energy intake recommendation. The average

American woman who 5 feet 4 inches tall and weighs 172 pounds right after pregnancy (156 lbs. pre-pregnancy weight + an average of 30 lbs. gained during pregnancy – 8 lbs. of average weight of baby – 3 lbs. of placenta weight – 3 lbs. of amniotic fluid[100]) is again used for the F&V intake values in Table 6. Women who breastfeed for the first six months should consume approximately 2,800 total calories with corresponding F&V recommendations of 2.5 cups of fruit and 3.5 cups of vegetables daily.[98] Women who breastfeed for at least half of the feedings and use formula the remainder should consume 2,600 total calories with corresponding F&V recommendations of 2 cups of fruit and 3.5 cups of vegetables.[98] Lastly, women who mostly feed their babies with formula and used only some formula should consume about 2,400 total calories with corresponding F&V recommendations of 2 cups of fruit and 3 cups of vegetables.[98]

Table 6 Energy and F & V Intake Recommendations for Pregnant and Postpartum Women

		Fruits		**Vegetables**	
	Energy Intake (Calories)	**Cups**	**Servings (1 serving = 1/2 cup)**	**Cups**	**Servings (1 serving = 1/2 cup)**
Non-pregnant	2,400	2	4	3	6
Pregnant 1st Trimester	2,400	2	4	3	6
Pregnant 2nd Trimester	2,600	2	4	3.5	7
Pregnant 3rd Trimester	2,800	2.5	5	3.5	7
Postpartum - Breastfeeding only	2,800	2.5	5	3.5	7
Postpartum - Half Breastfeeding/Half Formula	2,600	2	4	3.5	7
Postpartum - Some Breastfeeding/Mainly Formula	2,400	2	4	3	6

Source: [98]

2) Dietary Components of Fruits and Vegetables

The following section describes the dietary components such as vitamins and minerals found in fruits and vegetables.

Adolescents and adults need to consume F&V for healthy development, growth, and to reduce risks for chronic diseases and obesity. F&V are excellent sources of essential nutrients and are low in calories and fat as described in Table 7.[101,102] Most F&V are low in fat, contain no cholesterol, are a good source of dietary fiber, and provide some of the following vitamins and minerals: vitamin A, vitamin C, folate, potassium, calcium, iron, and magnesium. For example, the nutrient content for a banana: total calories = 67, total fat = < 0.5g, dietary fiber = 2g (8% daily value (DV)), sugars = 9g, protein = 1g, vitamin A = 1g, vitamin C= 11g, folate = 4g, potassium = 269g (8% DV), calcium = 4g (0% DV), iron = <0.5g (1% DV), and magnesium = 20g (5% DV).[103]

Table 7 Dietary Components and Health Benefits/Functions of F & Vs			
Dietary Component	**Fruit Sources**	**Vegetable Sources**	**Health Benefits/Functions**
Fiber	Apple, dried plum, dried fig, kiwi fruit, raspberry, pear, blueberry, lemon, lime, banana, avocado	Pea, root vegetables, cabbage, artichoke	Digestive health (regular bowels)
Vitamin A	Papaya, cantaloupe	Squash, pumpkin, carrots, broccoli, tomato, pea, spinach, red pepper, Chinese cabbage, kale, collard greens, sweet potato	Immune system, vision, cellular differentiation, epithelial cell growth, bone development of osteoblasts and osteoclasts, skin.
Vitamin C	Orange, cantaloupe, grapefruit, papaya, lemon, strawberry	Broccoli, kale, green pepper, asparagus	Oral cavity health, wound recovery, neurotransmitter synthesis, antioxidant activity, collagen synthesis
Folate	Strawberry, orange	Broccoli, asparagus, spinach	Reduces risk of spinabifida and other brain or spinal cord defects, reduces risk of megaloblastic macrocytic anemia
Potassium	Orange juice, prune juice, cantaloupe, watermelon, banana, avocado	Sweet potato, tomato, beet greens, white potato, carrot juice	Maintain healthy blood pressure, reduce risk of stroke, contractability of smooth, skeletal and cardiac muscle, excitability of nerve tissue, and maintaining electrolyte and pH balance
Calcium	Fortified orange juice, dried fruits	Turnip and mustard greens, broccoli, cauliflower, kale	Mineralization of bone, muscle contraction, blood clotting, nerve conduction
Iron (nonHeme)	Dried fig, raisin	Green leafy vegetables, asparagus	Krebs Cycle and Glycolysis
Magnesium	Plum, dried fig, raisin	Corn, pea, carrot, green leafy vegetables, artichoke	Bone structure, cardiac and smooth muscle contractability, protein synthesis, DNA synthesis and degradation

Sources: [101,102]

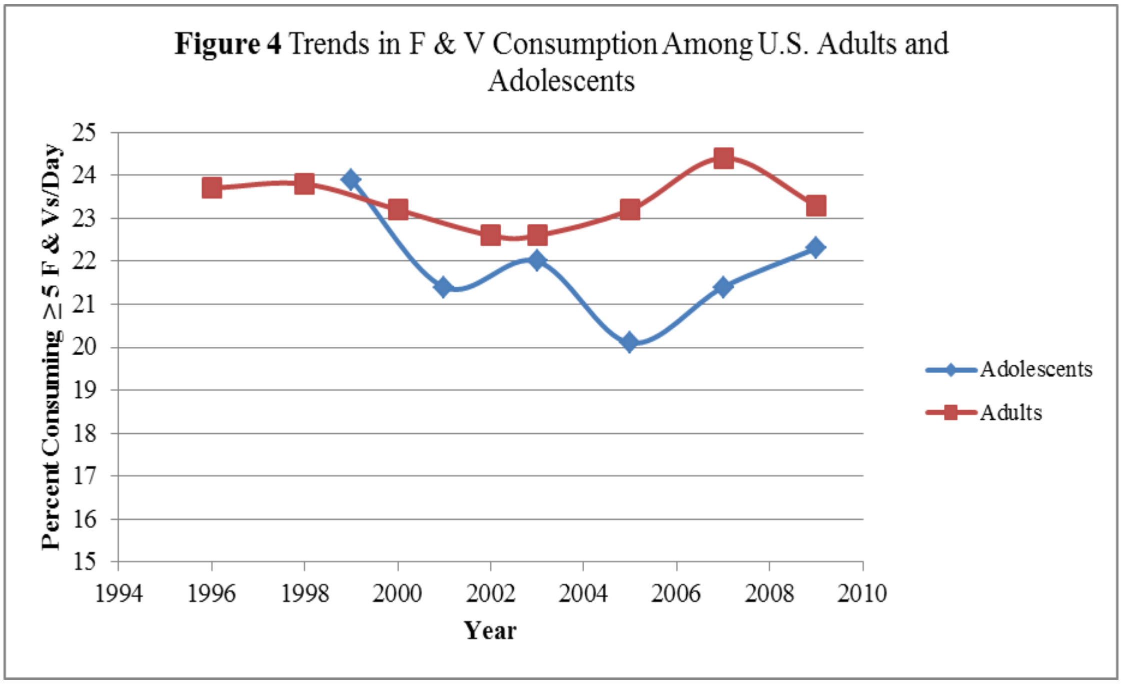
3) Fruit and Vegetable Consumption in the U.S. and Georgia Populations

The following section discusses fruit and vegetable intake among adults, adolescents, children, and pregnant and postpartum women in the U.S. and Georgia. F&V consumption is described further by age/grade, sex, race/ethnicity, education, and income for the U.S. and Georgia. Further, geographic characteristics of F&V intake are discussed.

a) Statistics

United States: Adults

Despite the importance of fruits and vegetables, consumption of F&V is low in the U.S.[1-3] Approximately one-quarter to one-third of adults meet fruit (≥ 2 fruit servings/day) and vegetable (≥3 vegetable servings/day) recommendations.[1,4] Nearly a quarter of U.S. adults consume a total of ≥5 F&V as shown in Figure 4; however, less than 15% meet the recommendation of ≥ 2 fruits and ≥3 vegetables/day.[1-3] When vegetable intake was further stratified by the *Healthy People 2010*'s objective 19-6 recommending that one-third or more vegetable servings were dark green or orange vegetables, approximately 5% of adults met this recommendation compared to around 50% consuming 3 or more daily vegetable servings.[38] The national recommendations of two or more fruit servings/day and three or more vegetable servings/day apply to people two years of age and older with any activity level.[96] Although Table 5 indicates that the number of servings of F&V is higher than the national recommendations for those who are older and more physically active, the overall national recommendation will be used in this dissertation for all participants.



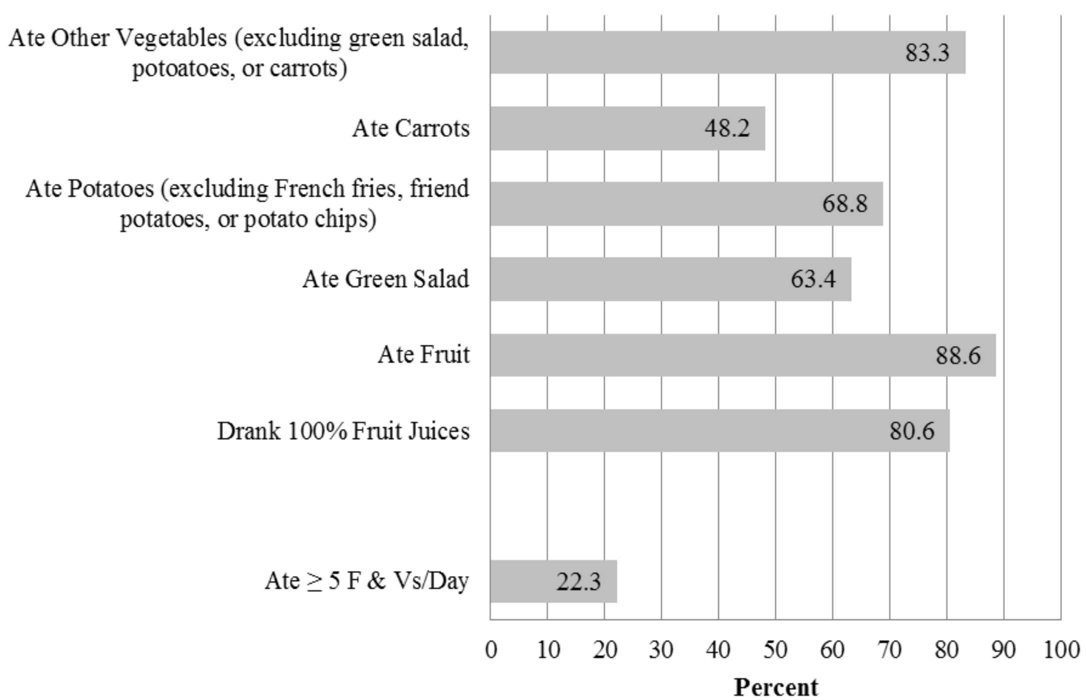
Source: [4,104]

The National Health and Nutrition Examination Survey (NHANES) 1999-2002 found that American adults meeting recommendations were as follows: 28.4% for fruits, 32.5% for vegetables, 23.6% for total F&V (≥ 5/day), and 10.8% for total F&V (≥2 fruit/day and ≥ 3 vegetable/day).[1] Data from the 2005 Behavioral Risk Factor Surveillance System (BRFSS) found that adult mean daily intakes of specific fruits and vegetables were: 0.20 for 100% fruit juice, 0.44 for fruit, 0.28 for green salad, 0.09 for carrots, 0.14 for potatoes (non-fried), and 0.86 for all other vegetables.[3] BRFSS 2007 statistics showed that more adults met the recommendations for fruits (32.8%) compared to vegetables (27.4%) and a higher percent (14.0%) met total F&V (≥2 fruits/day and ≥ 3 vegetables/day) recommendations compared to the previous NHANES data.[2,105]

United States: Adolescents

The percent meeting fruit and vegetable recommendations among adolescents in high school (9-12th grade) has been found to be lower than among adults and decreased slightly over time as shown in Figure 4.[2,4] The 2009 Youth Risk Behavior Surveillance Survey (YRBSS) of adolescent F&V intake for a seven day period found that 22.3% (95% CI: 21.1 – 23.7%) ate five or more fruits and vegetables daily, 33.9% (32.2-35.6%) ate fruit or drank 100% fruit juice two or more times daily, and 13.8% (12.9-14.8%) ate vegetables three or more times daily.[106] Further, more students drank 100% fruit juices (80.6%), ate fruit (88.6%), and ate other vegetables (83.3%) (not including green salad, carrots, and potatoes) compared to consumption of green salad, potatoes, and carrots in the past seven days as shown in Figure 5.[104]

Figure 5 Fruits and Vegetables Consumed by U.S. Adolescents, YRBS 2009



Source: [104]

United States: Children

Research has not focused on F&V consumption in young children compared to adults and adolescents. F&V intake for children often require parental reporting. This literature review will discuss the accuracy of parental report later. When F&V intake data is collected for children, the way F&V consumption is expressed varies from mean (standard error (SE)) intake as servings or cups, median (SE) intake of servings or cups, or the percent meeting the MyPyramid recommendations that are calorie specific and determined by age, sex and physical activity. Further, since the F&V recommendations (Table 5) are nearly identical for male and female children through eight years of age, many F&V statistics are not sex-specific until late childhood. F&V intake for young children is not as standardized as adolescent and adult consumption statistics and thus will not be included in tables and figures with adolescents and adults but instead a summary of a few studies' findings will be described in text.

Table 8 below summarizes NHANES data on F&V intake from 1988 to 2004 for children ≤ 11 years of age. The NHANES 1998-1994 and 1999-2002 vegetable data does include French fries[107,108], the 2001-2004 data also includes French fries, but excludes cooked dry beans and peas.[109] Overall, F&V consumption for children was below F&V recommendations with most consuming an average of one fruit serving and one to two vegetable servings daily.

Table 8 Summary of Fruit and Vegetable Intake Among Children				
Dataset	**Age of Children (years)**	**Sex**	**Fruit Servings (Mean (SE))**	**Vegetable Servings (Mean (SE))**
NHANES III (1988-1994) (1)	5 to 11	Female	1.4 (1.6)	2.3 (1.8)
		Male	1.4 (1.6)	2.5 (2.1)
NHANES 1999-2002 (2)	2 to 5	Both	1.29 (0.06)*	0.76 (0.03)*
	6 to 11		0.99 (0.05)*	0.98 (0.03)*
NHANES 2001-2004 (3)	1 to 3	Both	1.5 (0.05)	0.7 (0.02)
	4 to 8		1.1 (0.05)	0.9 (0.03)

*Cups instead of servings

Sources: (1) [107], (2) [108], (3) [109,110]

Untied States: Pregnant and Postpartum Women

F&V consumption among pregnant and postpartum women in America has not been as well documented as for non-pregnant or non-breastfeeding American women. Table 9 summarizes seven studies of F&V intake data for women during pregnancy through one year postpartum. Postpartum participants were often stratified by breastfeeding status since F&V intake recommendations for breastfeeding women include more F&V than non-breastfeeding women and breastfeeding has been found to be associated with F&V consumption.[111-113] Four of the seven studies below include low-income women.[113-116] Shah et al. used the Healthy Eating Index (HEI) to examine F&V intake[115] while three studies reported mean servings per day[113,117,118] and three articles provided the percent meeting the recommendations.[112,114,116]

Table 9 Summary of Fruit and Vegetable Intake Among Pregnant and Postpartum Women in the U.S.

1st Author (Year)	Study Description	N	Pregnancy/Postpartum Status	Fruits	Vegetables
Rifas-Shiman, SL (2006) (1)	Project Viva enrolled female prenatal patients at Harvard Vanguard Medical Associatiates	1,543	Pregnant: 1st and 2nd Trimester	Mean (SD) servings/day: 1st Trimester: 5.8 (2.9); 2nd Trimester: 5.9 (2.9); % Change in overall mean: 1.5	
Rifas-Shiman, SL (2009) (2)	Project Viva enrolled female prenatal patients at Harvard Vanguard Medical Associatiates	1,777	Pregnant: 1st Trimester	Mean (SD) servings/day: 2.9 (1.8)	Mean (SD) servings/day: 3.0 (1.8)
Watts, V (2007) (3)	North Dakota WIC recipients from 1996-2000	5,862	Pregnant: Overall	Met recommendations*: 51.4%	Met recommendations*: 22.2%
Shah, BS (2010) (4)	Low-income participants (87% WIC) were enrolled in Texas	125	Postpartum: 0 - 4 months	Mean HEI (SEM) Breastfeeding: 1.7 (0.2); Non-breastfeeding: 1.7 (0.1)	Mean HEI (SEM) Breastfeeding: 2.1 (0.2); Non-breastfeeding: 1.7 (0.2)
Fowles, ER (2006) (5)	Secondary analysis of a study examining psychosocial correlates of postpartum weight retention among new mothers in a Southwestern metropolitan community.	100	Postpartum: 3 - 6 months	Met recommendations**: 51%; Association with breastfeeding p=0.005	Met reommendation**: 24%; Association with breastfeeding p=0.008
George, GC (2005) (6)	Medicaid-eligible women were recruited 0 to 1 days after delivery at hospital and visited project site 1.5 and 6 months postpartum.	149	Pregnant: Overall	Mean servings/day: 3.4	Mean servings/day: 2.5
			Postpartum: 6 months	Overall Mean servings/day: 1.7; Met recommendations Breastfeeding: 40%, Non-breastfeeding: 30%	Overall Mean servings/day: 2.0; Met recommendations Breastfeeding: 33%, Non-breastfeeding: 17%
George, GC (2005) (7)	Medicaid-eligible women not lactating 1 year postpartum were recruited 0 to 1 days after delivery at hospital.	146	Postpartum: 1 year	Met recommendations**: 25.3%	Met reommendations**: 16.4%

* Recommendations of 2-4 servings of fruit/day and 3-5 servings of vegetables/day;

**Recommendations: ≥ 2 servings/day of fruits, ≥ 3 servings/day of vegetables

Sources: (1)[117], (2) [118], (3)[116], (4) [115], (5)[112], (6)[113], (7) [114]

Rifas-Shiman et al. found that women in their 1st trimester of pregnancy consumed a mean (SD) fruit intake of 2.9 (1.8) servings/day and vegetable intake of 3.0 (1.8) servings/day using the standard half-cup as a serving.[118] They found that overall average energy intake did not significantly vary from the 1st trimester to the 2nd trimester.[117] However, individual intakes did differ; for example, about 20% of participants increased their fruit and vegetable intake by one quartile from the 1st to 2nd trimester and about 8% increased by two quartiles.[117] Further, the mean daily servings of fruit and vegetable intake in the 1st trimester was 5.8 (SD 2.9) and 2nd trimester was 5.9 (2.9) with a 1.5% change in the overall mean between the trimesters.[117] Additionally, there was high correlation (r = 0.68) between the fruit and vegetable intake for the two trimesters. Retrospective F&V intake reports for pregnancy and 0-6 months postpartum revealed that overall fruit and vegetable intake decreased from pregnancy to postpartum with statistically significant decreases for corn (Pregnant: mean (SEM) daily servings = 0.21 (0.02), Postpartum: 0.17 (0.02)); orange juice (Pregnant: 0.59 (0.01), Postpartum: 0.30 (0.03)); apple juice (Pregnant: 0.39 (0.06), Postpartum: 0.18 (0.03)); bananas (Pregnant: 0.29 (0.04), Postpartum: 0.16 (0.02)); and other 100% fruit juices (Pregnant: 0.26 (0.05), Postpartum: 0.12 (0.03)).[113]

Additionally, Rifas-Shiman et al. found that those with fewer children had significantly lower intake of fruits (β = -0.27 (95% CI: -0.46 – - 0.07)) and non-significantly lower vegetable intake (-0.07 (-0.25 – 0.11)) compared to women with more children.[118]

Watts et al. found that among pregnant WIC recipients in North Dakota, 51.4% of the participants consumed 2-4 servings of fruit per day, yet this percentage decreased to 16.0% when juice intake was not included.[116] Further, Watts et al. indicated that 22.2% of participants consume 3-5 servings of vegetables per day, but only 9.6% meet this recommendation when potatoes were not included.[116]

Further, fruit [112,113] and vegetable [112,113,115] intake has been found to be higher among breastfeeding women compared to non-breastfeeding women, both during pregnancy and postpartum. Prenatal fruit intake was significantly higher among breastfeeding women than non-breastfeeding women ($p<0.05$).[113] Interestingly, from pregnancy to postpartum for both lactating and non-lactating women, vegetable intake increased while fruit intake decreased.[113]

Overall, pregnant women in the U.S. met fruit and vegetable recommendations [113,117,118], but postpartum women were below recommendations.[112,114] Among postpartum women, lactating or breastfeeding women had non-significantly higher fruit and vegetable intake that non-breastfeeding women.[113]

Georgia

On average, Georgia adults and adolescents consumed less F&V than the national averages except for adult vegetable intake as shown in Table 10.[2] Total F&V (≥2 fruits/day and ≥3 vegetables/day) intake among adolescents in Georgia (7.9%) was lower than that of the U.S. (9.5%).[2]

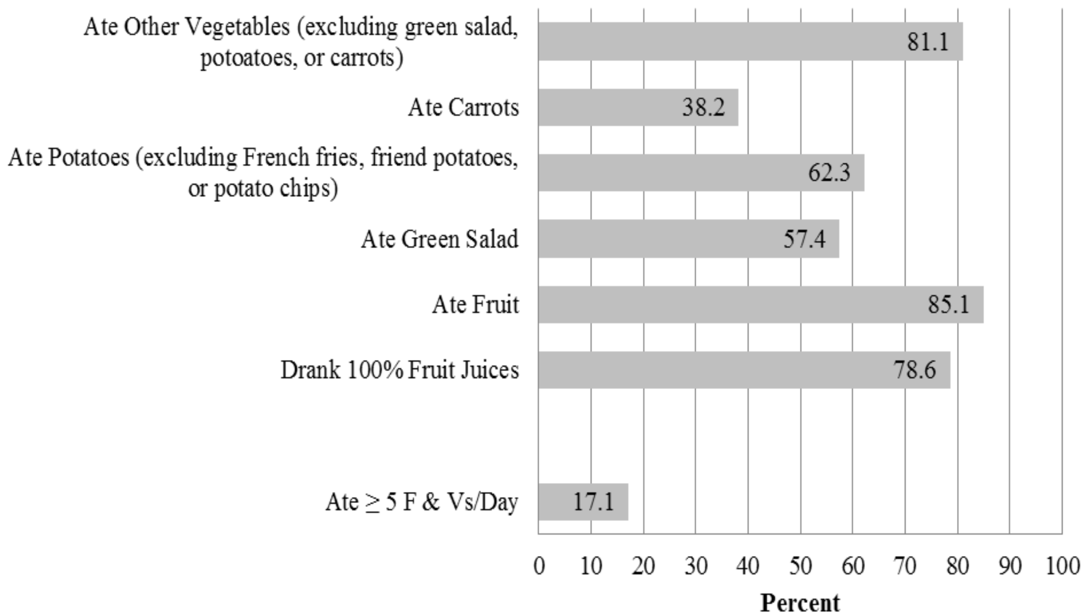
Table 10 Percent Meeting Fruit and Vegetable Recommendations in the U.S. and Georgia, 2007

	Fruit	Vegetable	Total F & V
	≥ 2 Fruits/Day	≥ 3 Vegetables/Day	≥ 2 Fruits/Day and ≥ 3 Vegetables/Day
U.S.			
Adults	32.8	27.4	14
Adolescents (9-12 Grade)	32.2	13.2	9.5
Georgia			
Adults	27.3	30.3	13.3
Adolescents (9-12 Grade)	28.9	12.6	7.9

Source: [2]

The YRBSS found that in a seven day period fewer adolescents in Georgia (17.1%) compared to the entire U.S. (22.3%) ate more than five fruits and vegetables/day as shown in Figure 6.[104,119] Further, Georgia's adolescents ate fewer of every fruit and vegetable category shown in Figure 6 than U.S. adolescents shown in Figure 5. This highlights the need for research examining why Georgia's youth consume fewer F&V and efforts to increase consumption among Georgia's youth.[2,119]

Figure 6 Fruits and Vegetables Consumed by Georgia Adolescents, YRBS 2009



Source: [119]

Similar to national data, fruit and vegetable intake among young children in Georgia is less documented than adolescents and adults. A school-based study part of the national "5 A Day – For Better Health" program found that the average servings/day of total F&V were 2.35 (SE 1.16), for fruits only 1.20 (0.86), and 1.15 (0.85) for vegetables among Georgia elementary school students aged 8-10 years.[120] When Georgia was compared to other study sites in Alabama and Minnesota, Georgia had the lowest fruit, vegetable, and total F&V intake levels.[120]

b) Epidemiology of Low Fruit & Vegetable Consumption in the U.S.

F&V intake is low in the overall U.S. population and groups with the lowest F&V consumption among adult males, adolescent females, African American adults, White adolescents, less educated, and lower-income.[4,104]

i) Age

Overall F&V intake has been found to generally increase from young to older adults as shown in Table 11.[1,3,38,93,105,121] From 1996 to 2009, F&V consumption decreased among individuals 55 years of age or older and slightly increased among adults less than 54 years of age. F&V intake among adolescents has decreased with increasing age of the adolescent.[104] The percent meeting total F&V (≥ 5/day) recommendations decreased for adolescents in 9th grade (23.0%) to 12th grade (20.8%) as shown in Table 11.[104] Fruit and vegetable intake appears to have decreased slightly from 1999 to 2009 among adolescents of all grade levels.[104]

Table 11 Trends in Fruit and Vegetable Consumption By Age/Grade in the U.S.

	Consume ≥ 5 F & Vs/Day						
		1999	**2001**	**2003**	**2005**	**2007**	**2009**
Adolescents							
9th Grade		25.6	23.6	23.3	21.3	23.7	23.0
10th Grade		23.1	21.0	23.0	21.4	22.4	22.6
11th Grade		23.1	20.3	21.4	18.8	19.9	22.3
12th Grade		23.5	20.2	19.5	18.3	18.6	20.8
	Consume ≥ 5 F & Vs/Day						
	1996	**1998**	**2000**	**2003**	**2005**	**2007**	**2009**
Adults							
18-24	19.6	20.1	21.6	20.4	21.0	23.0	20.2
25-34	20.0	20.0	19.2	19.5	21.7	23.5	22.5
35-44	20.9	21.7	20.0	20.7	20.1	22.0	21.4
45-54	22.2	23.1	22.2	22.5	22.4	23.1	22.9
55-64	26.2	25.1	26.9	23.6	24.8	24.9	24.3
65 +	32.7	33.4	32.0	29.8	31.0	28.7	27.5

Source: [4,104]

The total fruit intake for children using NHANES 2001-2004 data expressed as mean (SE) in cups was 1.5 (0.05) 1-3 year olds, 1.1 (0.05) for 4-8 year olds, and 1.0 (0.05) for 9-13 year olds.[110] Total vegetable intake for children described as mean (SE) in cups was 0.7 (0.02) for 1-3 year olds, 0.9 (0.03) for 4-8 year olds, 1.2 (0.06) for 9-13 year old males and 1.1 (0.04) for females.[109] Two studies found similar results in that fruit intake decreased from preschool age (2-5 years) to high school age (14-18 years) while vegetable intake steadily increased as age increased.[38,108]

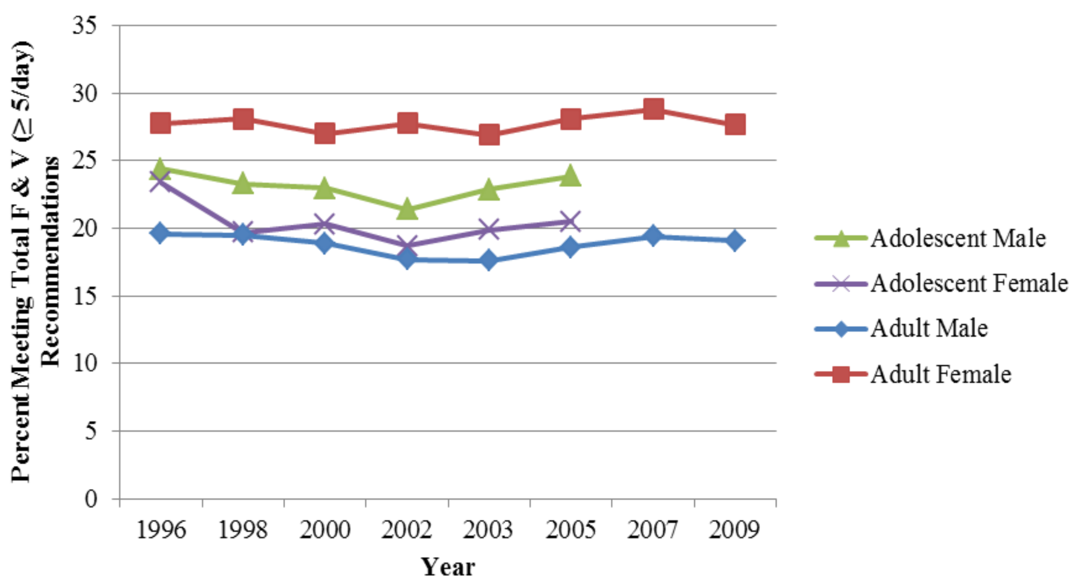
Among pregnant women in their 1st trimester, those who were older had significantly higher intake of vegetables (β = 0.34 (95% CI: 0.20 – 0.48)) and non-significantly higher fruit intake (0.13 (-0.02 – 0.28)) than those who were younger.[118] Another study including pregnant women in all trimesters found that the percent meeting the vegetable recommendation significantly increased with age (<20 years: 63.9%, 20-30: 70.7%, >30: 80.3%) while the percent meeting the fruit recommendation significantly decreased with increasing age (<20 years: 123.8%, 20-30: 115.0%, >30: 114.6%).[116] Among women 0 to 4 months postpartum, vegetable intake increased with age (18-24 years: HEI score mean (SEM) = 1.5 (0.2), 24-30 years: 1.6 (0.2), 30-40 years: 2.6 (0.3), but fruit intake was higher among 18-24 and 30-40 year olds and lowest among 24-30 year olds.[115]

ii) Sex

Some studies indicate that fewer American men meet F&V recommendations compared to women [3,4,93,105,122] as shown in Figure 10, while others show the opposite.[1,38,121,123] For example, one study found that more White men, but not African American men, met vegetable recommendations compared to women (White male = 31%, African American male = 21%; White female = 25%, African American female = 27%).[121] On the other hand, White women, but not African American women, met the fruit recommendations more than men (White male = 26%, African American male = 21%; White female = 32%, African American female = 24%).[121]

Among adolescents, total F&V intake was higher among males than females as shown in Figure 7.[4,107,108,124,125] One study using NHANES 1999-2002 data found that the total fruit intake (mean (SE) cups/day) for children 2-18 years of age was 1.07 (0.05) for males and 0.98 (0.04) for females and total vegetable intake was 1.10 (0.03) for males compared to 0.98 (0.03) for females.[108] Among all 5-11 year olds, mean (SD) fruit intake was 1.4 (1.6) servings/day and vegetable intake was 2.5 (2.1) vegetable servings/day for males and 2.3 (1.8) vegetable servings/day for females.[107] In 2009 YRBS, 35.3% of male high school students met fruit recommendations and 14.5% did so for vegetable recommendations compared to female students at 32.2% and 13.0% respectively.[124] On the contrary, total F&V (≥ 5 servings/day) intake among children aged 9-14 years was slightly higher among females (23.2%) than males (22.2%).[66] Fruit and vegetable consumption among male and female adults and adolescents appears fairly constant over time (Figure 7).

Figure 7 Trends in F & V Intake by Sex for Adolescents and Adults, U.S.



Source: [4,104]

iii) Race/Ethnicity

Most studies found that adult F&V intake is lower among African Americans and Hispanics compared to Whites as shown in Table 12[1,4,38,93,121-123,126,127]; yet some studies indicated the reverse.[105,122,125,126] For example, White adults had higher intake of fruits (Whites: 35.1%, African Americans: 31.2%) and vegetables (Whites: 28.6%, African Americans: 23.7%) than African American adults.[105,126] On the other hand, another study found that 21.5% of African American adults consumed five or more F&V daily, yet 19.5% of Whites met F&V recommendations.[122] From 1996 to 2009, F&V intake among African Americans increased as shown in Table 12.[4]

Among adolescents, the percent meeting total F&V recommendations (≥ 5/day) was lower for Whites (20.5%) and Hispanics (22.0%) than African Americans (26.6%) as shown in Table 12.[125,128] Specifically, the percentage consuming fruit or 100% fruit juices two or more times/day for Whites was 32.2%, African Americans 37.3% and Hispanics 34.1%.[125] Similar results were found for the percentage consuming vegetables three or more times/day with 12.8% for Whites, 14.3% for African Americans, and 13.7% Hispanics.[125] Total fruit and vegetable consumption among children and adolescents (2-18 years) was highest among Hispanics and lowest among non-Hispanic Whites.[108] For instance, fruit intake expressed as mean (SE) cups/day was 1.00 (0.05) for non-Hispanic Whites, 1.05 (0.04) for non-Hispanic African Americans, and 1.16 (0.04) for Mexican Americans.[108]

Table 12 Trends in Fruit and Vegetable Consumption by Race/Ethnicity in the U.S.								
			1999	**2001**	**2003**	**2005**	**2007**	**2009**
Adolescents								
White			22.5	20.2	20.5	18.6	18.8	20.5
African American			27.8	24.5	23.2	22.1	24.9	26.6
Hispanic			24.0	23.2	24.4	23.2	24.0	22.0
Other			24.9	24.7	26.9	22.8	28.2	NA
	1996	**1998**	**2000**	**2002**	**2003**	**2005**	**2007**	**2009**
Adults								
White	24.1	24.3	23.5	23.3	22.9	23.5	24.5	24.1
African American	18.9	18.0	21.3	21.2	21.1	21.5	23.1	21.2
Hispanic	20.1	20.6	22.4	21.1	20.5	20.4	22.6	21.6
Other	23.2	21.0	21.8	26.3	25.7	26.0	26.6	23.6

Source: [4,104]

Among pregnant women in their 1st trimester, fruit intake was significantly higher for those who were African American (β = 0.60 (95% CI: 0.19 – 1.01)) and non-significantly higher for those considered "Other" race (0.36 (-0.00 – 0.72)) compared to Whites.[118] Vegetable intake was non-significantly lower for African Americans (β = -0.09 (-0.48 – 0.30)) and non-significantly higher for those considered "Other" (0.20 (-0.14 – 0.54)) compared to Whites.[118] Another study that included pregnant women in all trimesters found that the percent meeting fruit recommendations was higher among Whites (117.9%) than Native Americans (109.8%), yet the reverse was true for vegetable intake (Whites: 70.4%; Native Americans 74.1%).[116] Among women 0 to 4 months postpartum, Whites and Hispanics had higher fruit intake compared to African Americans (HEI score mean (SEM): Whites: 1.8 (0.2), African Americans: 1.4 (0.4), Hispanics: 1.7 (0.1).[115] The opposite was true for vegetable intake with African Americans having higher intake (HEI score mean (SEM): 2.5 (0.5)) than Whites (1.5 (0.3) and Hispanics (2.0 (0.1)).[115]

iv) Education Level

Individuals with a lower education level tend to have lower F&V intake than those with a higher educational attainment as shown in Table 13.[1,3,4,93,105,123,126,127] One study examined fruit and vegetable intake separately and found the percentage meeting vegetable recommendations showed an increasing trend from 20.5% for those with less than a high school diploma , 22.3% for high school graduates, 27.9% for some college, and 33.3% for college graduates.[105] High school graduates (29.4%), those with some college education (30.6%), and college graduates (37.4%) showed an increasing trend as well for fruit intake, but individuals with less than a high school education also had a high percentage meeting fruit recommendations (32.0%).[105] As shown in Table 13 findings were consistent over time in that fewer individuals met the total F&V recommendations in lower education levels than in higher levels.

Table 13 Trends in Fruit and Vegetable Consumption by Education in the U.S.

	Consume ≥ 5 F & Vs/Day							
	1996	**1998**	**2000**	**2002**	**2003**	**2005**	**2007**	**2009**
Less than High School	18.8	19.5	20.0	19.2	18.2	18.7	18.4	18.3
High School or G.E.D.	20.9	21.5	19.6	18.9	18.9	19.0	19.9	19.5
Some post-High School	24.3	23.8	24.1	22.8	22.9	23.6	24.5	23.2
College Graduate	28.9	29.2	27.9	28.5	28.2	29.2	29.8	28.3

Source: [4]

Among pregnant women in their 1st trimester, fruit intake was non-significantly lower for those with less than a high school diploma or a high school diploma (β = - 0.20 (95% CI: - 0.68 – 0.28)) and those with some college education (- 0.15 (- 0.49 – 0.18)) compared to college graduates.[118] Vegetable intake was significantly lower for those with less than a high school diploma or a high school diploma (β = - 1.11 (95% CI: - 1.57 – - 0.66)) and those with some college education (- 0.44 (- 0.76 – - 0.12)) compared to college graduates.[118] Among women 0 to 4 months postpartum, fruit intake was highest among those with a partial high school education (HEI score mean (SEM): 1.9 (0.3)) and those with a partial college education (1.8 (0.1)) compared to high school graduates (1.4 (0.2)).[115] There was a non-significant increasing trend for vegetable intake by increasing education levels (HEI score mean (SEM): Partial high school: 1.6 (0.3), high school graduate: 1.9 (0.3), partial college: 2.0 (0.2).[115]

v) Income Level

Total F&V intake tends to be lower among those considered at a low-income level compared to individuals with higher-incomes as shown in Table 14.[1,4,38,105,123,127,129] For example, one study using NHANES 1999-2002 data reported that the average daily intake of total F&V in cups was 1.43 for low-income, 1.54 for middle-income, and 1.72 for high-income.[129] A few studies found that the lowest income level had slightly higher fruit [105] or total F&V intake [4] than the second lowest income level. As shown in Table 14, the trends in F&V intake by income level have slightly decreased from 1996 to 2009.

Table 14 Trends in Fruit and Vegetable Consumption by Annual Income in the U.S.

	Consume ≥ 5 F & Vs/Day							
	1996	**1998**	**2000**	**2002**	**2003**	**2005**	**2007**	**2009**
< $15,000	21.2	21.5	22.3	23.0	20.7	21.0	20.7	20.6
$15,000 - 24,999	22.2	21.6	21.9	22.2	21.3	22.1	21.7	21.0
$25,000 - 34,999	22.2	22.7	21.7	21.0	22.1	22.8	22.5	22.0
$35,000 - 49,999	23.9	23.3	22.2	21.9	21.1	22.4	23.2	22.2
≥ $50,000	26.6	25.6	24.5	24.4	24.0	24.9	26.1	25.2

Source: [4]

NHANES 1988-1994 data for preschool-age (2-4 years) children reported HEI scores for various food groups and dietary components. The fruit HEI score for all children was 6.2 and the score was highest for higher income non-WIC participants at 6.9.[130] Among children who were income-eligible for WIC, the HEI score for fruit was higher for WIC participants (6.4) than those who were non-participants (5.3).[130] Vegetable HEI scores did not follow similar trends as fruit HEI scores. Overall vegetable HEI score was 5.0 and income-eligible non-WIC participants had the highest vegetable HEI score of 5.3 followed lower HEI scores for WIC participants (5.1) and higher income non-WIC participants (4.8).[130]

NHANES 1999-2002 data indicated that fruit intake (mean (SE) cups) was significantly higher among children and adolescents (2-18 years) with a family income > 350% of the federal poverty level (1.17 (0.04)) compared to those < 130% of the federal poverty level (0.99 (0.06)).[108] However, a similar trend was not shown for vegetable intake (>350%: 1.08 (0.04) vs. < 130%: 1.05 (0.03)).[108]

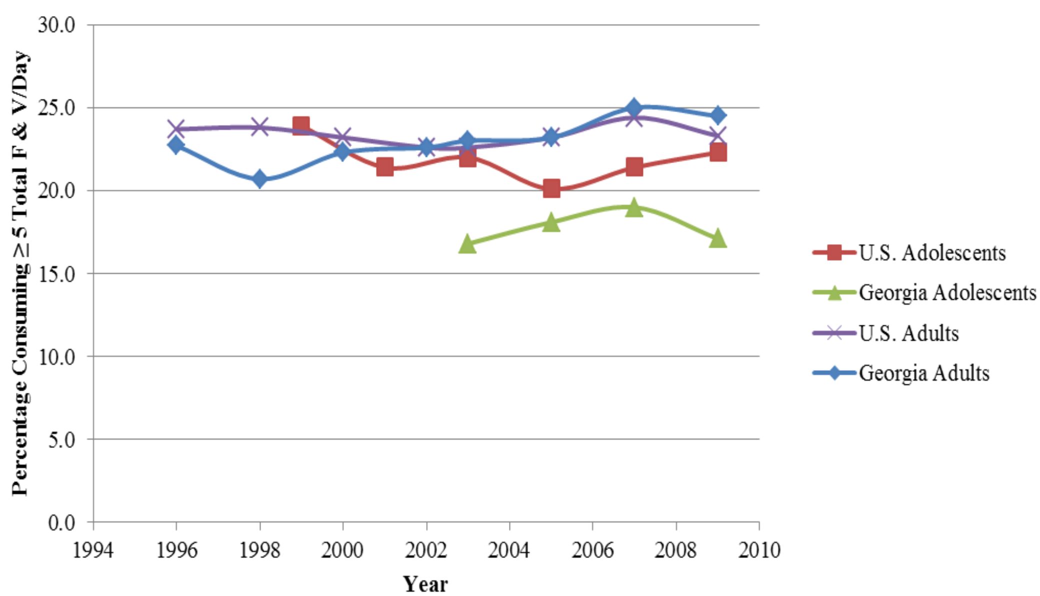
Specifically among pregnant women, NHANES III data (1988-1994) found that WIC recipients met the fruit recommendation of two or more servings of fruit daily, but were just under the vegetable recommendation of three or more servings per day.[131] Similarly, participants who were above 185 % of the poverty level and thus not income eligible for WIC had similar fruit intake as WIC recipients, but slightly higher vegetable intake.[131] Yet, participants who were income eligible for WIC, but were not WIC recipients had the lowest fruit and vegetable intake of all 3 groups.[131] Another study including pregnant WIC recipients found that as the percent above the poverty level increased, the percent meeting the vegetable intake increased significantly (<100%: 69.9%, 100-133%: 70.6%, 133-185%: 72.8%) but a similar trend was not shown for fruit intake.[116]

Among women 0 to 4 months postpartum, fruit intake varied little among each household income level (HEI score mean (SEM): < $15,000: 1.8 (0.2), $15,000-29,999: 1.6 (0.2), $30,000-44,999: 1.7 (0.3).[115] However, vegetable intake increased with increasing household income levels (HEI score mean (SEM): <$15,000: 1.7 (0.3), $15,000-29,999: 1.9 (0.2), $30,000-44,999: 2.0 (0.3).[115]

c) Epidemiology of Low Fruit and Vegetable Consumption in Georgia

In Georgia, F&V intake among adolescents was lower than for the overall adolescent United States Population as shown in Figure 8 below.[104] However, F&V intake among Georgia adults surpassed the national adult consumption levels in 2007 and 2009.[4]

Figure 8 Percentage of Adults and Adolescents Meeting F & V Recommendations, U.S. and Georgia



Sources: [4,104]

i) Age

The Georgia population did not show similar trends in F&V consumption by age/grade as was found for the national population as shown in Table 15 below.[4,104] For example, the percentage consuming five or more F&V daily did not show a trend of decreasing percentage with increasing grade among Georgia adolescents.[104] Among Georgia adults, no trend can be established as the percentages are too varied year to year; however, in 2009 more 35-54 year olds and those 65 years or more were meeting recommendations than those 25-34 years or 55-64 years.[4]

Table 15 Trends in Fruit and Vegetable Consumption By Age/Grade in Georgia

	Consume ≥ 5 F & Vs/Day						
	1996	**1998**	**2000**	**2003**	**2005**	**2007**	**2009**
Adolescents							
9th Grade				17.1	17.0	17.5	18.2
10th Grade				17.3	18.9	21.5	18.7
11th Grade				15.9	19.3	19.0	15.1
12th Grade				16.9	17.4	17.9	16.0
Adults							
18-24	20.4	20.7	25.1	25.2	22.7	28.1	NA
25-34	25.0	19.3	19.6	19.8	21.0	23.5	21.0
35-44	18.6	17.4	19.1	21.5	20.1	25.2	26.3
45-54	20.9	23.1	21.0	24.2	25.8	24.9	24.0
55-64	26.4	25.2	22.4	25.4	23.5	23.3	22.5
65 +	27.1	21.2	30.0	23.7	28.6	27.1	24.0

Sources: [4,104]

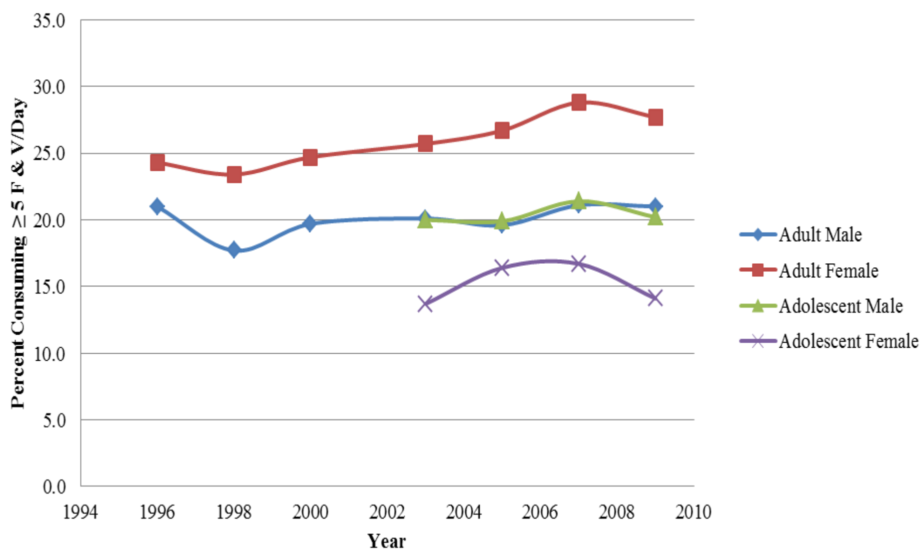
In comparison of U.S. and Georgia children, fruit and total F&V intake was significantly higher among African Americans compared to Whites in Georgia and this is consistent with national results (Total F&V: 2.67 for African American children (8-10 years) vs. 2.28 for Whites ($P<0.05$), Fruits: 1.40 vs. 1.16 ($P<0.10$).[120] Vegetable intake was not significantly higher among African American (1.26) compared to Whites (1.13).[120] Additionally, fruit, vegetable, and total

F&V intake was significantly lower among elementary school age (8-10 years) males compared to females (total F&V = 2.25 for males vs. 2.43 for females; p-value < 0.05) which is the opposite of national findings.[120]

ii) Sex

Fruit and vegetable intake by sex among Georgia residents indicates that adult females have the highest percent meeting F&V recommendations as shown in Figure 9.[4,104] Adult females had the highest percentage meeting recommendations for the overall U.S. population also as shown above in Figure 7.[4] Interestingly, Georgia's adolescent females have the lowest F&V intake and adult and adolescent males have similar intake as shown in Figure 9.[104] Compared to the U.S. population (Figure 7), fewer of Georgia's adolescent males and especially females meet the F&V recommendations.[104]

Figure 9 Trends in F & V Intake by Sex for Adolescents and Adults, Georgia

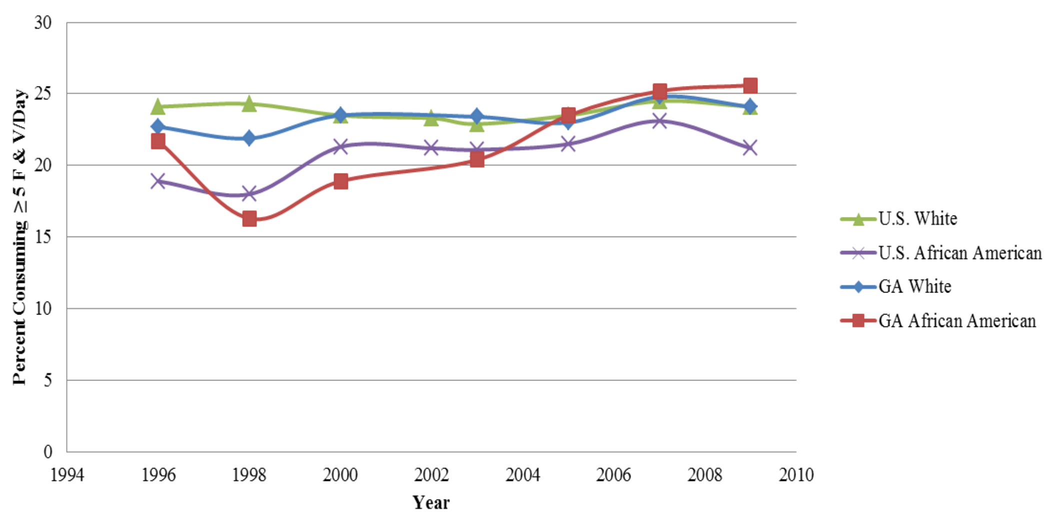


Sources: [4,104]

iii) Race/Ethnicity

Fruit and vegetable intake was similar among U.S. and Georgia White adults from 1996 to 2009 as shown in Figure 10.[4] More African American adults in the overall U.S. compared to Georgia were meeting F&V recommendations from 1998 to 2003; however the percentage of Georgia African Americans surpassed that of U.S. African Americans in 2004 and has continued to rise.[4] Additionally, U.S. Whites total F&V intake has been than U.S. African Americans; yet Georgia African Americans rose above Georgia Whites in 2005.[4]

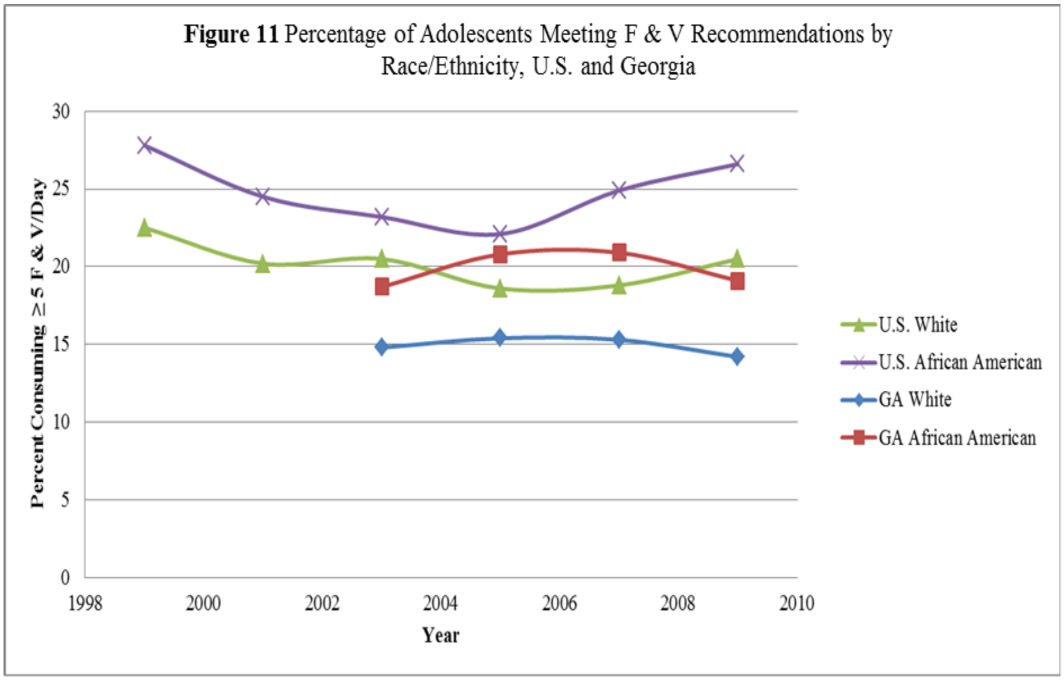
Figure 10 Percentage of Adults Meeting F & V Recommendations by Race/Ethnicity, U.S. and Georgia



Source: [4]

African Americans in the overall U.S. and Georgia had more adolescents meeting the F&V recommendations than Whites a shown in Figure 11.[104] However, Georgia Whites and Georgia African American adolescents had lower F&V consumption than U.S. Whites and U.S. African Americans.[104] Further, the percentage meeting F&V recommendations has increased among U.S.

White and African American adolescents since 2006, but the opposite is true for Georgia adolescents.[104]



Source: [104]

iv) Education

The percentage of Georgia residents meeting total F&V recommendations increases with increasing education level as shown below in Table 16.[4] From 1996 to 2009, the percentage consuming five or more F&V per day has decreased from 18.2 to 14.7 for those with less than a high school education as shown in Table 16.[4] Those with a high school or some post-high school education have increased from 1996 to 2009.[4] Compared to the overall U.S. population (18.3%) as shown in Table 13 above, fewer of Georgia residents with less than a high school education met the F&V recommendations in 2009 (14.7%).[4] However, more Georgia residents with a high school or some post-high school education met F&V recommendations in 2009 than did those in the overall U.S. population with these educational levels as shown in Table 10.[4]

Table 16 Trends in Fruit and Vegetable Consumption by Education in Georgia							
	Percentage Consuming ≥ 5 F & Vs/Day						
	1996	**1998**	**2000**	**2003**	**2005**	**2007**	**2009**
Less than High School	18.2	13.3	18.1	15.3	16.3	16.2	14.7
High School or G.E.D.	18.7	16.7	18.3	20.6	20.3	19.3	22.4
Some post-High School	23.7	24.9	22.8	21.4	24.8	26.2	25.7
College Graduate	28.4	26.3	28.7	29.8	27.9	30.8	28.3

Source: [4]

v) Income

The percentage of Georgia adults meeting F&V recommendation in Table 17 does not show a consistent pattern of increasing percentage with increasing income as was shown with the overall U.S. population shown in Table 14 above.[4] However, the highest income level (≥ $50,000) did always have the highest percentage meeting recommendations.[4]

Table 17 Trends in Fruit and Vegetable Consumption by Income in Georgia							
	Percent Consuming ≥ 5 F & Vs/Day						
	1996	**1998**	**2000**	**2003**	**2005**	**2007**	**2009**
< $15,000	23.2	18.9	19.7	17.7	19.9	19.4	22.2
$15,000 - 24,999	20.5	15.8	19.6	20.0	18.5	22.5	24.5
$25,000 - 34,999	24.3	20.3	19.7	20.9	23.7	22.9	22.1
$35,000 - 49,999	20.6	21.9	22.3	22.8	22.5	25.0	21.3
≥ $50,000	24.8	25.1	25.1	25.9	24.9	28.0	25.7

Source: [4]

d) Geographic Characteristics of Fruit and Vegetable Intake in the U.S. and Georgia

Geographically, American adults residing in Western states, Northeastern states, and Florida had higher intake of fruit (≥2 fruits/day) and total F&V (≥2 fruits/day and ≥3 vegetables/day).[2] However, the highest percentage of adults meeting vegetable recommendations was concentrated in the Southeast along with Texas and Arizona in 2007.[2]

Geographical findings for adolescents in high school (9 – 12th grade) were not reflective of that for adults.[106] Moderate percentages (25.8 – 28.3% for fruit and 11.0-12.3% for vegetables) of adolescents consuming fruit and vegetable recommendations include most states in which data was available in 2009.[106] States with the highest percentages for fruit (31.8 -35.0%) and total F&V (≥5/day) intake among adolescents were primarily states in the South Central region of the U.S. including Texas, Arizona, Colorado, and Louisiana.[106]

Although geographic trends in F&V consumption by county are not available for Georgia, Georgia is located in the South region of the U.S. that has lower total F&V intake and fruit intake, but moderately high vegetable intake.[2]

4) Increased Attention on Fruit and Vegetable Consumption

This section describes how F&V intake, access to F&V, and childhood obesity have been at the forefront of national goals, programs, and policies in recent years.

Rising trends in obesity, especially among children, and F&V consumption below *Healthy People 2010* target goals led the Obama administration to increase the public's awareness of childhood obesity.[28] The administration outlined an action plan in the May 2010 White House Task Force on Childhood Obesity to reduce the prevalence of childhood obesity to 5% by 2030, "in a generation."[28]

The Task Force on Childhood Obesity will further help implement and track progress for specific benchmarks of First Lady Michelle Obama's *Let's Move!* Program.[28,132] *Let's Move!*, is a nationwide campaign targeting unhealthful dietary practices and childhood obesity launched in February 2010.[132] The key components of *Let's Move!* include: 1) early childhood (e.g. prenatal care and breastfeeding), 2) providing parents and caregivers with information and tools to make healthy choices, 3) improving the quality of healthy food in schools, 4) encouraging more physical activity, and 5) eliminating "food deserts" by increasing access to affordable, healthy foods.[28,132]

Further, Michelle Obama's agenda of promoting healthier eating habits has included an organic vegetable garden in the South Lawn of the White House.[132,133] The first family along with White House staff and a class of Bancroft Elementary School fifth graders planted 55 vegetable varieties, berries, and herbs in Spring of 2009.[133] While, the Obama family and distinguished guests will enjoy consuming the garden's fruits and vegetables, the garden's primary function is to "educate children about healthful, locally grown fruit and vegetables."[133] The First Lady hopes her family's garden will encourage others to plant their own garden, take part in an urban community garden or make changes such as "eliminating processed food, trying to cook a meal a little more often, trying to incorporate more fruits and vegetables" if people lack the time or resources for gardening.[133]

In addition to individual education and state and national campaigns on fruit and vegetable recommendations, there have been environmental and policy strategies for improving access to fruits and vegetables. For example, methods of improving access to retail venues that sell or increase the availability of fruits and vegetables have been described in "The CDC Guide to Fruit and Vegetable Strategies to Increase Access, Availability and Consumption.[134] Additionally there has been increased expansion of farm to institution programs and farmers markets such as the Fresh Fruit and Vegetable Program (FFVP) for schools.[134,135]

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Chapter 2: Project 1 Maternal Nutrition Knowledge and Competencies and Fruit and Vegetable Intake of Mother and Child

1) Motivations and Purpose of Project 1

This section describes the motivations, aims, and specific objectives for Project 1 of this dissertation. Project 1's contributions to this research and the skills developed during participation in the Emory WIC FMNP Study and completion of Project 1 are also discussed.

a) Motivations

Fruits and vegetables (F&V) provide essential nutrients for growth and development in children, adolescents and adults. Diets rich in F&V have been shown to prevent certain types of cancer and reduce risks for cardiovascular diseases, Type II diabetes, and obesity.[1-4] Despite the importance of F&V, consumption of recommended amounts of F&V is low in the United States.[5-7] The Healthy People 2010 objectives aim for at least 75% of Americans to eat two or more daily servings of fruit, and for at least 50% of Americans to eat three or more servings of vegetables daily.[8] However, data from 2009 indicate that only 32.5% of adults meet the recommendation for fruit consumption and 26.3% eat the recommended number of servings of vegetables.[9]

F&V intake is dependent on numerous factors, including financial means to purchase F&V and nutrition knowledge and competencies about F&V. Since F&V consumption is generally lower among low-income individuals[6,10], the understanding of factors associated with F&V intake among individuals with low incomes, specifically recipients in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) program, is of specific interest in this project. Analyzing the impact of WIC programs on mother-child dyads is particularly important since approximately 32% of all years children under 5 years of age in the U.S. participated in WIC in 2009.[11,12] Mother-child dyads are defined as a mother and one of her children. Specifically in Georgia, 31% of all 1-4 year olds were WIC recipients in 2007.[13]

In addition to receiving WIC food vouchers for specific food items, WIC recipients are required to attend nutrition education classes and have the opportunity to participate in the WIC Farmers' Market Nutrition Program (FMNP). During the growing season, WIC recipients receive $10 to $30 worth of FMNP coupons to purchase fresh F&V from a local farmer and they have an additional opportunity to learn about fruits and vegetables through this program. WIC clinics vary in terms of the nutrition education content and administration of the FMNP. The impact of the Georgia WIC FMNP on nutrition knowledge and competencies about F&V and fruit and vegetable consumption of mother-child dyads has never been formally evaluated.

b) Aims and Specific Objectives

The aims of project 1 are to explore how nutrition knowledge and competencies about F&V are related to F&V intake among women and children WIC recipients who did not participate in the FMNP compared to WIC recipients who participated in the FMNP in metropolitan Atlanta.

Specific objectives of project 1 are to:

First, describe demographic characteristics and WIC FMNP use, stratified by FMNP participation.

Second, describe nutrition knowledge and competencies about F&V and any differences in these after the WIC FMNP.

Third, describe the mother's and child's F&V intake at baseline, one-week, and four-week surveys, stratified by FMNP participation.

Fourth, determine whether changes in nutrition competencies following the FMNP increase F&V intake from baseline.

Fifth, determine whether baseline nutrition knowledge is related with baseline F&V intake for mother or child, controlling for demographic characteristics and potential confounders.

c) Study Contributions

Project 1 of this dissertation research will provide at least five contributions to research examining F&V consumption. First, this dissertation will advance my understanding of factors that influence F&V consumption in the WIC population. Second, this research is the first to evaluate the Georgia WIC FMNP, specifically the program's impact on F&V intake of both mother and child and on nutrition knowledge and competencies about F&V. Third, this project will be the first to report the child's F&V intake among WIC recipients participating in the FMNP. Fourth, this project will be the second to assess the impact of the WIC FMNP on both F&V intake of the mother and the mother's nutrition knowledge and competencies about F&V. Fifth, the Emory WIC FMNP study participants were all African American postpartum WIC recipient women and/or women who had a child WIC recipient. Since only one other study in the existing literature has included only African American women, in which all were pregnant, my study will gain information about post-partum African American women.

d) Skills Developed

I was involved in the Emory WIC FMNP Study during all phases of the study including: organization, questionnaire development, data collection, and data entry stages. I also participated in project team meetings. I gained experience designing questionnaires and incorporating nutrition knowledge and competencies about F&V questions. I participated in nearly all baseline survey interviews at both WIC Clinics and completed some 4-week follow-up phone surveys. I was the only data enterer for the WIC surveys for the Non-FMNP and FMNP groups (baseline (n=172), 1-week (n=125), and 4-week (n=126)).

1) Literature Review

WI

Project 1's study population includes WIC recipients who are either post-partum women, mothers of child recipients, and children recipients attending WIC clinics in the metropolitan area of Atlanta, Georgia. Therefore, this section describes the history of the WIC program, enrollment criteria and the classification system, and WIC benefits including: food vouchers for the supplemental food package, education on nutrition, and referrals for health care and other social services. Further, food vendors that accept WIC food vouchers and the WIC FMNP are discussed. Details about the WIC program and WIC FMNP in Georgia, with specific statistics for Fulton and DeKalb counties, are described.

a) WIC

i) Motto

"To safeguard the health of low-income women, infants, and children up to age 5 who are at nutrition risk by providing nutritious foods to supplement diets, information on healthy eating, and referrals to health care."[14]

ii) History

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) stemmed from the Commodity Supplement Food Program in the United States in the 1960s as a national response to target malnutrition among not only America's poor, but more specifically among low-income pregnant women and young children.[15] The Commodity Supplement Food Program was established by the United States Department of Agriculture (USDA) for low-income pregnant women, infants, and children under six years of age.[16] However, this program's commodities were found to not be fulfilling the nutritional requirements of this special population.[16]

Therefore, in 1968 a group of physicians partnered with the USDA and the Department of Health, Education, and Welfare to establish food commissaries in which a physician would write a prescription for the specific foods the woman and/or children attending his/her clinic were lacking in their diet.[16] The woman could purchase these foods with the prescriptions at the commissaries.[16] A similar program involving physicians was developed by Dr. David Paige of Johns Hopkins University during this same time period and his program later became the model for the WIC pilot program.[16] The pilot program, called the Special Supplemental Food Program for Women, Infants, and Children (WIC), was formally authorized on September 26, 1972 as a two-year pilot.[16] The pilot program included pregnant women, postpartum women who were only breastfeeding, and children up to 4 years of age.[16] The pilot fulfilled the need for essential nutrients the women and children were lacking in their diets, but it had not yet incorporated nutrition education sessions or referrals to health care and other social services.[16]

WIC was established as a permanent program, the Special Supplemental Food Program for Women, Infants, and Children, on October 7, 1975.[16] WIC services were extended to children up to five years of age and women who were six months postpartum and no longer breastfeeding.[16] Eligibility requirements included low-income, although not yet defined, and women and children who were at nutritional risk as decided by medical doctors, nurses, and other health professionals.[16] If eligible, recipients received supplemental foods high in specific nutrients such as protein, vitamins A and C, iron, and calcium; these nutrients were historically known to be deficient in dietary patterns and food intake of people at nutritional risk.[16] Further, recipients sometimes received nutrition education, but this was not yet required.[16]

The WIC program became more defined and specialized for its target population in 1978 with detailed definitions for eligibility requirements of nutritional risk and income.[16] WIC clinics were then required to provide nutrition education and referrals to health care while other social services were still sometimes available to WIC recipients.[16]

The WIC supplemental food package was designed to supplement the diet of WIC recipients with specific nutrients found to be lacking in their diets and thus it was not meant to be the main food source.[15] Therefore, WIC program recipients can still remain eligible for other social services such as Medicaid, Supplemental Nutrition Assistance Program (SNAP) formerly known as Food Stamps, Temporary Assistance to Needy Families (TANF), and Aid to Families with Dependent Children.[16] The 1989 Child Nutrition and WIC Reauthorization Act helped streamline the WIC application process by creating the same income eligibility for Medicaid, Food Stamps, WIC, and Aid to Families with Dependent Children (AFDC).[16] For example, in 2006, 66% of WIC recipients at the time of their WIC certification were obtaining benefits from at least one of the following programs: SNAP, Medicaid, TANF.[16]

Additionally in 1989, legislators decided to expand WIC's supplemental foods to include seasonal coupons valued at $10-$20 for fresh fruits and vegetables grown by local farmers.[16] This three-year grant program established in ten states was called the Farmers' Market Coupon Demonstration Project.[16] The success of this grant program led to the permanent WIC Farmers' Market Nutrition Program (WIC FMNP) in 1992.[16]

In 1994, the Healthy Meals for Healthy Americans Act altered WIC's name to the Special Supplemental Nutrition Program for Women, Infants, and Children, emphasizing the nutritional basis of WIC.[16] Eligibility was defined by "residence" in the William F. Goodling Child Nutrition Reauthorization Act of 1998 which stated that WIC applicants must by physically present during certification with proof of residency and income.[16] Further, the criteria for nutritional risk which were once varied per state were compiled to a national list to be used by WIC state agencies for eligibility requirements in 1999.[16]

From 1974 to 1998 WIC participation increased, but from 1998 to 2000 there was a decline in participation.[15] From 2000 to 2007 there was a gradual increase (2% annually) and a 5% increase followed in 2008.[15]

Although the food supplement benefits of the WIC package have remained fairly constant since the late 1970s, in December 2007, adjustments to the food supplement were made to take into account improvements in medical and nutritional research.[15] These revisions were scheduled to take effect no later than October 1, 2009.[15] The changes to the food package included new WIC food vouchers for fruits and vegetables, 100% whole wheat bread, and low-fat milk (skim or nonfat and 1%) as shown in Table 1.[15] Although WIC does include infants, the changes to the WIC food package for these recipients were not shown in Table 1 because they were not included as study participants in my analyses.

Table 1 WIC Food Packages for Select Recipient Groups, Before and After the 2007 Revisions to Food Package

Food	Recipient Groups			
	Children 1-4 Years	Women		
		Pregnant and partial breastfeeding	Fully breastfeeding	Non-breastfeeding, postpartum
Before 2007 Revisions				
Juice	X	X	X	X
Cereal	X	X	X	X
Milk	X	X	X	X
Eggs	X	X	X	X
Cheese			X	
Dried beans/peas and/or peanut butter	X	X	X	
Tuna (canned)			X	
Carrots			X	
After 2007 Revisions				
Juice	X	X	X	X
Cereal	X	X	X	X
Milk	X	X	X	X
Eggs	X	X	X	X
Cheese			X	
Fruits/Vegetables	X	X	X	X
Whole-wheat bread and other whole grains	X	X	X	X
Legumes and/or peanut butter	X	X	X	X
Fish (canned)			X	

Adapted from source: [15]

iii) Locations

WIC's initial clinic opened on January 15, 1974 in Pineville, Kentucky and in approximately one year the program had expanded to clinics in 45 states.[16] Currently, WIC services are available in all 50 states, the District of Columbia, 34 Indian Tribal Organizations and U.S. territories or insular areas of American Samoa, Guam, Commonwealth Islands of the Northern Marianas, Puerto Rico, and the U.S. Virgin Islands.[17]

iv) Enrollment/Classification Criteria

To receive WIC benefits, a woman and/or her child(ren) must meet categorical, residential, income, and nutritional risk application requirements.[15] These requirements are described below.

(1) Categorical

Since the two WIC Clinics, Kirkwood and Adamsville, included in this project had not yet enacted the 2007 WIC revisions at the time of the Emory WIC FMNP Study, the categorical criteria before the 2007 revisions will be described.

For the first WIC enrollment criterion, recipients must meet any one or combination of the following seven categories or participant groups:

1. infants through three months
2. infants four to eleven months
3. children or women with special dietary needs
4. children ages one to four years (<5 years)

5. pregnant and breastfeeding women (basic)
6. non-breastfeeding postpartum women
7. breastfeeding women (enhanced)

In the above categories, breastfeeding is defined as the practice of feeding a mother's breast milk to her infant(s) at least once a day, on average.[15] Among breastfeeding women, those in the "basic" group partially breastfed their infants and those in the "enhanced" group fully breastfed their infants. Of these seven recipient categories, the largest (49%) was children aged one to four years in 2006.[15] The next largest group making up nearly a quarter of the recipients were infants (26%) with the remaining quarter consisting of women.[15] Postpartum women and breastfeeding women each comprise 7% .[15]

(2) Residential

For the second criterion, WIC recipients must be able to show documentation of residence within the state in which they receive WIC benefits in order to prevent dual participation in more than one state.[15]

(3) Income

The third criterion requires WIC recipients to have a family income below 185 percent of the Federal poverty guidelines where family is defined as a group of people living as one economic unit whether related or unrelated.[15] For example, less than or equal to 185 percent of the Federal poverty guidelines was approximately at or less than $40,793 annually or $3,400 monthly for a family of four residing within the 48 contiguous states, Washington, D.C., Guam, and territories from July 1, 2009 to June 30, 2010.[18] This eligibility requirement depends on residential location, family size and the most accurate family income status as either over the past year or the current income.[15]

(4) Nutritional Risk

The last criterion requires that a physician, nurse, dietitian, nutritionist, or other health professional must deem WIC recipients at nutritional risk. Nutritional risk is evaluated by measuring height (or length), weight, a serum sample for anemia (except infants under 9 months), and a historical review of medical charts and diet.[15] WIC recipients must meet one of these five major types of nutritional risk: "1) Detrimental or abnormal nutritional conditions detectable by biochemical or anthropometric measurements (such as anemia, underweight, or overweight); 2) Other documented nutritionally related medical conditions (such as nutrient deficiency diseases, metabolic disorders, or lead poisoning); 3) Dietary deficiencies that impair or endanger heath (such as inadequate dietary patterns); 4) Conditions that directly affect the nutritional health of a person (including alcoholism or drug abuse); or 5) Conditions that predispose a person to inadequate nutritional patterns or nutritionally related medical conditions (including, but not limited to, homelessness and migrancy)."[15]

v) Re-Certification

Once eligibility criteria are met and the application process complete, most WIC recipients receive WIC benefits for six months before they must re-certify by showing proper documentation of WIC eligibility.[15] However, depending on recipients' categorical eligibility criterion, the length of time for certification and limitations on re-certification vary as shown in Table 2 below. Certification and re-certification information is not provided for infants since they were not included in this dissertation.

Table 2 Certification Periods by WIC Recipient Categories		
Recipient Group	Recertification Required	Certification Terminated
Child	Every 6 months	Last day of month in which child turns 5 years of age
Women		
Breasfeeding	Every 6 months	Stops breasfeeding or last day of month in which infant turns 1 year old, whichever occurs first
Postpartum	None	Last day of the month in which infant turns six months old
Pregnant	None	Last day of month in which infant turns six weeks old

Adapted from source: [15]

vi) Priority System

Since WIC is a federal grant program and not an entitlement program, all eligible WIC recipients may not be able to receive WIC services if the allocated annual funding cannot support the number applying for WIC services.[15] In 1979, the WIC Nutritional Risk Priority System was created to aid in guaranteeing that when WIC clinics are at full-capacity, recipients on the waiting list are prioritized based on nutritional risk and greatest potential to gain from the WIC program.[15,16] There has been little need for the priority system in recent years due to the cost-containment practices.[15] The highest priority group includes nutritionally at risk infants, pregnant women, and breastfeeding women due to conditions that require supplemental foods.[15]

vii) WIC Benefits

There are three WIC benefits including: supplemental food package, nutrition education, and referrals to health care and social services. Additionally, most states provide the WIC FMNP during the growing season. These benefits are discussed below.

(1) Supplemental Food Package

The first WIC benefit is the supplemental food package. The food package items, prior to the 2007 revisions, included foods historically known to be lacking in the diet of Americans at nutritional risk for protein, vitamins A and C, iron, and calcium deficiencies.[15] The food package prior to the 2007 revisions was described in the top half of Figure 2 by food item and WIC recipient category. The food items include infant formula, juice, infant cereal, cereal, milk, eggs, cheese, dried beans/peas and/or peanut butter, tuna (canned), and carrots. Juice and carrots were the only fruits and vegetables provided in the WIC food package. Juice was available to all recipients except infants 0 to 3 months and carrots were only available to fully breastfeeding women.

The WIC vouchers for the food supplement package can only be redeemed for the specific food item and quantity indicated on the voucher.[15] These food vouchers can only be redeemed at vendors or food stores approved to accept WIC vouchers.[15]

(a) Vendors

Vendors can redeem WIC food vouchers and vendors include: grocery stores, supermarkets, pharmacies, military commissaries, and convenience stores. Of 44,458 vendors authorized to accept WIC vouchers in the U.S. at the end of fiscal year 2005, ninety percent of these were grocery stores, supermarkets or convenience stores; six percent were pharmacies; and the remaining four percent were made up of a combination of other outlets such as military commissaries.[15]

Numerous stores in a given area may be eligible to be authorized as vendors; however, the state agency is required to only authorize enough vendors to provide sufficient recipient access and the lowest feasible costs for food while remaining manageable for supervision by the WIC state agency.[15] Vendors are not allowed to charge state or local taxes on food items purchased by WIC vouchers and vendors must be re-authorized to accept WIC vouchers every three years.[15]

(2) Nutrition Education Sessions

The second WIC benefit is nutrition education and it was incorporated into the benefits in the mid-1970s.[15] Nutrition education is currently offered to all WIC recipients or to parents/caretakers of infant/child recipients. Nutrition education is provided at least twice during each certification timeframe (every six months).[15] Participation in the WIC nutrition education aims to enhance the nutritional health status of the recipients by educating them on how to improve dietary habits, on the benefits of breastfeeding, and on the associations between health, nutrition, and exercise.[15]

(3) Referrals to Health Care and Social Services

While WIC is not to be used as a sole source of health care needs, WIC's third benefit provides an important health care referral service and some medical needs by following immunization schedules.[15] Additionally, WIC facilitates recipients in gaining access to Food Stamps or SNAP, Medicaid, and other social providers.[15]

(4) Farmers' Market Nutrition Program (FMNP)

In 1992, Congress created the WIC Farmers' Market Nutrition Program (FMNP) through the WIC Farmers Market Nutrition Act.[15,19] The FMNP provides WIC recipients with fresh fruits and vegetables from a local farmer and brings attention to and increases the use of local farmers' markets.[15,19] WIC recipients are provided with FMNP coupons ranging from $10 to $30 to be used at an authorized farmers' market or roadside stand.[15] Recipients receive these FMNP coupons during the growing season (June through August) in addition to their WIC supplement food package vouchers.[15] The WIC FMNP is available to nearly all WIC recipients except infants under 4 months of age for whom breastfeeding should be the sole nutrition source.[20] In 2009, approximately 2.2 million WIC recipients were provided with FMNP coupons.[20]

The WIC nutrition education during the timeframe of the FMNP often focuses on fruits and vegetables, however, nutritional information can be provided by others such as local chefs and/or Cooperative Extension Programs.[20] Further, WIC recipients participating in the FMNP have an additional opportunity to learn about F&V informally from the farmer and farmers' market. WIC recipients have the chance to try new fruits and vegetables, learn which F&V are in season, and ask farmers questions about F&V. Participation in the FMNP makes good quality F&V available to WIC recipients and reduces common barriers such as costs of F&V.

The FMNP's fruit and vegetable expenses are covered by federal funds (100%), but at least 30% of the administrative fees must be paid by the states participating in the program.[15] Twenty million dollars in funding was appropriated to the FMNP in fiscal year 2010.[20]

Farmers, farmers' markets, roadside stands, and farms can be authorized to accept WIC FMNP coupons.[20] Authorization requires that the fruits, vegetables, and herbs be grown by the farmer and not by someone else and not purchased from a wholesale distributor.[20] After a farmer sells fruits, vegetables, and/or herbs to WIC recipients in exchange for FMNP coupons, a farmer or farmers' market is reimbursed for the monetary amount of the coupons by the FMNP state agency or a designated bank.[20] In fiscal year 2002, approximately 13,200 farmers from 36 states, Washington, D.C., five Indian Tribal Organizations, Guam, and Puerto Rico participated in the FMNP.[19] By fiscal year 2009, the WIC FMNP included 17,543 farmers, 3,635 farmers' markets, and 2,662 roadside stands and the farmers brought in over $20 million in revenue.[20]

viii) Georgia WIC and WIC FMNP

Georgia is the state with the seventh most WIC recipients in the U.S.[21] In the federal fiscal year of 2008, the Georgia Department of Community Healthy, Division of Public Health, WIC Branch administered monthly WIC benefits to 305,516 recipients including: 146,919 children, 80,696 infants, 32,591 non-breastfeeding women, 23,697 prenatal women, and 21,612 breastfeeding women.[21]

Fulton and DeKalb counties serve the highest number of WIC recipients in Georgia with 27,797 in Fulton county and 24,508 in DeKalb county in the 2007 fiscal year [22,23] (Table 3). In each county, approximately 40-50% of the WIC recipients were children, nearly 30% were infants, and about 25-30% were women in 2007.[22,23] In the 2007 fiscal year, 58,937 WIC food vouchers were used in Fulton county and 47,122 in DeKalb county.[22,23] Further, Georgia has nearly 1,600 authorized food vendors that accept WIC vouchers, with 79 in Fulton County and 147 in DeKalb County.[21-23] Fulton and DeKalb counties were among six counties in the state that had the highest 2008 WIC monetary voucher redemptions.[24] In 2007, DeKalb county had $15.1 million and Fulton county had $14.4 million in WIC food dollar contributions.[22,23]

Table 3 Georgia WIC Statistics by Fulton and DeKalb Counties, 2007 Fiscal Year		
	Fulton County	DeKalb County
Number of WIC Recipients	27,797	24,508
Number of WIC food vouchers used	58,937	47,122
Vendors accepting WIC vouchers	79	147
WIC food dollar contributions ($ million)	14.4	15.1

Sources: [22,23]

Participation in the FMNP during the 2002 fiscal year included 8,687 Georgia WIC recipients consisting of approximately 58% (N = 5,016) children and 42% (N = 3,671) women with 30% (N = 1,067) of the women being postpartum.[19] In the same year, there were 55 farmers, 4 farmers' markets, and no roadside stands or farms participating in the FMNP.[19] By the 2009 fiscal year, the number of WIC recipients participating increased to 32,622 and there were substantial increases in number of participating farmers (N = 131), farmers' markets (N = 196), and roadside stands (N = 137).[25]

b) Literature Review Search Terms

This section describes the literature review search terms and exclusions that were used to identify the studies included in Project 1's literature review.

Research included in this literature review focuses on the F&V intake and nutrition knowledge and competencies about F&V of 1) WIC recipients, and 2) WIC recipients who participate in the WIC FMNP. Many search terms were used and similar terms were included such as "intake" and "consumption", "WIC" and "low-income women", and "attitudes" and "beliefs." To reduce repetition of listed search terms, similar words as stated above will be enclosed in parenthesis.

Publications included in this review were found by the following search terms in PubMed on July 11, 2010:

- **WIC recipients:**
    - “WIC and fruit and vegetable intake”,
    - “WIC (low-income women) and nutrition knowledge about fruit and vegetables”,
    - “WIC (low-income women) and knowledge of fruit and vegetable recommendations”,
    - “WIC (low-income women) and attitudes (beliefs) about fruits and vegetables”,
    - “WIC (low-income women) and fruit and vegetable competencies”,
    - “WIC (low-income women) and choosing fruits and vegetables”,
    - “WIC (low-income women) and storing fruits and vegetables”,
    - “WIC (low-income women) and preparing fruits and vegetables”;
- **WIC recipients who participate in the WIC FMNP:**
    - “WIC FMNP”, “farmers market nutrition program”,
    - “WIC (low-income women) farmers market”,
    - “WIC (low-income women) farmers’ market nutrition program”,
    - “WIC (low-income women) farmers market and fruit and vegetable intake (consumption)”,
    - “WIC (low-income women) famers market nutrition program and fruit and vegetable intake (consumption)”,
    - “WIC (low-income women) farmers market nutrition program and nutrition knowledge”,
    - “WIC (low-income women) farmers market nutrition program and attitudes (beliefs) about fruits and vegetables”,
    - “WIC (low-income women) farmers market nutrition program and fruit and vegetable competencies”,

- “WIC (low-income women) farmers market nutrition program and choosing fruits and vegetables”,
- “WIC (low-income women) farmers market nutrition program and storing fruits and vegetables”,
- “WIC (low-income women) farmers market nutrition program and preparing fruits and vegetables.”

These searches yielded a total of 205 articles. After duplicate articles were identified, 88 distinct publications remained. Fourteen of the 88 articles were included in this literature review; fruit and vegetable intake and nutrition knowledge and competencies were described by eight articles for WIC recipients and six publications pertained to WIC FMNP participants. The remaining articles (N = 74) were excluded for the following nine reasons: 1) article did not include WIC recipients (N = 32); 2) study location was not in the United States (N = 29) of which three were not in the English language; 3) results reported only F&V consumption (N = 4); 4) inclusion of some, but not only, WIC recipients (N = 3); 5) only discussed food insecurity (N = 2); 6) only described attendance at nutrition education intervention (N = 1); 7) only focused on coupon redemption rates (N = 1); 8) only discussed the new WIC package (N = 1); and 9) only described qualitative results of a focus group discussion (N=1).

Exclusion criteria numbers three, four, and nine require more explanation. For criterion three (results reporting only F&V consumption), the four publications that only reported F&V intake results were excluded because they simply provided cross-sectional F&V intake data for WIC recipients and this information has already been described in this dissertation in the “Importance of F&V Intake” section. Among the three articles that were excluded for criterion four (inclusion of some, but not only, WIC recipients), two articles did not report the number or percentage of study participants that were WIC recipients and one publication focused on energy added from sugars. The last article was excluded by criterion nine (only described qualitative results) because it presented five themes that emerged from focus group discussions of WIC recipients. No quantitative data was reported that compared the participants who attended the "Finding the Teacher Within" nutrition education class to the usual WIC education session.

There was inclusion of three additional publications [19,26,27] that were not listed in PubMed. The publication by Anliker et al. was a reference in four of the included PubMed articles [28-31], Galfond et al. was found in two included articles [28,30], and the Program Impact Report for the 2002 WIC Farmers' Market Nutrition Program was listed in an included review article.[28]

Therefore, a total of 17 articles that described F&V intake and nutrition knowledge and competencies about F&V of WIC recipients (N = 8 articles) and WIC recipients who participate in the WIC FMNP (N = 9) were included in this review. An overview of 15 of these articles (N = 7 WIC articles, N=8 WIC FMNP articles) is displayed below in Table 4. The review article by McCormack et al. and the article by Serrano et al. about the WIC staff's perceptions of the WIC nutrition education sessions are not similar to the other publications, thus are not included in the table below but are included by text in subsequent sections of this literature review.

This research took place in locations across the United States with one quarter of the WIC publications from WIC clinics in Maryland [32-35] as shown in Table 4. Most of the included studies were longitudinal in design [26,29,32-40] and four publications were cross-sectional.[19,27,30,31] Nearly all studies included women WIC recipients, five studies did not include women with child WIC recipients [27,29,30,38,40], and no publications included child WIC recipients. Sample size was relatively small (N < 500) for most studies and follow-up participation rates were consistent with other reported rates for low-income populations. Lastly, all but one study [19] assessed the mother's/caregiver's F&V intake, but fewer publications examined nutrition knowledge and competencies about F&V, especially for the WIC FMNP studies.[19,32-37,39]

Table 4 Overview of WIC and WIC FMNP Studies Included in Project 1's Literature Review										
WIC Studies										
			Inclusion		**Sample Size (N)**				**Main Measures**	
Author, Year	**Location**	**Study Design**	**Women WIC Recipients**	**Women with Child WIC Recipients**	**Baseline**	**Follow-up 1**	**Follow-up 2**		**F & V Intake**	**Nutrition Knowledge, Attitudes, & Competencies**
Havas 1998 (2), Langenberg, 2000	Maryland	Cross-over of 2 phases (Baseline/Follow-up)	Yes	Yes	3,122	2,358	Not Measured		Yes	Yes
Havas, 2003	Maryland	Cross-over of 2 phases (Baseline/2 Follow-ups)	Yes	Yes	2,066	1,508	540		Yes	Yes
Birmingham, 2004	Washington	Baseline/Follow-up	NA	Yes	225	167	Not Measured		Yes	Yes
Campbell, 2004	North Carolina	Baseline/Follow-up	Yes	Yes	410	307	Not Measured		Yes	Yes
Chang, 2010	Michigan	Pilot: Baseline/ 2 Follow-ups	Yes	No	129	70	48		Yes	No
WIC FMNP Studies										
					Sample Size (N)					
			Inclusion		**Baseline**		**Follow-up**		**Main Measures**	
Author, Year	**Location**	**Study Design**	**Women WIC Recipients**	**Women with Child WIC Recipients**	**FMNP**	**WIC**	**FMNP**	**WIC**	**F & V Intake**	**Nutrition Knowledge, Attitudes, & Competencies**
Galfond, 1991	IA, MA, PA, TX, VT, WA	Cross-sectional	Yes	No	1,503	1,126	Not Measured		Yes	No
Anliker, 1992	Connecticut	Baseline/Follow-up	Yes	Yes	411	78	172	44	Yes	No
Anderson, 2001	Michigan	Baseline/Follow-up	Yes	Yes	564		244	97	Yes	Yes
National Association of FMNP, 2003	U.S.	Cross-sectional	Yes	Yes	24,800	0	Not Measured		No	Yes
Herman (2), 2006	Los Angeles, California	Baseline/Follow-up	Yes	No	168	143	141	101	Yes	No
Kroph, 2007	Ohio	Cross-sectional	Yes	Yes	65	170	Not Measured		Yes	No
Racine, 2010	Charlotte, NC; Washington, D.C.	Cross-sectional	Yes	No	41	108	Not Measured		Yes	No

The survey details of the studies included in this literature review are described below in Table 5. Common time periods to conduct follow-up surveys were at two-months, eight-months, and one-year after the baseline survey. The majority of the surveys were self-administered [26,31-37,39] and the remaining surveys were interviewer-assisted.[26,29,30,38,40] The surveys were most commonly completed in-person at the WIC clinic [26,29,30,32-34,36,39,40] and other methods of survey administration included: computer, mail, and phone.[26,31,37,38]

Table 5 Survey Details of Studies Included in Literature Review				
WIC Studies				
			Survey Administration	
Author, Year	**Number of Surveys**	**Follow-up Survey Time**	**Self-Administered**	**Method**
Havas 1998 (2), Langenberg, 2000	3	8-months, 1-year	Yes	In-person
Havas, 2003	3	8-months, 1-year	Yes	NA
Birmingham, 2004	2	2-months	Yes	In-person
Campbell, 2004	3	Immediate after intervention, 1-2 months	Yes	Computer
Chang, 2010	3	2-months, 8-months	No	Phone
WIC FMNP Studies				
			Survey Administration	
Author, Year	**Number of Surveys**	**Follow-up Survey Time**	**Self-Administered**	**Method**
Galfond, 1991	1	None	NA	NA
Anliker, 1992	2	2-months	Baseline: No; Follow-up: Yes	Baseline: In-person; Follow-up: Phone, Mail
Anderson, 2001	2	2-months	Yes	In-person
National Association of FMNP, 2003	1	None	NA	NA
Herman (2), 2006	4	2-months, 8-months, 14-months	No	In-person
Kroph, 2007	1	None	Yes	Mail
Racine, 2010	1	None	No	In-person

Demographic characteristics such as age, race/ethnicity, education level, and pregnant/breastfeeding status are described in Table 3 below. The most common average age of participants included in these publications was 27.0 (Average range: 24.0 – 29.5) years with an overall range from 16 to 61 years. Four studies included primarily one racial/ethnic group: White [31,36], African American [30], or Hispanic [29,40] and the other publications had a mixture of race/ethnic groups. Among the studies that included pregnant women and reported the frequency of pregnancy, Racine et al. enrolled only pregnant women [30] and the other studies included approximately 22% pregnant women (Range: 14.5 – 23.0%). The percentage of women breastfeeding was lower around 10% (Range: 4.0-72.2%). Marital status was not included in Table 6 since about half of the studies did not report this demographic characteristic. Two publications indicated that more than 50% of the participants were married [29,31] while three studies reported that less than one-third of participants were married.[34,35,39]

Table 6 Demographic Characteristics of WIC and WIC FMNP Participants Included in Literature Review										
WIC Studies [1]										
	Age (years)		**Race/Ethncity**			**Education Level**				
Author, Year	**Intervention**	**Control**	**White (%)**	**African American (%)**	**Other (%)**	**< High School (%)**	**High School (%)**	**> High School (%)**	**Pregnant (%)**	**Breastfeeding (%)**
Havas 1998 (2), Langenberg, 2000	18-24: 39.7%, 25-29: 26.3%, 30+: 34.0%	18-24: 41.3%, 25-29: 26.7%, 30+: 32.0%	I: 38.2, C: 43.1	I: 58.2, C: 53.2	I: 3.6, C: 3.8	I: 17.1, C: 15.6	I: 42.0, C: 43.9	I: 40.9, C: 40.5	I: 22.2, C: 22.4	I: 11.1, C: 10.4
Havas, 2003	18-24: 41.8%, 25-29: 23.7%, 30+: 34.4%	18-24: 44.4%, 25-29: 23.8%, 30+: 31.9%	I: 43.1, C: 40.4	I: 53.7, C: 56.7	I: 3.2, C: 2.9	I: 19.8, C: 19.2	I: 40.7, C: 40.9	I: 36.1, C: 36.9	I: 22.9, C: 18.7	I: 12.0, C: 11.5
Birmingham, 2004	28.0 (Range: 17-59)		77	11	12	13	28	57	0	NA
Campbell, 2004	27.3	27.5	I: 48.9, C: 60.6	I: 39.7, C: 26.7	I: 11.4, C: 12.7	I: 21.3, C: 17.1	I: 66.7, C: 67.1	I: 12.0, C: 15.8	I: 23.0, C: 19.0	I: 4.0, C: 5.0
Chang, 2010	25.5	25.1	I: 45.3, C: 50.8	I: 54.7, C: 49.2	I: 0, C: 0	I: 25.0, C: 9.2	I: 29.7, C: 15.4	I: 45.3, C: 75.4	NA	NA
WIC FMNP Studies										
			Race/Ethncity			**Education Level**				
Author, Year	**Age (years)**		**White (%)**	**African American (%)**	**Other (%)**	**< High School (%)**	**High School (%)**	**> High School (%)**	**Pregnant (%)**	**Breastfeeding (%)**
Galfond, 1991	NA		NA			NA			NA	NA
Anliker, 1992	27.1		38.5	36.4	24.8 (Hispanic)	42.8	40.3	16.8	NA	NA
Anderson, 2001	29.5 (Range: 17-61)		49.4	43.3	7.3	49		51	13.8	
National Association of FMNP, 2003	NA		NA			NA			NA	NA
Herman (2), 2006	27.5 (Range: 17-43)		2.8	5.9	89.1 (Hispanic)	Average of 9.3 years (Range: 0-16)			0	72.2
Kroph, 2007	NA		NA, but 93% of county are White			FMNP: 4.8, WIC: 16.0	FMNP: 95.2, WIC: 84.0		14.5	10.6
Racine, 2010	24 (Range: 16-40)		0	100	0	Average of 12.2 years (Range: 9-18)			100	NA

[1] "I" stands for the intervention group and "C" for the control group.

c) Nutrition Knowledge and Competencies

This section describes the nutrition knowledge and competencies questions and statements about fruits and vegetables found in the literature among studies of WIC recipients and recipients who participate in the FMNP included in this review. Statements specifically relevant to this dissertation such as knowledge of the F&V recommendations and storing and preparing F&V are *discussed in more detail. Factors associated with nutrition knowledge and competencies such as maternal education level and race are also covered. Lastly, limitations of the previous literature on this topic are explained.*

i) Nutrition Knowledge and Competencies About F&V Assessment Questions/Statements

Large-scale efforts to provide educational nutrition information, such as the “5 A Day - For Better Health” and “Fruit & Veggies – More Matters” campaigns have demonstrated increases in F&V knowledge of the F&V recommendations and awareness of the programs’ messages.[41,42] However, particular subgroups of the U.S. population, such as low-income individuals who often have low educational attainment, may need more nutrition education efforts targeting specific nutrition knowledge and competencies about fruits and vegetables. The WIC program is required to provide nutrition education session every time food vouchers are issued to recipients. These sessions vary in nutrition education covered by time of year, WIC Clinic, and WIC staff leading the nutrition class.

For example, Serrano et al. surveyed WIC staff (e.g. office support staff, nutrition assistants, nutritionists, and nurses) at a Virginia WIC clinic regarding their comfort levels in discussing F&V intake and childhood overweight and obesity, which are topics usually covered in WIC’s nutrition education classes.[43] Overall, WIC staff spoke to WIC recipients often (score = 2.89, with score of 1.0 = “never” and 4.0 = “20 or more hours per week”) about nutrition with nutritionists talking the most frequently (score = 3.74).[43] WIC staff felt more comfortable discussing consumption of F&V (score = 3.40, with score of 1.0 = “very uncomfortable” and 4.0 = “very comfortable”) than excessive weight/overweight (score = 2.87).[43] Interestingly, more than half (54.5%) of the WIC staff who were overweight (26.1%) felt uncomfortable talking about consumption of F&V with WIC recipients.[43]

These potential concerns of the variation among WIC staff providing consistent nutrition education has led many research studies to conduct lengthier and more involved nutrition education interventions at WIC clinics. Most of the studies incorporating nutrition education interventions divided WIC recipients into those who received the intervention and those who received the usual WIC nutrition education sessions (controls). Only one publication included in this literature review simply examined the nutrition knowledge and competencies of WIC recipients receiving the usual WIC and WIC FMNP education.[39] Among the WIC FMNP studies included in this review, none of them incorporated any additional nutrition education beyond the normal WIC sessions.

Tables 7 and 8 describe the nutrition knowledge and competencies questions or statements found in the studies included in this literature review. The number of questions was listed along with the overall topics covered if the actual wording of the statements was not published. If the question wording was provided, it was included in Tables 7 and 8 since it directly applied to this dissertation. The questions' response categorization or scoring was included along with the summary score's internal reliability statistic (Cronbach's alpha).

The nutrition knowledge questions are included in Table 7 and were often asked by a single question that sought knowledge of the F&V recommendations, "How many servings of fruits and vegetables (including 100% juice) do you think a person should eat each day on the average?" [33-35,39] The nutrition knowledge responses were categorized according to the F&V recommendations into a dichotomous variable of less than five servings of F&V per day versus five or more servings per day in three studies [33-35] and remained as a F&V total count in the remaining study.[39] All of these studies sought general nutrition knowledge for "a person," but did not specifically ask the WIC recipient to respond in regard to the amount she/he should consume or her/his child.

Table 7 Examples of Nutrition Knowledge From Research Included in Literature Review

First Author, Year	Number	Actual Wording / Overall Topic	Response Categorization/Scoring	Cronbach's Alpha
WIC Studies				
	Statements or Questions			
Havas (Factors), 1998	1	"How many servings of fruits and vegetables do you think a person should eat each day on the average?"	< 5 = Incorrect, ≥ 5 = Correct	Not measured
Havas (Final), 1998	6	NA	Summary score (Range: 0 - 6)	NA
Langenberg, 2000	1	"How many servings of fruits and vegetables (including 100% juice) do you think a person should eat each day on average?"	< 5 = Incorrect, ≥ 5 = Correct	Not measured
Havas, 2003	1	NA	Correct/Incorrect	Not measured
Birmingham, 2004	None			
Campbell, 2004	3	Ability to choose low-fat foods: breakfast, snack, restaurant fast food	Correct choice = 1 point, summed to summary score	0.94
Chang, 2010	None			
WIC FMNP Studies				
	Statements or Questions			
First Author, Year	**Number**	**Actual Wording / Overall Topic**	**Response Categorization/Scoring**	**Cronbach's Alpha**
Galfond, 1991	None			
Anliker, 1992	None			
Anderson, 2001	1	Number of fruits and vegetables a person should eat per day	Number of F & Vs/day	Not measured
National Association, 2003	None			
Herman (2), 2006	None			
Kroph, 2007	None			
Racine, 2010	None			

Data on what the Emory WIC FMNP Study calls nutrition competencies (e.g. storing and preparing F&V) were usually found in measures of nutrition attitudes, self-efficacy, and perceived barriers in the included studies as shown in Table 8 below. Among these studies that assessed nutrition competencies, two did not publish the actual nutrition attitudes and/or competencies statements or questions included in the surveys [32,35], three reported some examples of the statements but not the entirety [33,34,36], and two articles stated all questions or statements.[37,39] Examples of some of the attitude and competency questions or statements that were published are shown in Table 8 and include “After receiving the MBB (Market Basket Booklet), has there been a change in how confident you feel about how to store fruits and vegetables appropriately?” and "They learned a new way to prepare fresh fruits and vegetables."[19,36] Not publishing the exact wording used in survey questions makes comparisons of results among studies difficult and does not provide examples from existing literature for new research.

Data on nutrition competencies about F&V were often collected by questions or statements with responses on 3- to 5-point Likert scales of agreement (e.g. 0 = disagree a lot, 4 = agree a lot), certainty (sure) (e.g. 0 = unsure, 2 = sure), or bother (e.g. 1 = not much bother, 5 = very much a bother) as shown in Table 8. Higher scores indicated more positive attitudes and self-efficacy and greater perceived barriers.[32-34,36,39] Most of the Likert-scale response questions/statements were combined to create a summary score with the internal reliability estimated by a Cronbach’s alpha as shown in Table 8.[32-34,37,39] For instance, Anderson et al. combined five statements about the taste of fruit and vegetables, family response to fruits and vegetables, preparation knowledge, and importance of F&V for health into a single construct with an internal consistency (Cronbach’s alpha) of 0.68.[39] Cronbach’s alphas for the included studies ranged from 0.68 - 0.94.[32-34,37,39]

Table 8 Examples of Nutrition Attitudes and Competencies About F & Vs From Previous Research				
WIC Studies				
	Statements or Questions			
First Author, Year	**Number**	**Actual Wording / Overall Topic**	**Response Categorization/Scoring (#-point Likert Scales)**	**Cronbach's Alpha**
Havas (Factors), 1998	5	Attitudes	5-point (agreement), summary score	0.8
	7	Perceived Barriers	5-point (agreement), summary score	0.82
	10	Self-efficacy	3-point (sure), summary score	0.87
Havas (Final), 1998	5	Attitudes	5-point (agreement), summary score	Ranged from 0.80 to 0.92
	10	Self-efficacy	3-point (sure), summary score	
	7	Perceived Barriers	5-point (agreement), summary score	
Langenberg, 2000	10	Self-efficacy	3-point (sure), summary score	Ranged from 0.80 to 0.92
	7	Perceived Barriers	5-point (agreement), summary score	
	5	Attitudes	5-point (agreement), summary score	
Havas, 2003	3	Self-efficacy	5-point Likert scale	Not measured
Birmingham, 2004	4	Attitudes	5-point (agreement)	Not measured
	6	Beliefs	5-point (agreement)	Not measured
	1	"After receiving the MBB, has there been a change in how confident you feel about choosing good quality fresh produce?"	3-point (sure)	Not measured
	1	"After receiving the MBB, has there been a change in how confident you feel about how to store fruits and vegetables appropriately?"	3-point (sure)	Not measured
Campbell, 2004	5	Self-efficacy	5-point (sure)	0.8
Chang, 2010	None			
WIC Studies				
	Statements or Questions			
First Author, Year	**Number**	**Actual Wording / Overall Topic**	**Response Categorization/Scoring (#-point Likert Scales)**	**Cronbach's Alpha**
Galfond, 1991	None			
Anliker, 1992	None			
Anderson, 2001	5	Attitudes and Beliefs (e.g. "preparation knowledge")	5-point (agreement), summary score	0.68
	1	"How much bother it is to prepare fruits and vegetables"	5-point (bother)	Not measured
National Association, 2003	1	"They learned a new way to prepare fresh fruits and vegetables"	NA	Not measured
	1	"They learned a new way to store produce to prevent spoilage"	NA	Not measured
Herman (2), 2006	None			
Kroph, 2007	None			
Racine, 2010	None			

To summarize, research on nutrition knowledge and competencies of WIC recipients and those who received the WIC FMNP focused on knowledge of the F &V recommendations and overall summaries of attitudes, competencies, beliefs, self-efficacies, and perceived barriers of fruits and vegetables. Among the few studies that published the exact wording of statements or questions included in summary scores, one discussed choosing F&V [36], two covered F&V storage [19,36], and two studies discussed preparing F&V.[19,39]

ii) Maternal Nutrition Knowledge and Competencies Associated With Maternal Educational Attainment

Low-income individuals, such as WIC recipients, often also have lower educational levels.[44] Having a lower educational attainment (e.g. less than high school) may provide fewer opportunities to gain nutrition education and limited the skills acquired to read, comprehend, and practice later nutrition education information. The WIC program's nutrition education sessions focused on fruits and vegetables provide an additional chance for these primarily low-educated women to enhance their nutrition knowledge and improve their competencies.

Maternal education level has been found to be significantly associated with nutrition knowledge of the F&V recommendations ($p < 0.001$).[33] For example, 46.5% of respondents with more than a high school education correctly answered the nutrition knowledge question compared to 35.9% of those with less than a high school education.[33] Further, self-efficacy significantly increased ($p = 0.006$) and perceived barriers significantly decreased ($p = 0.0001$) from those with educational attainment of less than high school to high school graduate to more than high school.[33] Attitudes were not found to be significantly associated with educational attainment ($p = 0.59$).[33]

Only one WIC study, Havas et al., included in this review reported the association of nutrition knowledge, attitudes, and competencies as described above. More research of this relationship is needed, especially among WIC recipients with lower education levels. Further, a non-WIC study by Harnack et al. found interaction by adult education level of the association of nutrition knowledge about cancer and diet and intake of fiber among non-WIC recipients.[45] A similar assessment of potential interaction by maternal educational attainment of the relationship of nutrition knowledge of F&V recommendations and F&V consumption would fill a relatively unexplored gap in the existing literature.

iii) Factors Associated With Nutrition Knowledge and Competencies

Additional factors associated with nutrition knowledge and competencies beyond education level as described in the previous section were again only described by one study included in this review.[33] These factors include demographic variables such as age, race/ethnicity, marital status, currently receiving food stamps, and breastfeeding.[33] Nutrition knowledge of the F&V recommendations was significantly associated with race, marital status, currently receiving food stamps, and breastfeeding (all p-values ≤ 0.001).[33] Knowledge was highest for White breastfeeding women who were married and not receiving food stamps.[33]

Self-efficacy was significantly associated with race/ethnicity ($p = 0.0001$) and marital status ($p = 0.04$) and highest among African American women who were single.[33] Maternal age ($p = 0.0001$), race/ethnicity ($p = 0.0001$), and breastfeeding ($p=0.003$) were significantly related to attitudes and the attitude scores were highest among breastfeeding women of the “other” racial/ethnic group.[33] Lastly, perceived barriers were significantly associated with race/ethnicity ($p = 0.0002$) and marital status ($p = 0.009$) and married, separated, divorced, and widowed women of the “other” racial/ethnic group had the highest perceived barriers.[33]

Therefore, one study has indicated specific variables such as race/ethnicity, marital status, and breastfeeding were associated with nutrition knowledge and competencies. Yet, more research is needed to compare to these results and possibly describe additional demographic factors related to nutrition knowledge and competencies about F&V.

iv) Limitations of Research on Nutrition Knowledge and Competencies

There were at least five limitations with the previous research on nutrition knowledge and competencies of fruits and vegetables. First, most of the studies did not publish the exact wording or an abbreviated version of the statements/questions that were included in summary scores. Second, the nutrition knowledge question was too general ("person") and should be more specific to the mother/caregiver and/or the child. My study sought nutrition knowledge of the F&V recommendations by the mother's response in reference to herself and to her oldest child receiving WIC services. Third, there were few WIC FMNP studies that examined nutrition competencies for storing and preparing fruits and vegetables. My study assessed both measures. Fourth, of the eight studies that examined nutrition knowledge and competencies among WIC recipients, only two included recipients who participated in the WIC FMNP. My study adds to these few publications since it includes FMNP recipients. Fifth, few of the studies assessed the nutrition knowledge and competencies of WIC recipients who received the usual WIC nutrition education and not an educational intervention. The Emory WIC FMNP Study did not incorporate any additional educational material beyond that provided by WIC.

d) F&V Intake Assessments and Reporting

This section describes the assessment tools and methods used to collect fruit and vegetable consumption data for WIC recipients participating in special studies. Further, since *mothers/caregivers of child WIC recipients often report the F&V intake of the child, the accuracy of the mother/caregiver reporting and the correlation of the mother's and child's consumption are discussed. Fruit and vegetable consumption for WIC recipients are described in the "Importance of F&V Intake" section of this dissertation.*

i) Measures of F&V Intake

Measures of fruit and vegetable consumption are similar to those for the overall diet intake. Depending on the study's goals, the method of recording F&V intake data differ. Some F&V research has focused on specific vitamins and nutrients (e.g. vitamin C) in fruits and vegetables while other studies have examined intake of certain fruits and vegetables (e.g. green salad). Further, the time frame (day, week, month, year) to which the dietary intake information is referenced to varies depending on the outcome of interest, the metabolism of the food item or nutrient(s), and the needs/limitations of the study (e.g. cost and time).[46] Dietary intake has been found to vary day to day, but is "superimposed on an underlying consistent pattern" and thus reasonably consistent year to year.[47] F&V intake can be collected in person, on paper, by telephone, and more recently by computer.

Examples of F&V intake assessments include semi-quantitative food frequency questionnaires (FFQ), 24-hour dietary recalls, dietary diaries, and national surveys such as BRFSS. The main differences between FFQs and dietary diaries or 24-hour recalls is that the former is based on "perceptions" of food consumption over a lengthy time period whereas the latter methods gather actual intake of foods on a certain previous day(s).[48] The specific day(s) chosen for the 24-hour dietary recalls and dietary diaries is important as intake on holidays and weekends likely varies from weekdays.

The most common measurement tools used to assess F&V intake among adult WIC recipients or mothers/caregivers of child WIC recipients of research included in this review were the FFQ and 24-hour dietary recall as shown in Table 9. Out of 13 articles that examined F&V intake, eight used a FFQ that ranged from including seven to 90 food items.[26,27,32-37] The next most common measurement tools were 24-hour recalls [27,29] and National Cancer Institute (NCI) surveys (17-item Multifactor Screener [30] and 19-item Fruit and Vegetable Short Assessment Form.[38] Additional tools included a 6-item Behavioral Risk Factor Surveillance System (BRFSS) instrument [39] and a 7-item Food Behavior Checklist for a Limited Resource Audience.[31]

Table 9 Fruit and Vegetable Intake Measurement Tools

WIC Studies		
Author, Year	**Measurement Tool**	**Number of Food Items**
Havas 1998 (2), Langenberg, 2000	FFQ	7
Havas, 2003	FFQ	90
Birmingham, 2004	FFQ	NA
Campbell, 2004	FFQ	26
Chang, 2010	NCI Fruit and Vegetable Short Assessment Form	19
WIC FMNP Studies		
Author, Year	**Measurement Tool**	**Number of Food Items**
Galfond, 1991	24-hour dietary recall	NA
	7-day short FFQ	NA
Anliker, 1992	Short FFQ	NA
Anderson, 2001	BRFSS	6
National Association of FMNP, 2003	None	
Herman, 2006	24-hour dietary recall	NA
Kroph, 2007	Food Behavior Checklist for a Limited Resource Audience	7
Racine, 2010	NCI Multifactor Screener	17

(1) Semi-quantitative FFQs

Semi-quantitative FFQs contain many food items, usually more than 50, and they ask frequency of intake (e.g. number per day, week, month, or year). FFQs can be used to measure absolute consumption of the foods included on the FFQ or to rank study participants by their consumption.[46] Further, FFQs should have the following three characteristics: 1) an adequate number of study participants should consume the FFQ foods “reasonably often”; 2) the FFQ food intake should differ among participants; and 3) the FFQ should list an adequate amount of foods with the nutrient(s) of interest.[46] FFQs often gather dietary intake data in reference to the previous month, multiple months, year, or multiple years. Seasonal variations in the average diet are accounted for when a year or multiple years are considered. Further, there are methods to convert FFQ data to nutrients such as at the Channing Laboratory at Harvard.

(2) 24-Hour Dietary Recall

The 24-hour dietary recall method collects information on the participant’s food and drink consumption over the previous day or 24-hour period. The amount of specific food items is usually requested to approximate portion size such as mug, bowl, measuring cups and spoons, and descriptive terms (small, large, “pat” of butter, can of soda).[48] The recall is either completed by trained interviewers recording participants’ intake responses or by study participants themselves. Therefore, the correctness of the food consumption information is dependent on the short-term memory of the participant.[48]

(3) Dietary Diary

The dietary diary method gathers detailed food intake information over a day or day(s). The amount of detail depends on the study’s needs and can include food items consumed, amount consumed or portion size, and method of preparation. Dietary diary information is recorded at time of consumption by a trained interviewer or a study participant with training.[48] This method of collecting dietary intake reduces dependence on the study participant’s memory.[48]

(4) Behavioral Risk Factor Surveillance System (BRFSS) 6-Item Fruit and Vegetable Screener

State-based surveys, such as the BRFSS, collect standardized dietary information from a sample of the U.S. population and are useful for making dietary comparisons among states, geographic areas, and by groups (e.g. age, sex, race/ethnicity). The BRFSS is a "state-based system of health surveys" that collects monthly data on preventive health practices, health risk behaviors, dietary consumption, and access to health care by a standard core questionnaire and sometimes optional modules and/or state-added questions.[49,50] The BRFSS asks six specific questions about fruits and vegetables: fruit juice, fruit, green salad, potatoes, carrots, other vegetables.[51] The reference periods for intake are day, week, month, and year.[51] The actual BRFSS directions and questions are found in Table15 since the Emory WIC FMNP Study's F&V intake questions were modified from BRFSS questions.

In conclusion, different assessment tools can be used to collect F&V intake and they depend on the degree and type of consumption data wanted by the researchers and the needs of the study. Studies including WIC recipients have primarily used FFQs and 24-hour recalls although a more recent study of the WIC FMNP used questions from the BRFSS.[39]

ii) Accuracy of Mother's Report of Child's F&V Intake

Fruit and vegetable consumption information for children, especially preschool-age children, are often reported by parents. Young children usually have not fully developed the cognitive abilities to accurately recall their past F&V intake such as familiarity of types of fruits and vegetables, ability to remember consumption, a good attention span, and an understanding of the notion of time.[52] The accuracy of parental report of child's F&V intake is of interest for research assessing consumption for children.

None of the 17 included articles discussed accuracy of the mother's reporting of the child's F&V intake because not one of the publications examined F&V consumption of the child WIC recipient. Therefore, a separate literature search was used to identify relevant articles. Again, similar search terms such as "consumption" and "intake", "parent" and "mother", and "WIC" and "low-income" were included in parenthesis. The following search terms were used in PubMed on July 12, 2010:

- "parent recall of child fruit and vegetable intake (consumption)",
- "accuracy of parent report of child fruit and vegetable intake (consumption)",
- "accuracy of parental dietary recall for children",
- "validation of mother reports of dietary intake (consumption) for child",
- "parent recall of child fruit and vegetable intake (consumption) and WIC (low-income)",
- "accuracy of parent report of child fruit and vegetable intake (consumption) and WIC (low-income)",
- "accuracy of parental dietary recall for children and WIC."

These searches yielded a total of 40 articles. After duplicate articles were identified, 29 distinct publications remained. Three of the 29 articles were included in this literature review. The remaining articles (N = 26) were excluded for the following five reasons: 1) study location was not in the United States (N = 14); 2) F&V intake was reported, but not validated with an outside observer (N = 4); 3) foods other than fruits and vegetables or diet components (e.g. protein, carbohydrates, fat) were the focus of the article (N = 4); 4) the child, not the parent, reported his/her F&V intake (N = 2); and 5) parent and child reported child's F&V intake together (N = 2).

Overall, parents have been found to be accurate reporters of child's F&V intake.[53-55] Child's consumption was documented by trained observers during either a lunch-time meal at a cafeteria [53,54] or in the home-environment.[55] These observations were compared to the parents' reports on the following day by either a 24-hour recall [54,55] or a F&V FFQ [53] to assess accuracy of parental report of the child's F&V consumption. Children included in these studies were age two to nine-and-a-half with one of the studies including only preschool-age children (2-5 years) which is applicable to the ages of children included in this dissertation.[53] None of the studies included primarily African Americans.

Mothers' report of their child's fruit intake was found to be highly and significantly correlated with the observations ($r = 0.84$, $p < 0.01$).[54] Basch et al. found that mothers reported 69.6% of the same fruit items as the observer and tended to under-report (19.6%) as opposed to over-report (10.9%) if the mother's report differed from that of the observer.[55] Linneman et al. found moderate agreement on parental and observer reports of peaches (kappa = 0.79 (95% CI: 0.63 – 0.95) and grapes (k = 0.65 (0.44 – 0.86), but not for 100% apple juice (k = 0.17 (0 .00 - 0.39)) or raisins (k = 0.05 (0.00 – 0.18)).[53]

Significant correlation was also found for mother's report of child's vegetable intake when compared to observations ($r = 0.91$, $p < 0.01$).[54] However, Basch et al. demonstrated that there was poor agreement between mother's and observer's reports of the child's vegetable consumption.[55] Only 41.3% of the mothers reported the same vegetable items as the observer and 30.4% under-reported and 28.3% over-reported the child's vegetable intake.[55] Linneman et al. indicated moderate accuracy of parent's report for specific vegetables with the highest agreement for carrots (kappa = 0.81 (95% CI: 0.66 – 0.97)) and the lowest for tomatoes (k = 0.57 (0.24 – 0.90)).[53]

In summary, mothers and fathers are accurate reporters of their child's fruit and vegetable consumption. When specific fruits and vegetables are considered, parents are less accurate at reporting fruit juices and fruits mixed into food items (e.g. raisins in an oatmeal raisin cookie).

iii) Correlation of Mother's and Child's F&V Intake

None of the 17 included articles discussed correlation of the mother's and child's F&V intake because none of the publications examined F&V consumption of the child WIC recipient. Therefore, a separate literature search was used to identify relevant articles. Again, similar search terms such as "consumption" and "intake", "association" and "correlation", "adult" and "mother", and "WIC" and "low-income" were included in parenthesis. The following search terms were used in PubMed on July 10, 2010:

- "association (correlation) of adult (mother) and child fruit and vegetable intake (consumption)",
- "association (correlation) of mother and child fruit and vegetable intake (consumption) and WIC (low-income)"
- "mother and child fruit and vegetable consumption (intake) and WIC (low-income)."

These searches yielded a total of 57 articles. After duplicate articles were identified, 39 distinct publications remained. Only one of the 39 articles was included in this literature review. The remaining articles (N = 38) were excluded for the following six reasons: 1) study location was not in the United States (N = 20); 2) the study's primary association results did not include F&V intake (N = 6) (e.g. association of cigarettes and obesity); 3) no inclusion of child's F&V consumption (N = 5); 4) F&V intake assessed, but not among adult-child pairs (N = 4); and 5) no actual F&V intake data was reported (N = 2), and 6) no inclusion of adult's F&V consumption (N = 1).

The included article published cross-sectional F&V intake data for both parent and child (N = 662) participating in Head Start pre-school program in 2004-2005.[56] Child consumption was reported by the parent and both parent and child F&V intake (excluding fruit juice and fried vegetables) were documented by three-day dietary recalls.[56] Less than half (43.8%) of the participants were African-American, most of the parents had greater than a high school education (40.5%), and the average age of the child was 4.5 (SD 0.6) years.[56] O'Connor et al. found that F&V intake (servings) for the child were significantly correlated with those of the parent ($r = 0.50$, $p = 0.01$).[56]

iv) Limitations of Research on F&V Intake Assessments and Reporting

Research of F&V intake assessments and reporting among WIC recipients is limited by two main limitations. First, the use of multiple F&V consumption assessment tools such as the FFQ, 24-hour dietary recall, dietary diary, and national surveys (BRFSS) lends to difficulty in study comparisons. Further, among studies that did include a similar tool, there were many versions of this tool such as the FFQ with seven to 90 food items. The Emory WIC FMNP Study used the BRFSS, a standardized tool already existing in the literature, to assess F&V intake. Second, no WIC studies included in this review examined the child's F&V intake and therefore additional literature review searches were required to examine the accuracy of the mother's reporting of her child's F&V consumption and to assess the correlation of the mother's and child's F&V intake. My study will describe the relationship between the mother and child's F&V consumption.

e) Research on Nutrition Education Interventions Among WIC Recipients about F&V Intake and Nutrition Knowledge and Competencies

This section describes the studies and the findings that examined the impact of nutrition education interventions on F&V intake and nutrition knowledge and competencies among WIC recipients. WIC recipients who participated in the WIC FMNP are not described here but in the following section "Research on WIC FMNP about F&V Intake and Nutrition Knowledge and Competencies." The limitations of this research will be discussed along with how the Emory WIC FMNP Study addressed these limitations.

This literature review includes seven publications as shown in Table 10 below. However, these articles actually describe only five studies since three articles [32-34] discussed results of the same WIC 5 A Day Promotion Program. Every WIC study assessed nutrition education interventions [32-38] and all studies included controls, except one.[36] The nutrition education intervention often replaced the usual WIC education for the intervention group.[32-36] The control group received the usual WIC nutrition education in most of the studies [32-35] and in one study both the controls and intervention group participated in the usual WIC education.[38]

All of these articles discussed aspects of nutrition education sessions (usual WIC nutrition education or study intervention) and the sessions' impact on the following: 1) fruit and vegetable intake and/or 2) knowledge and/or competencies. The woman's F&V intake and nutrition knowledge and competencies were assessed in all studies except Chang et al. which only examined F&V consumption.

Table 10 Nutrition Education Intervention Details of WIC Studies						
WIC Studies						
Author, Year	**Number of WIC Clinics**	**Intervention Name**	**Length of Intervention**	**Intervention**	**Concepts Covered**	**Received Normal WIC Education**
Havas 1998 (2), Langenberg, 2000	15	WIC 5 A Day Promotion Prgoram	6 months	3 group discussions, brief nutrition education sessions, printed matierls, mail, food demonstrations	F & V intake, value of eating F & Vs, barriers to F & V intake	Yes (control group only)
Havas, 2003	10	Food For Life Program (FFL)	6 months	1 video, FFL brochure, kick-off fair, four 45-minute workshops, 7 mailings, phone calls, food demonstrations	F & V intake, F & V recommendations	Yes (control group only)
Birmingham, 2004	3	Market Basket Booklet (MBB)	2 months	1 booklet (recipes, goals)	Seasonality, F & V quality, storage, and preparation	No
Campbell, 2004	2	FoodSmart	Time at WIC Clinic (Baseline)	1 computer program with soap opera & infomercials, printed materials	F & V intake, Food Guide Pyramid, meal planning	NA
Chang, 2010	3	Mothers in Motion (MIM)	10 weeks	5 weekly DVDs, 5 peer support group teleconferences	F & V intake	Yes

The nutrition education interventions had more extensive educational sessions (e.g. multiple follow-up sessions) and materials (e.g. recipe books and DVDs) about F&V consumption than is provided by the usual WIC education as shown in Table 10. Some studies trained WIC staff to assist in the intervention [36,37] while others trained peer educators to help administer the intervention and follow-up with participants.[32-35] All nutrition interventions discussed F&V intake as shown in Table 10 in the "Concepts Covered" column.[32-38] The measurement tools used to assess F&V and nutrition knowledge and competencies have already been described in sections "Nutrition Knowledge and Competencies about F&V Assessment Statements/Questions" and "Measures of F&V Intake" of this dissertation.

i) F&V Intake Findings

The impact of the nutrition interventions among WIC recipients on F&V consumption yielded inconsistent results among the seven studies. At follow-up surveys, two studies reported statistically significant increases.[32-35] Further, these two studies demonstrated that with each additional nutrition education session attended, F&V consumption significantly increased (p for trend < 0.002).[32,35] One study found that F&V intake remained relatively constant throughout the study period for both the intervention and control groups.[37] However, another study found that F&V intake statistically significantly decreased ($p < 0.05$).[36] Lastly, one publication indicated that F&V intake increased at the two-month follow-up for both the intervention and control groups; however, at the eight-month survey the intervention group's intake had decreased below pre-assessment levels while the control group's consumption had continued to rise.[38] The F&V consumption results are described in more detail in Table 11.

Three publications from the Maryland WIC 5 A Day Promotion Program cross-over study indicated that F&V consumption statistically significantly increased after the extensive intervention.[32-34] The cross-over study design involved two phases in which the intervention and control groups in phase one were reversed for phase two.[32-34] Baseline overall fruit and vegetable intake showed a mean of 4.1 servings/day (SD = 2.9) and was higher among controls (4.20 (0.10)) than those in the intervention group (3.88 (0.11)).[32,33] F&V consumption increased from baseline to follow-up by over half a serving (change = 0.56 (SE = 0.11)) in the intervention group compared to a change of 0.13 (0.07) for the control group with a statistically significant difference between the changes of the two groups ($p = 0.002$).[32] Further, with attendance at each additional nutrition education session, F&V intake significantly increased ($p= 0.02$) as shown in Table 11.[32] However, attendance at the education sessions was low as shown in the top half of Table 11 and this study was further limited by an intense intervention that is likely not adoptable by the normal WIC program.

Another study that demonstrated a significant increase in F&V intake was the Maryland WIC Food For Life (FFL). The FFL was very similar to the Maryland WIC 5 A Day cross-over study design and intervention.[35] Baseline mean daily fruit and vegetable intake was similar for women in the control (3.5 (SE = 0.08)) and intervention group (3.5 (0.07)) and lower than that reported in the Maryland WIC 5 A Day Promotion Program.[32,35] At follow-up, intake decreased (-0.24 (SE 0.08)) for the control group and slightly increased for the intervention group (0.16 (0.08)) resulting in a net difference of change in intake between the control and intervention groups of 0.41 (0.11) servings/day (p = 0.0003).[35] Similar to the Maryland WIC 5 A Day Promotion Program, attendance at each additional nutrition education session in the FFL program, led to a significant increase in F&V intake (p = 0.002) as shown in the bottom half of Table 11.[35] This study was also limited by an extensive intervention that would likely not be able to be adopted by the usual WIC program.

Table 11 Impact of Attendance at Nutrition Education Sessions

Maryland WIC 5 A Day Promotion Program						
		Intervention (Number of Sessions)				
	Control	**0**	**1**	**2**	**3**	**P for trend**
Attendance (%)	NA	46.0	20.0	14.0	19.0	NA
Increase in F & V intake (mean servings)	NA	0.15	0.68	0.91	1.25	0.02
Correct knowledge [1]	0.143	0.143	0.256	0.303	0.366	0.0001
Positive attitudes [1]	0.056	0.061	0.201	0.249	0.284	0.0001
Perceived barriers [1]	-0.063	-0.019	-0.123	-0.144	-0.227	0.001
Self-efficacy [1]	0.055	0.123	0.215	0.289	0.338	0.0001
Maryland WIC Food For Life Program						
		Intervention (Number of Sessions)				
	Control	**0**	**1**	**2 or 3**	**4 or 5**	**P for trend**
Attendance (%)	NA	54.0	22.0	15.0	9.0	NA
Increase in F & V intake (mean servings)	-0.24	0.06	0.04	0.38	0.93	0.002
Correct knowledge (% correct)	49.7	46.0	61.4	74.7	86.0	<0.0001

[1] Mean changes in standardized psychosocial scores from regression models, adjusted for baseline score

Sources: [32,35]

Campbell et al. indicated relatively constant F&V consumption throughout the study for participants in both the FoodSmart computer-based intervention and those in the control group.[37] The caregiver's daily mean (SD) servings of fruit and vegetable intake did not significantly increase from baseline to follow-up for either the intervention group (3.5 (2.3) vs. 3.6 (2.2)) or the control group (3.1 (2.3) vs. 3.2 (2.4)).[37] A limitation of this study involves use of two methods for follow-up surveys by computer and phone.

The study that found a decrease in F&V intake was the Market Basket Booklet (MBB) intervention.[36] The mother's baseline daily F&V intake showed a mean (SE) of 4.5 (2.8) servings with 68% not meeting the five a day recommendations.[36] At the two-month follow-up, 86% had looked at the booklet and 60% had used a recipe(s).[36] Despite use of the MBB, F&V intake significantly decreased to 4.0 (2.7) ($p < 0.05$).[36] This study was limited by lack of a control group to compare intake results.

Chang et al. reported an initial increase in F&V intake, but this rise in consumption was not sustained at the second follow-up for the intervention group.[38] The Mothers in Motion (MIM) study reported that the average number of DVD chapters reviewed was 3.2 (mean) and participation in peer support group teleconferences (PSGT) sessions was 2.17.[38] F&V consumption increased at the 2-month follow-up for both the intervention and control groups (Intervention: baseline = (mean = 4.87 cups/day (SD = 4.41), two-month = (6.33 (3.42); Control: baseline = 4.25 (SD = 2.91), two-month = 4.73 (3.41)).[38] However, at the eight-month follow-up, intake decreased to below baseline levels for the intervention group (3.87 (3.52)), yet continued to rise for the control group 5.56 (3.50).[38] Limitations of this study include low-response rates at post-assessments (two-month: 54.3%, eight-month: 37.2%), and narrow inclusion criteria of overweight and obese women aged 18-34 years.[38]

ii) Nutrition Knowledge and Competencies Findings

The literature review found that there was an increase in nutrition knowledge and competencies for all WIC nutrition interventions. Evidence suggests two main results 1) fruit and vegetable intake was higher among WIC recipients who were: a) knowledgeable of the fruit and vegetable recommendations, b) had positive attitudes and self-efficacy about F&V, c) had better F&V competencies, and/or d) had less perceived barriers; and 2) following a nutrition education intervention targeting the WIC population, improvements can be found for: a) nutrition knowledge, b) attitudes, c) self-efficacy, d) competencies, and/or e) perceived barriers.[19,33-37] These primary two results will be discussed for nutrition knowledge and then for nutrition competencies.

(1) Nutrition Knowledge

Among the studies that examined how F&V intake was associated with nutrition knowledge and how a nutrition education intervention influences nutrition knowledge, four publications assessed knowledge in reference to the F&V recommendations [32-35] and one study described knowledge by three questions about choosing low-fat food options as previously shown in Table 7.[37]

The three publications describing the results of the Maryland WIC 5 A Day Promotion Program study found that the intervention group demonstrated a greater increase in correct nutrition knowledge of the F&V recommendations (baseline: 41%, follow-up: 57%) compared to the control group (baseline: 41%, follow-up: 46%) with a statistically significant difference of the knowledge change in the two groups ($p < 0.0001$).[32] Havas et al. estimated by multiple regression modeling that those with this nutrition knowledge consumed 0.87 more F&V servings per day than those who lacked this knowledge, adjusting for potential confounders ($p = 0.0001$).[33]

Langenberg et al. found that WIC recipients who gained correct nutrition knowledge following a nutrition education intervention consumed an average significant increase of 0.83 daily F&V servings ($p = 0.0001$).[34]

Further, a significant increase in correct nutrition knowledge of the F&V recommendations was demonstrated for attendance at each additional nutrition education session in the Maryland WIC 5 A Day Promotion Program study (p for trend = 0001) and the Maryland WIC FFL study (p for trend < 0.0001) as shown in Table 7.[34,35] The Maryland WIC FFL study indicated that 46% of intervention participants who participated in no nutrition education sessions correctly answered the knowledge question, compared to 86% of those who attended 4 or 5 sessions replied correctly.[35]

Campbell et al. indicated a similar increase in nutrition knowledge of selection of low-fat diet options for both the FoodSmart Program intervention and control groups. The mean knowledge score at baseline was 1.94 (SD = 1.2) for the intervention and 1.86 (1.2) for the control group with comparable increases at follow-up of 2.76 (0.46) for the former and 2.63 (0.55) for the latter.[37] Possible explanations for these similar results include a potential “ceiling effect” on knowledge questions since nearly all participants reported high knowledge and a lack of ability to examine the influence of additional nutrition education (e.g. usual WIC education) during the study.[37]

(2) Nutrition Attitudes and Competencies About F&V

Studies included in this section examined how F&V intake was associated with competencies about F&V and how a nutrition education intervention influences these competencies. These articles mainly examined measures of self-efficacy and one specifically examined choosing and storing F&V.[36] Results of these publications will be briefly described by study.

The Maryland WIC 5 A Day Promotion Program found that the mean (SD) baseline perceived barrier score was 9.4 (7.1) with a range of 0 to 28 with a higher score indicating more barriers.[33] The mean (SD) baseline attitude score was 17.3 (2.9) with a range of 0 to 20 with a higher score indicating higher attitudes.[33] There was a statistically significant change at follow-up from baseline between the intervention and control groups for the attitude score ($p = 0.003$), but not for the perceived barriers score.[32] Multiple regression modeling results including sociodemographic variables and all psychosocial characteristics, estimated that each standard deviation above the mean standardized perceived barrier score corresponded to 0.87 fewer servings of F&V ($p=0.0001$) and similarly 0.73 more servings for the attitude score ($p = 0.0001$).[33]

Further, the Maryland WIC 5 A Day Promotion Program and the Maryland WIC FFL Program found statistically significant increases in positive attitudes ($p = 0.0001$) and self-efficacy ($p = 0.0002$) and decreases in perceived barriers ($p = 0.001$) with the increasing number of nutrition education sessions attended as shown in Table 11.[34,35]

Campbell et al. in the FoodSmart study reported that the mean self-efficacy scores for eating fruits and vegetables increased from baseline to follow-up for both the intervention group (3.56 vs. 3.65) and control group (3.23 vs. 3.53), however the intervention group had a higher increase on the immediate follow-up survey (3.84).[37] Again, similar increases in self-efficacy of both groups might be explained by a lack of ability to examine the influence of additional nutrition education (e.g. usual WIC education) during the study.[37]

Lastly, the Market Basket Booklet study found that at follow-up, 86% had looked at the booklet and 60% had used a recipe(s).[36] Among participants who used the booklet, 70% felt much or somewhat more confident in choosing good quality fresh produce, 68% felt much or somewhat more confident in storing F&V appropriately, 96% felt the information on F&V seasonality was somewhat or very helpful, and 74% strongly or slightly agreed that they could more easily include fruits and/or vegetables in their family's meals.[36] Further, among participants who used the booklet and had more confidence in choosing good quality F&V, they were more likely to have more confidence in storing F&V too ($p < 0.0001$).[36]

In summary, the WIC nutrition interventions described above had a greater and more consistent impact on increasing nutrition knowledge, attitudes, and competencies than on F&V intake. This influence on nutrition knowledge, attitudes, and competencies was found to be the greatest from baseline to follow-up among women with a baseline F&V intake below five or more servings/day.[34] Despite these results, the limitations of these studies should be considered.

iii) Limitations of Research on WIC Nutrition Interventions

There are at least seven overall limitations from the research described above on the impact of nutrition interventions on F&V intake and nutrition knowledge and competencies. First, fruit and vegetable intake was only assessed for adult (> 16 years of age) WIC recipients or women with children WIC recipients. Fruit and vegetable intake was never described for children WIC recipients although children comprise 49% of all WIC recipients.[15] The Emory WIC FMNP Study assess F&V intake for both the mother and the child. Second, interventions were likely too extensive to be adopted by or incorporated into usual WIC nutrition education sessions. My study examined WIC as it normally functions with no additional intervention. Third, there have been no studies specifically in Georgia. Georgia is among the top seven states with the most WIC recipients.[21] Fourth, it is difficult to compare the existing literature due to differences in F&V measurement tools and questions/statements used in nutrition knowledge and competencies. The Emory WIC FMNP Study mainly uses existing measurement tools such as BRFSS. Fifth, most of the research has had moderate sample sizes (N< 500) with the exception of the two cross-over studies. Sixth, nearly all studies had self-administered surveys which may lead to less participation of women with low-literacy. All surveys were read aloud by trained interviewers to participants in my study. Seventh, no study included primarily African American women (largest percentage African American was 58.2%) as shown in Table 6. My study will fulfill the need for a study enrolling more African American recipients.

f) Research on WIC FMNP about F&V Intake and Nutrition Knowledge and Competencies

This section describes the studies and findings that examined the impact of nutrition education interventions on F&V intake and nutrition knowledge and competencies among WIC recipients who participated in the FMNP. The limitations of this research will be discussed along with how the Emory WIC FMNP Study addressed these limitations.

There were nine publications describing eight studies included in this section of the literature review since two articles [29,40] discussed results of the same project as shown in Table 12. All included publications discuss aspects of the WIC FMNP's impact on the following: 1) fruit and vegetable intake; 2) knowledge and/or competencies about F&V; and/or 3) types of fruits and vegetables purchased at the farmers' market. Every study included exclusively WIC recipients or caregivers of WIC recipients except Anderson et al. enrolled low-income female participants of the Community Action Agency Commodity Supplemental Food Program (CSFP); results for CSFP participants will not be discussed in this review. The CSFP population is similar to that of

WIC but it also includes elderly people and CSFP participants cannot also be WIC recipients simultaneously.[57] Further, CSFP participants receive actual foods to supplement their diets, whereas WIC recipients receive food vouchers for the supplemental food package.[57]

Table 12 Descriptions of WIC FMNP Studies

WIC FMNP Studies				
Author, Year	**Number of WIC Clinics**	**FMNP Coupon Value**	**Coupon Redemption Rate**	**Received Normal WIC Education**
Galfond, 1991	NA	Average $18.50/year	NA	Yes
Anliker, 1992	9 (6 FMNP, 3 WIC)	$10 (five $2)	79.1% used some, 57.6% used all	Yes
Anderson, 2001	NA	$20/year	87% used some, 58% used all	Yes
National Association of the FMNP	30 FMNP	NA	57%	NA
Herman (2), 2006	2 (1 FMNP, 1 WIC)	$40/month (five $2/week)	90.70%	Yes
Kroph, 2007	All in Athens County	NA	NA	Yes
Racine, 2010	2 (1 FMNP, 1 WIC)	$30/growing season	NA	Yes

Nearly all WIC FMNP studies assessed the WIC FMNP as it normally functions by providing a WIC staff-led nutrition education session and issuing FMNP coupons valued at $10-$30/year.[19,26,27,30,31,39] One study did not alter the usual WIC nutrition education but did provide a larger FMNP coupon subsidy ($40/month) than is distributed in the normal WIC FMNP program.[29]

Most publications assessed the impact of the FMNP on adult F&V intake [26,27,29-31,39] and few examined the effect on nutrition knowledge and competencies [19,39] with only one study assessing both consumption and knowledge and competencies about F&V.[39] Only two studies described specific fruits and vegetables commonly purchased at the farmers' market.[26,40] The measurement tools used to assess F&V and nutrition knowledge and competencies have already been described in sections "Nutrition Knowledge and Competencies about F&V Assessment Statements/Questions" and "Measures of F&V Intake" of this dissertation.

i) Fruit and Vegetable Intake Findings

Research that examined the impact of the FMNP on fruit and vegetable consumption used two methods: 1) cross-sectional comparison of WIC recipients not receiving FMNP coupons (controls) to those receiving FMNP coupons [27,30,31] or 2) longitudinal comparison of WIC recipients' intake before and after receiving FMNP coupons in addition to comparison with controls' intake during the same period.[26,29,39]

(1) Comparison of FMNP and non-FMNP Participants

Among the three studies that used the former method, the results were not consistent.[27,30,31] Comparison of those who received and did not receive FMNP coupons revealed that total F&V intake did not significantly vary in two studies by Racine et al. and Galfond et al.[27,30] On the contrary, Kroph et al. found that vegetable intake, but not fruit consumption, was significantly higher among those receiving FMNP.[31] These study results are described in more detail below.

Racine et al. demonstrated a non-significant difference in F&V consumption between pregnant women receiving (FMNP group) and not receiving FMNP coupons (WIC group) valued at $30 per year.[30] The FMNP group was from Washington, D.C. and the WIC group from Charlotte, NC since Charlotte had never issued FMNP coupons.[30] Average daily total F&V intake was slightly higher for those who received FMNP coupons (8.0 (SD = 7.6)) compared to those in Charlotte (7.7 (SD = 6.1)), but the difference was not statistically significant.[30] Non-significant results remained when F&V intake was considered with exclusions of fried potatoes and fruit juice.[30] This study was limited by inclusion of only pregnant women who likely have different dietary needs than non-pregnant women and secondly that the WIC and WIC FMNP groups were from different geographical locations with potential differences that were not accounted for.

Similar non-significant F&V intake differences between WIC and WIC FMNP recipients were also found by Galfond et al. A multi-state random sample of WIC recipients with those in the FMNP receiving $18.50 worth of FMNP coupons on average showed that F&V consumption was 5% higher for those with the coupons.[27] This study was strengthened by the use of two F&V intake measurement tools (24-hour recall and 7-day FFQ) to help resolve response variation, but the inclusion of six states made drawing conclusions difficult due to differences in access to farmers' markets.[27,28]

On the other hand, a statistically significant increase in vegetable intake, but not fruit consumption was found by Kroph et al.[31] Average daily fruit consumption did not vary among recipients who received FMNP coupons (1.69 (SD = 0.97)) and those who did not receive coupons (1.64 (1.21)) (p=0.769).[31] However, average daily vegetable intake was significantly different (p = 0.040) between these two groups with consumption higher among those who received FMNP coupons (2.23 (1.18)) than those without coupons (1.91 (0.98)).[31] Although this study included WIC recipients from the same clinic for both the WIC and FMNP groups, the low response rate (22.0%) to the mailed survey might make this study not representative of the recipients at this WIC clinic.[28,31]

(2) Longitudinal Comparison of WIC Recipients' Intake Before and After Receiving FMNP Coupons in Addition to Comparison with Controls' Intake During the Same Period

There were three studies that used the latter method of a longitudinal comparison of WIC recipients' F&V intake before and after receiving FMNP coupons in addition to comparison with controls' intake during the same period.[26,29,39] As with the former method, the findings of these studies were not consistent either. Anliker et al found no statistically significant difference between baseline and follow-up F&V intake between WIC recipients receiving FMNP coupons and those not receiving coupons.[26] On the other hand, Herman et al. indicated that intake of fruits, vegetables, and total F&V increased at follow-up more greatly for WIC recipients receiving FMNP coupons than those without coupons (control).[29] Lastly, Anderson et al. found that receiving FMNP coupons, but not FMNP education had a statistically significant effect on increasing F&V intake.[39] Results from these three studies are described in more detail below.

No significant difference was found by Anliker et al between baseline and follow-up F&V intake among WIC recipients receiving FMNP coupons valued at $10 compared to those not receiving coupons.[26] There were significant increases from baseline to follow-up for fruit (non-melon and non-citrus) and citrus juices ($p \leq 0.047$) and significant decreases in the intake of dark green vegetables ($p \leq 0.039$), peaches, nectarines, melons, and citrus fruits (All p's = 0.002); however, these intake differences were believed to be due to seasonal changes in availability of certain F&V.[26] Further, consumption of fresh vegetables was significantly greater among women who used their own resources (e.g. money or Food Stamps) at the farmers' market ($p< 0.01$).[26] This study was strengthened by collection of information on previous FMNP coupons use. Yet, this study was limited by late completion of approximately 35% of the follow-up surveys and a F&V measurement tool that may not have been sensitive enough to detect changes in intake due to survey responses: once a day or more, 3-6 times a week, once a week, once every 2 weeks, once a month or less.[26]

On the contrary, Herman et al reported that consumption of F&V increased at follow-up more greatly for primarily Hispanic WIC recipients receiving FMNP coupons worth $40/month than those without FMNP coupons (control).[29] The baseline average daily intake of servings of fruit and vegetables was higher for those in the FMNP group (5.4 servings) than the control group (5.0).[29] Following the intervention, the FMNP group increased to 7.8 servings per day at the end of the intervention and remained high at 7.5 servings 6 months after the end of the intervention.[29] On the other hand, the control site remained relatively steady with an average daily F&V intake of 4.8 servings at the end of the intervention and 4.9 servings six months after the intervention.[29] Linear regression indicated that participation in the FMNP intervention was significantly associated with higher F&V intake six months after the intervention ($p < 0.001$).[29] When fruit and vegetable intake were considered separately, FMNP participants significantly increased both fruit intake 0.51 servings per 4,186 kJ and vegetable intake 0.89 servings from baseline to the end of the intervention when compared to controls.[29] This study is limited in that the economic FMNP subsidy was greater than that provided by WIC.[29]

Anderson et al. found that receiving FMNP coupons valued at $20, but not WIC FMNP education, significantly increased F&V intake ($p < 0.01$) in Project FRESH (Farm Resources Encouraging and Supporting Health).[39] Average pre-assessment F&V intake was similar for the coupon and education group (5.83) and education only group (5.93), but less for the no intervention group (5.50).[39] Receiving the FMNP coupon was significantly associated with a change in F&V consumption behavior ($\beta = 0.33$, $p < 0.01$).[39] Strengths of this study involve use of a validated F&V consumption measure (BRFSS).[28]

ii) Nutrition Knowledge and Competencies

There were two publications that examined the impact of the FMNP on nutrition knowledge and competencies about F&V.[19,39] Project FRESH's impact on F&V intake has already been described above, however it should also be mentioned that the article by Anderson et al. was the only study to examine both adult F&V intake and nutrition knowledge and competencies following the WIC FMNP.[39] The other publication, "Program Impact Report for the 2002 WIC Farmers' Market Nutrition Program," primarily assessed F&V competencies such as storing and preparing [19]. Evidence from these studies suggests that nutrition knowledge and competencies can be improved following the WIC FMNP.[19,39] Study results by Anderson et al. and the National Association of FMNP are described in more detail below.

Anderson et al. demonstrated that participation in the nutrition education, but not receiving the FMNP coupon, was significantly associated with nutrition knowledge and competencies ($p < 0.01$).[39] The 20-minute nutrition education was an interactive lecture with questions asked in a game show format and covered "health, buying power, seasonality, storage, and preparation of fruits and vegetables."[39] More specifically, the education component had a positive significant effect on the attitude of "how much bother it is to prepare fruits and vegetables" ($p < 0.05$).[39]

The "Program Impact Report for the 2002 WIC Farmers' Market Nutrition Program" published information on the effects of the WIC FMNP on F&V competencies from 26 states, three Indian Tribal Organizations, and one territory (Guam).[19] The findings were focused on F&V competencies and found that nearly half of the overall U.S. FMNP participants "learned a new way to prepare fresh fruits and vegetables" (53%) and "learned a new way to store produce to prevent spoilage" (47%) following the FMNP.[19] The results for Georgia were lower with 45% for the former statement and 41% for the latter statement.[19] Interestingly, 38% of U.S. farmers participating in the WIC FMNP indicated that "they offer more nutrition education to market customers, e.g. recipes, product samples, advice on how to select, prepare or store fresh produce."[19] Yet, Georgia farmers fell well below this national average with only 18% of farmers in Georgia offering more nutrition education to WIC FMNP participants.[19] The expansive geographic representation of many WIC FMNP and the large sample size (N = 24,800) are strengths of this study.[28]

iii) Specific F&V Purchased from the Farmers' Market

The specific fruits and vegetables purchased at the farmers' markets were often not reported by the FMNP studies. Anliker et al. and Herman et al. did list the most common F&V purchased by WIC recipients using WIC FMNP coupons with tomatoes, lettuce, broccoli, potatoes, green beans, corn, apples, and peaches ranking high for both studies.[26,40] Study details were described in previous sections, and results listing specific F&V purchased using FMNP coupons are described below.

Anliker et al. reported the F&V that were purchased by more than 5% of the FMNP recipients. The fruits that most recipients purchased were apples (28.5%), peaches (13.9%), pears (11.1%), and plums (9.0%).[26] Similarly the most common vegetables were corn (38.2%), tomatoes (31.3%), peppers (13.2%), cucumbers (12.5%), squash (12.5%), green beans (9.7%), cabbage (9.0%), and lettuce, potatoes, greens/Collard Greens, and broccoli (each at 8.3%).[26]

Herman et al. assessed the fruits and vegetables as a percent of the total F&V items reported to have been purchased by FMNP recipients. At a post-assessment two months after the pre-assessment, study participants were asked, "What did you buy with your fruit and vegetable coupons last week?"[40] The top ranking fruits purchased at the farmers' market included: apples (25.4%), oranges (19.2%), peaches (13.9%), grapes (8.4%), and strawberries (7.1%).[40] Similarly, the most purchased vegetables were tomatoes (14.2%), lettuce (13.2%), broccoli (11.7%), carrots (9.8%), potatoes (9.1%), green beans (7.1%), and corn (5.0%).[40]

iv) Previous Use of FMNP Coupons

The use of previous FMNP coupons has the potential to influence use of FMNP coupons from the current year. For example, if the WIC recipient had an enjoyable experience and received good quality F&V from the farmer using her FMNP coupons, she would be likely to return the following year. Racine et al. found that WIC recipients with previous FMNP participation had statistically significantly greater use of the current farmers' market (61.0%) compared to recipients with no prior involvement (40.0%) ($p = 0.006$).[30] Further, 80.5% of WIC FMNP recipients in the Washington, D.C. clinic who had previous FMNP participation had actually redeemed their coupons.[30] Unadjusted linear regression results estimated that recipients who had previously participation in the FMNP were three times more likely to use the current farmers' market (OR = 3.30 (95% CI: 1.57 – 6.93)) and those who had used their FMNP coupons in prior years were nearly five times more likely to use the farmers' market (OR = 4.96 (2.15 – 11.45).[30] These results support (or suggest) that previous participation in the FMNP and current use of FMNP coupons are important to consider in the Emory WIC FMNP Study.

v) Limitations of Research on WIC FMNP

There are at least eight overall limitations from the research described above on the impact of the WIC FMNP on F&V intake and nutrition knowledge and competencies. These limitations are similar to those listed in the previous section on nutrition education interventions. First, fruit and vegetable intake was only assessed for adult (> 15 years of age) WIC recipients or women with children WIC recipients, but not for children WIC recipients. The Emory WIC FMNP Study assessed F&V consumption for both mother and child. Second, there was no distinction between consumption of fruits and vegetables purchased at farmers' markets versus those bought at supermarkets. Third, there has only been the national report including residents of Georgia, but no studies located specifically in Georgia. For more than 15 years, Georgia's WIC FMNP has been functioning and my study will be the first to formally evaluate the farmers' market. Fourth, it is difficult to compare the existing literature due to differences in F&V measurement tools, variation in FM coupon values, and lack of reporting of descriptive demographic characteristics. My study primarily uses measurement tools already existing in the literature and fully reports descriptive demographic characteristics. Fifth, half of the research has been cross-sectional and there is a need for more longitudinal studies with larger sample sizes and improved response rates. The Emory WIC FMNP Study was longitudinal in design with three assessments, baseline, 1-week, and 4-week for approximately 125 women and 125 children with approximately 82% response rates for each of the follow-up surveys. Sixth, among women WIC recipients, pregnancy and breastfeeding status should be accounted for due to likely increased F&V intake compared to non-pregnant and non-breastfeeding women. My study excluded pregnant women, but did assess breastfeeding status among postpartum women. Seventh the only study that enrolled only African American WIC recipients included only pregnant women.[30] My study fulfills the need for a study enrolling non-pregnant African American recipients. Lastly, only one study examined the impact of the WIC FMNP on F&V intake and nutrition knowledge and competencies about fruits and vegetables. The Emory WIC FMNP Study will be the second study to examine these impacts; my study will use the same F&V intake measurement tool (BRFSS), but will include more nutrition knowledge and F&V competency questions.

2) Emory WIC FMNP Study

This section will describe the Emory WIC FMNP Study design, sample size calculations, and inclusion/exclusion criteria.

a) Study Overview

The Emory WIC FMNP Study was a prospective study evaluating the impact of the Georgia WIC FMNP. The study was longitudinal with three surveys: baseline (in-person at the WIC clinic), 1-week follow-up (phone), and 4-week follow-up (phone). There were two study arms: 1) non-Farmers' Market group and 2) Farmers' Market group. Data was collected from June – August 2009 for the non-FM group and from July – September 2009 for the FM group from WIC recipients attending two WIC clinics, Kirkwood and Adamsville, in metropolitan Atlanta, Georgia. The planned interview dates for the two study arms are shown in Table 13 for both the non-FM and FM groups at each WIC clinic.

Table 13 Planned Emory WIC FMNP Study Interview Dates

Survey	Non-FMNP Group		FMNP Group	
	Adamsville	**Kirkwood**	**Adamsville**	**Kirkwood**
Baseline	June 10, 17, 24	June1, 2, 3, August 3	July 1, 8, 15, 22, August 12	July 1, 2, 6
One-Week	June 17, 24, July 10	June 8, 9, 10, August 10	July 8, 15, 22, 29, August 19	July 8, 9, 13
Four-Week	July 1, 8, 15	June 29, 30, July 1, August 31	July 29, August 5, 12, 19, September 9	July 29, 30, August 3

The non-FM group was included as a "control" group and was compared to the FM group which was similar to the non-FM group except that the non-FM group did not participate in the FMNP.

The non-Farmers' Market (non-FM) group received:

1. Usual WIC food vouchers every three months;
2. Usual nutrition education sessions at every WIC visit provided by WIC staff; and
3. WIC re-certification assessment every six months.

The Farmers' Market (FM) group received:

1. Usual WIC food vouchers every three months;

2. Usual nutrition education sessions at every WIC visit with focus on the Farmers' Market, FM coupon redemption, and F&V provided by WIC staff; and
3. Five-$6.00 ($30 total) FM coupons to be redeemed at any of the WIC certified farmers' markets across Georgia for locally grown F&V;
4. WIC re-certification assessment every six months.

The usual WIC vouchers listed for the non-FM and FM groups included vouchers for 100% fruit juice among WIC recipients 4 months of age or older. Vouchers for carrots were issues to WIC recipients who were fully breastfeeding. Other than 100% fruit juice and carrots, vouchers did not include any other fresh, canned, frozen, or dried fruits and vegetables.

ii) Power/Sample Size Calculations

During study planning, I determined that an estimated sample size of approximately 60 participants in both the FM and non-FM groups (120 total participants) were needed to detect an effect size of half a unit change in daily fruit and vegetable intake when the standard deviation was one unit with 80% power and alpha level of 0.05.[58] The sample size calculations were completed by Paul Weiss in the Biostatistics Department at the Rollins School of Public Health at Emory University during the grant writing phase of the WIC study. The calculations can be repeated at www.openepi.com using the sample size for comparing two means. The confidence interval is set at 95%, power at 80%, ratio of sample size at 1, the mean difference in the F&V intake between the non-FM and FM groups at 0.5 and the standard deviation at 1 for both groups. The OpenEpi program computes sample sizes of 63 for the non-FM group and 63 for the FM group, making a total of 126 participants.

iii) Inclusion/Exclusion Criteria

Inclusion criteria comprised the following:

- Women receiving WIC services for themselves and/or their children
- Women who were 18 years of age or older
- Women who were not pregnant
- Women who were English-speaking as defined as English is the primary language spoken in their home
- Women whose oldest child receiving WIC services was at least one year of age, but not older than five years of age
- Women who had custody of their oldest child who received WIC services during the past year
- WIC recipients could be present for a health assessment or nutritional risk appointment for herself or her child
- Women who participated in my pilot phase of the survey, if they volunteered again

Exclusion criteria included the following:

- Women who visited the WIC Clinic and attempted to pick up WIC vouchers, but could not pick up vouchers
- WIC recipients who were enrolled to receive WIC services at a WIC clinic different than the study's two clinics of Kirkwood or Adamsville
- Women who had not previously received WIC vouchers (this was their first day of receiving WIC vouchers)

b) Comparison of WIC Clinics

This section will describe the two WIC clinics, Kirkwood and Adamsville, regarding their physical location and facility characteristics, issuance of WIC food vouchers, and nutrition education. Also, the WIC FMNPs will be described for each clinic location including the F&V available at the farmers' markets, the issuance of the FMNP coupons, and the farmers' market visitation process.

i) Physical Location and Facility Description of WIC Clinics

Two WIC clinics in the metropolitan Atlanta area were selected from the two counties that serve the highest number of WIC recipients in Georgia, Kirkwood WIC Clinic in DeKalb County (N = 24,508 WIC recipients from 2007 fiscal year data) and Adamsville WIC Clinic in Fulton County (N = 22,797).[22,23] Selection of the WIC clinics was based on the following six criteria: 1) study feasibility including dates/days of WIC re-certification and FM coupon issuance; 2) ease of data collection (e.g. lack of time/funds to travel to clinic too far from the metro Atlanta area); 3) large number of WIC recipients in order to meet sample size requirements; 4) similar demographic characteristics of recipients; 5) approximate number of families meeting inclusion/exclusion criteria per day; and 6) presence of a farmers' market on-site at the WIC clinic during the FMNP coupon issuance period.

Although the WIC clinics included in the Emory WIC FMNP Study were similar in regard to the selection criteria, there were differences that are worthy of comment since WIC clinic was a potential confounder included in the analysis. The variations include: the physical WIC facility, issuance of WIC vouchers, WIC nutrition education sessions, WIC FMNP logistics, issuance of WIC FMNP coupons, and selection of F&V from the farmer's markets.

Kirkwood

The Kirkwood WIC Clinic was located in the Kirkwood Health Center at 30 Warren Street SE, Atlanta, Georgia, 30317. This WIC clinic was separated by a wall and closed door from the other services provided in the health center such as children and adolescent health, family planning, and pregnancy testing. Inside the WIC clinic was a spacious waiting room with vinyl chairs, couches, tables, a play area with puzzles and wood-block toys for the children, and a television which often played children's media (e.g. Dora the Explorer). The noise level in this room was often low and the temperature cool. There was nutrition educational material in both English and Spanish on the walls available to WIC recipients free of charge.

There was one check-in window connected to the office for WIC recipients to drop-off their WIC identification folders in a basket. There were three windows connected to the office for WIC clinic staff to interact with the recipients regarding questions or paperwork. Off of the waiting room, there was a room with scales for measuring weight and height and medical equipment to take blood for assessing serum nutrient levels. Connected to both the waiting room and the room for medical assessments was a hallway which led to the WIC office and approximately four small rooms used by nutritionists and dietitians for nutritional counseling for nutritionally-at-risk WIC recipients. At the end of this hallway was a large room with long tables and chairs along with food demonstration tools used for the nutrition education session such as examples of portion sizes and samples of various foods for tasting.

The Kirkwood WIC clinic was open from 8:15 AM until 5 PM, with a one hour lunch break for clinic staff from noon until 1 PM. The first nutrition class began around 9 AM and the last was around 4:15 PM.

Adamsville

The Adamsville WIC Clinic was located in the Adamsville Health Center at 3699 Bakers Ferry Road SW, Atlanta, Georgia, 30331. This WIC clinic was not separated by a closed door from the other services provided at the health center including: child health check exams, dental services, family planning, HIV screening and treatment, STD screening and treatment, pregnancy tests, lead screening, tuberculosis screening, and eye, ear, and dental screening.[59] Inside the WIC clinic's general area was a small waiting room with vinyl chairs and there were no toys or areas for children to play. The room was noisy, crowded, and the temperature was often warm. There was no nutrition educational material available free of charge to WIC recipients.

There was one check-in window in the WIC office for the WIC recipients to take a numbered ticket from a ticket wheel. There were two windows connected to the office for WIC clinic staff to interact with the WIC recipients regarding questions, paperwork, and issuing WIC vouchers; however, only one window was usually open and the drop-off window was usually used concurrently for check-in, questions, paperwork, and issuing WIC vouchers. Off of the waiting room, there was the dental waiting room and check-in window for dental services. WIC recipients often over-flowed into the dental waiting area or were standing in the hallway. Nutrition education was given in the waiting room. Nutritional counseling for mothers and/or children at nutritional risk was given at the office window or another area of the WIC clinic that was not near enough for the woman to hear her ticketed number called at the WIC window.

The WIC clinic was open from 8:30 AM until 5 PM, with a one hour lunch break for clinic staff from noon until 1 PM. The first nutrition class began around 10 AM and the last was around 3:30 PM.

ii) Issuance of WIC Vouchers

Kirkwood

At the Kirkwood WIC Clinic, WIC recipients dropped off their WIC identification folder at the check-in window upon entry. The WIC identification folder was the recipient's WIC record which the recipient received during enrollment for WIC services. The women sat in the waiting area until they were called back for nutrition education that lasted about twenty to thirty minutes. Often the women were given their printed WIC vouchers at the end of the education session and would leave the WIC clinic. However, sometimes the women returned to the waiting area after the education session and their name would be called to pick up their WIC vouchers at one of the four front windows. The average waiting time was one hour with a range of approximately half of an hour to two hours.

Adamsville

WIC recipients entering the Adamsville WIC facility would take a numbered ticket at the check-in window and then take a seat in the waiting area. Sometimes the WIC staff at the window would take the WIC recipients' WIC identification folder, place half of a numbered ticket in the folder, and give the women the other ticket half in order to call the WIC recipients back to one of the office windows to pick up their WIC vouchers. At other times, the WIC recipients took a seat with their numbered ticket and WIC identification folder and the WIC staff collected the folders and half tickets as a group at a later time. While the WIC recipients sat until their number was called, nutritional education material was often administered to the entire group in the waiting area. Once their WIC vouchers were printed, the WIC recipients' ticketed number was called from one of the three windows and the women sat at the chair at the window and obtained their vouchers before leaving. The average waiting time was two hours with a range of approximately an hour-and-a-half to four hours.

iii) Nutrition Education Sessions

Kirkwood

Kirkwood WIC recipients participating in the non-farmers' market group received nutritional education on low-fat milk, such as 1% or skim milk. Milk education was in response to the changes in the WIC supplemental food package that began in October 2009. The nutritionist leading the educational session discussed three components: 1) nutrients (e.g. calcium) and the importance/benefits of these nutrients in milk and dairy products, 2) the recommended number of eight-ounce glasses a day for various ages, and 3) the pros/cons of flavored milk (e.g. chocolate or strawberry). Further, the nutritionist had tasting samples of different fat contents of milk.

The educational material changed to fruits and vegetables for the farmers' market group and the following three topics were discussed: 1) the farmers' market and how to use the farmers' market coupons, 2) nutritional value of fruits and vegetables, and 3) the addition of WIC vouchers for fresh, frozen, and canned fruits and vegetables in the new WIC package.

Educational materials at Kirkwood after the farmers' market were focused on the new WIC food package.

Due to exclusions of non-farmers' market participants due to the child's age under one year, interviewers returned to Kirkwood to enroll more participants after the conclusion of the farmers' market to be considered in the non-farmers' market group.

All nutrition education sessions lasted about 20 to 30 minutes. The educational material was fairly constant from session to session since one to two women were the primary leaders of the nutrition sessions.

Adamsville

At the Adamsville WIC Clinic, WIC recipients in both the non-farmers' market and farmers' market groups received nutritional education on fruits and vegetables. The education primarily focused on the upcoming or current farmers' market, but also introduced the approaching changes in the WIC food package. The main component of the education was a pre-/post-test with three true/false questions to which the WIC staff provided answers with minimal elaboration. However, on one occasion, the educational content was expansive with the benefits of F&V and the importance of colorful F&V explained and handouts with instructions for preventing food spoilage and recipes were provided.

Although five non-farmers' market participants were excluded due to the child being less than one year of age, there remained an adequate number of non-farmers' market participants after these exclusions. Therefore, interviewers did not return to Adamsville after the farmers' market to enroll more non-farmers' market participants as was done at the Kirkwood clinic.

Length of nutrition education sessions varied from less than five minutes to 15 minutes and one day there was no education session. The educational material depended on the WIC staff available. The nutrition material varied nearly every session since the leader of the session was different also.

iv) WIC FMNP Location and F&V Available

Kirkwood

The WIC FMNP at the Kirkwood WIC Clinic was located in a parking lot across the street from the WIC Clinic and not easily visible to WIC recipients who did not drive their own vehicle and park down the hill from this parking lot. The F&V were displayed neatly on two or three clean fold-up tables in either a clear plastic bag (e.g. grapes) or in green cardboard bins yielding similar amounts of F&V (e.g. three apples, five yellow squash). The melons, cantaloupe and watermelon, were on the ground or in the back of the farmers' pick-up truck.

The fruits available at the farmers' market were: apples, bananas, cantaloupe, grapes, peaches, plums, strawberries, watermelon, and nectarines. The vegetables available were: cabbage, collard greens, cucumbers, squash, sweet peppers, tomatoes, sweet potatoes, white potatoes, and turnips. With the exception of bananas and grapes, all fruits and vegetables were native to Georgia.

An umbrella and a tree provided shade for the fruits and vegetables. For a customer wishing to taste a fruit or vegetable, the farmer had water bottles and paper towels to clean the produce. On one day, the farmer provided a sample of cherries to all the women and children standing in line. There was a main farmer and an assistant who answered questions, bagged produce, and acted as cashier. The farmer was present on all days of the WIC FMNP coupon issuance beginning around 9:30 AM until he was out of F&V (anywhere from 2-5 PM).

Adamsville

The Adamsville WIC FMNP was located in the main WIC parking lot and easily visible upon leaving the WIC Clinic regardless of type of transportation. The fruits and vegetables were displayed in large wooden, cardboard, and plastic boxes on two to three clean fold-up tables and in the grass. The fruits and vegetables were either pre-packaged in a bag (e.g. green beans) or stored loosely in a box (e.g. corn).

The F&V available at the farmers' market were primarily native to the Georgia area. The fruits included: cantaloupe, peaches, plums, and nectarines. The vegetables included: broccoli, cabbage, collard greens, corn, green beans, okra, squash, sweet potatoes, and white potatoes.

A shade tent was set up to cover some of the tables. There was a main farmer and two to three assistants who answered questions, bagged produce, and acted as cashier. The farmer was present on all days of the WIC FMNP coupon issuance beginning around 10-10:30 AM until out of produce (anywhere from 4-5PM).

v) Issuance of WIC FMNP Coupons and Farmers' Market Visitation

There were five important differences in methods of the WIC FMNP administration at the two clinics: 1) the degree of interaction with the farmer (e.g. chance to ask questions about F&V); 2) opportunity to select own F&V from the farmers' market; 3) packaging of F&V purchased at farmers' market; 4) ability to save some of the FMNP coupons for later use; and 5) requirement to use FMNP coupons at specific farmers' markets. The fifth difference, requirement to use FMNP coupons at specific farmers' markets, needs further explanation. WIC recipients at the Kirkwood clinic had the opportunity to use their FMNP coupons at the farmers' market located near the WIC clinic or a different farmers' market or roadside stand that was approved to receive WIC FMNP coupons. However, at the Adamsville clinic, recipients were required to use their FMNP coupons at the farmers' market at the WIC clinic.

Kirkwood

Along with the usual WIC vouchers, the Kirkwood WIC Clinic provided WIC recipients with $30 (six $5 vouchers) worth of FMNP coupons with an expiration date in two weeks. The WIC recipients who chose to visit the farmers' market had an opportunity to interact with the farmer such as ask questions about fruits and vegetables, were able to select the F&V of their choice from the farmer, and then left with their F&V packaged in plastic grocery-sized bags. WIC recipients had an opportunity to purchase more F&V with their own money from the farmer and if they did not use all of the FMNP coupons, they could return within the two week period to purchase more F&V from the farmer or at another approved farmers' market. The average waiting time from check-in until the WIC recipients' vouchers and coupons were printed was again one hour with a range of approximately half-an-hour to two hours.

Adamsville

The Adamsville WIC Clinic provided WIC recipients waiting to pick-up regular WIC vouchers with an ordering form for the farmers' market. The farmers' market ordering form included the F&V that were available at the farmers' market. Recipients selected up to $30 worth of the type and quantity of F&V they would like to purchase from the farmer with their FMNP coupons (e.g. 10 peaches for $6.00, 2 collard bunches for $6.00, or 8 ears of corn for $6.00). The forms were collected and given to the farmer to begin filling the orders by gathering and bagging the selected produce for each recipient. Once WIC recipients received their WIC vouchers and FMNP coupons, they exited the health center to pick up a trash bag-sized plastic bag of their ordered F&V from the farmer. This method of administration limited interaction with the farmer and the opportunity for the WIC recipient to choose their own F&V after visualizing them at the farmers market in person. Thus, WIC recipients at the Adamsville FMNP could select which F&V they wanted from the ordering list, but they did not have the opportunity to hand-select their own F&Vs. WIC recipients were able to purchase more F&V from the farmer with their own money. However, recipients were not allowed to only use some of their FMNP coupons; they had to use all of their coupons during this visit to the farmers' market. The average waiting time from check-in until the WIC recipient's number was called and F&V were bagged by the farmer was about two-and-a-half hours with a range of approximately two to four-and-a-half hours.

c) Emory WIC FMNP Study Data Collection

This section will describe the Emory WIC FMNP Study data collection process and include a flow diagram detailing participation at baseline and one- and four-week follow-up surveys. Study interviewer training and the pilot study will be discussed along with a calendar indicating scheduled interview dates.

The data collection process for all three surveys (baseline, 1-week, and 4-week) was similar at both WIC clinics (Kirkwood and Adamsville) and for the non-farmers' market and farmers' market groups.

Upon entering the WIC Clinic, WIC recipients provided the WIC staff with their WIC identification packets to begin processing and printing WIC food package vouchers for both the non-FM and FM groups and FMNP coupons for the FM group. Once the women found a seat in the waiting area, trained Emory WIC FMNP Study interviewers introduced the study either individually to each woman or to a group of women in the waiting area. If a woman showed interest in participating, the interviewer stated inclusion/exclusion criteria to see if the recipient was willing to volunteer and eligible to participate. After WIC recipients were confirmed as meeting inclusion criteria, they reviewed and voluntarily signed an informed consent form. The trained interviewer provided the recipient with a copy of the consent and then began reading the baseline interview aloud in the WIC waiting room.

The baseline interview was sometimes interrupted for the nutrition education session or nutritional risk counseling, but the survey was always resumed. Attempts were made to complete the baseline interview before the education session was started to record the woman's "true baseline" nutrition knowledge and competencies prior to receiving education on F&V from the WIC staff. However, this was not always feasible since the study was designed to not interfere with the normal WIC operations. If a woman's name or ticketed number was called from one of the WIC staff's windows or she or her children were called to meet with a nutritionist and/or have any laboratory tests completed (e.g. blood drawn), then the interview was once again stopped and then resumed.

At the close of the interview, study participants were given a $5.00 grocery store (i.e. Kroger) gift card to thank them for their participation. The gift card number was recorded before given to the participant to document disbursement of the card to be able to account for missing cards. WIC recipients then left the WIC clinics after the education session was finished, the baseline survey was complete, and they received their WIC vouchers (non-FM group) or WIC vouchers and FM coupons (FM group). Review of the informed consent and the reading and responding of the baseline survey lasted approximately 25 minutes in length.

Approximately one week from the date of completing the baseline interview, WIC study participants were contacted by telephone to complete the one-week follow-up survey. The one-week survey was approximately ten minutes for the non-farmers' market participants and about twenty minutes for the farmers' market group since additional questions regarding the farmers' market experience were asked. Nearly four weeks from the date of the baseline interview, WIC study participants who participated in the baseline survey were contacted by phone for the four-week follow-up survey. The four-week survey was approximately ten minutes for both the non-FM and FM groups. Recipients were contacted regardless of whether they completed the one-week survey. If the FM participant did not complete the one-week survey, the four-week survey was extended to include thirteen questions about the farmers' market from the one-week survey.

The baseline survey asked for a phone number and a convenient time and day to complete the one-week survey. Multiple phone numbers were sought because many of the women moved often or had pre-paid cell phone minutes. The one-week survey asked similar telephone contact information and confirmed the convenient time/day to complete the four-week survey. If participants did not answer the telephone for the follow-up surveys, a message was left stating that the Emory WIC FMNP Study team was calling to complete the one-week or four-week survey and that a member of the study team would call back at a later time and/or day. The participant was re-contacted to complete a follow-up survey up to three times.

For completion of either the one-week or four-week phone surveys, the participant was mailed a $5.00 Kroger gift card. However, if the participant completed both follow-up phone surveys, she was mailed a $20.00 Kroger gift card. The gift card number was recorded before all mailings to document disbursement of the card to be able to account for missing cards.

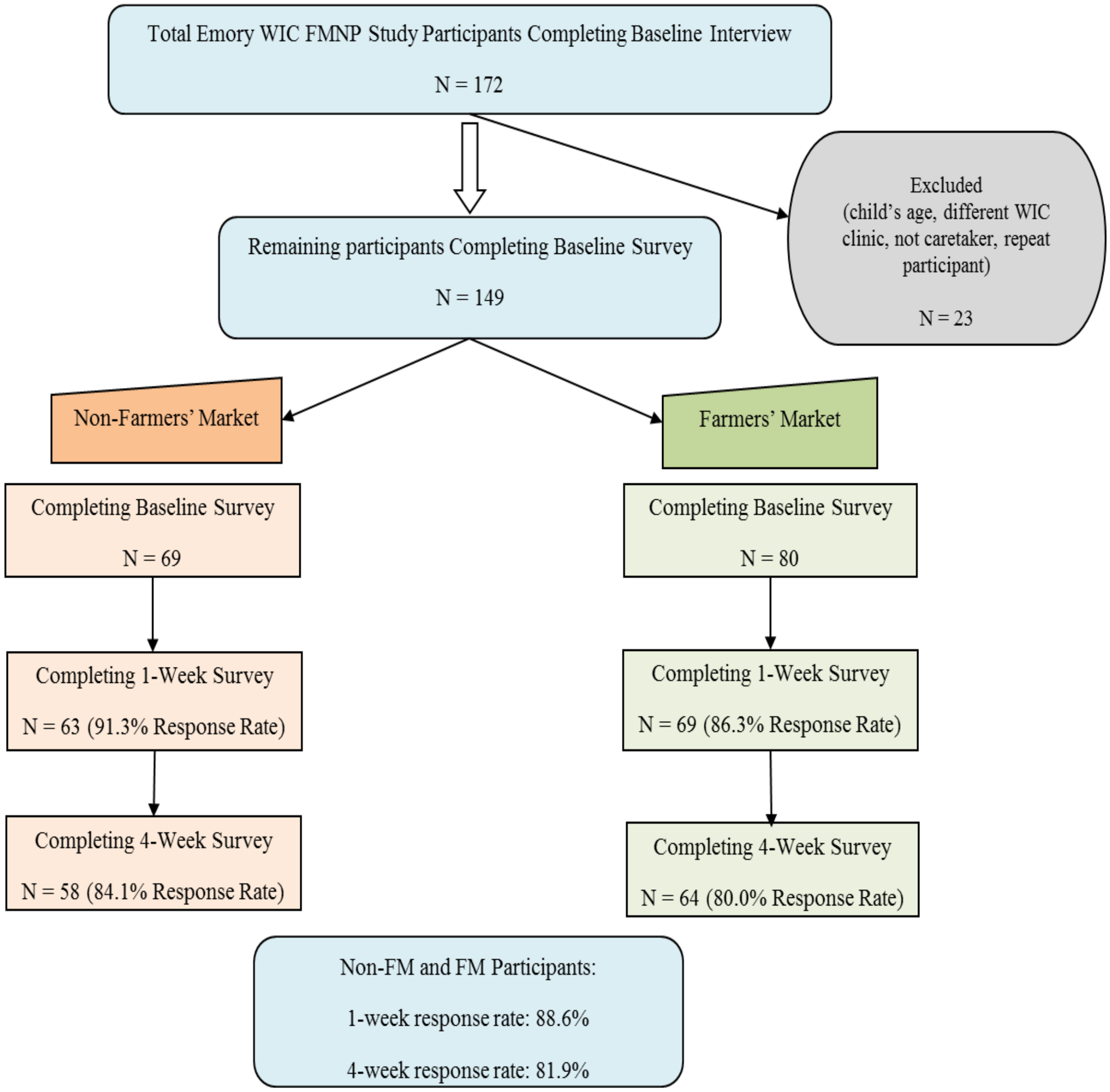
i) Additional Exclusion

Originally, the study included children less than one year of age. However, during the second week of baseline interviews, the study team decided that the F&V intake for children less than one year of age was minimal because these children were primarily on a milk-based diet (e.g. breast milk, formula) or not eating solid foods (e.g. baby foods). This additional age-based exclusion criterion resulted in 16 study participants being excluded. These excluded women and children received a mailed letter stating that they were no longer eligible and no further follow-up interviews were completed. The inclusion/exclusion criteria used by interviewers at the WIC clinics were modified to include this new age-based criterion for the continuation of the study. An additional five study participants were excluded after the baseline survey due to various reasons including: WIC recipient was enrolled in a different WIC clinic than Kirkwood or Adamsville (N = 1), recipient did not have custody of the child (N = 1), recipient was previously included as a study participant in the actual study (N = 1), and recipients agreed that their primary language was English during review of the inclusion criteria, but answered that French or Patois was their primary language spoken at home in the baseline survey (N = 2). Study participation, exclusions, and follow-up are described in the below flow diagram.

ii) Flow Diagram of Participation

The final baseline study population included 69 women and 69 children in the non-FM group and 80 women and 80 children in the FM group as shown in Figure 1. Overall participation rates were high and similar for the one-week (88.6%) and four-week (81.9%) surveys. These rates were comparable or higher than those of other studies of including WIC recipients as shown previously in Table 4.

Figure 1 Flow Chart of Emory WIC FMNP Study Participants



iii) Interviewer Training and Pilot of Emory WIC FMNP Study

Interviewers were trained prior to the pilot study and actual Emory WIC FMNP Study. The study protocol, informed consent, and surveys were reviewed at training. Interviewers completed the Collaborative Institutional Training Initiative (CITI) online course. Emory WIC FMNP Study staff along with Emory Rollins School of Public Health Students participated in practice interviews to help interviewers learn potential responses and questions that could be asked by WIC recipients. All interview training took approximately 15 hours.

A pilot phase of the Emory WIC FMNP Study was completed to determine study feasibility at the Kirkwood and Adamsville WIC Clinics in terms of adequate participant enrollment and location and ability to administer the survey. The pilot provided trained interviewers an opportunity to familiarize themselves with the WIC clinic and WIC staff, the flow of WIC recipients throughout the WIC clinic regarding receipt of WIC food vouchers and nutrition education sessions, and practice enrolling participants in the Emory WIC FMNP Study. The pilot phase was completed on May 1, 2009 at the Kirkwood WIC clinic and May 20, 2009 at the Adamsville WIC Clinic. The pilot phase data was entered into Excel files to determine if any changes were needed in the data entry system for the full study.

d) Survey Questions for Emory WIC FMNP Study

This section describes the when the F&V consumption, nutrition knowledge and competencies, potential confounders of interest, and demographic characteristics are asked by survey. The sources for the F&V intake and nutrition knowledge, and competencies about F&V survey questions as discussed also.

i) Overview of Surveys

The specific outcomes, exposures, potential confounders, and demographic characteristics of interest and the surveys (baseline, one-week, and four-week) in which these measures are included are summarized in Table 14.

Table 14 Survey Questions Included in Analysis			
Measure	**Survey**		
	Baseline	**1-Week**	**4-Week**
Outcomes			
Mother's F & V Consumption	X	X	X
Child's F & V Consumption	X	X	X
Exposures			
Nutrition Knowledge	X		X
Nutrition Attitudes and Competencies		X	
Potential Confounders			
Farmers' Market Participation	X	X	
WIC Clinic	X		
Other Food Aid (TANF, SNAP)	X		
Demographic Characteristics			
Mother's Age	X		
Child's Age	X		
Educational Level	X		
Marital Status	X		
Number of WIC Recipients	X		
Number in Household	X		
Previous WIC FMNP Coupon Use	X		
Breastfeeding	X		

ii) Fruit and Vegetable Intake Questions

The mother’s and child’s fruit and vegetable consumption questions used in this research were modified from F&V questions on the BRFSS as shown in Table 15 and previously described in the “National Surveys” section. Consumption of the same six fruits and vegetables (fruit juice, fruit, green salad, carrots, potatoes, other vegetables) were included in both the Emory WIC FMNP Study and BRFSS. There were two main modifications: 1) a shorter time period applying to reported F&V intake (Emory WIC FMNP Study: day, week; BRFSS: day, week, month, year) and 2) more detailed explanations of specific fruits and vegetables as shown in Table 15.

The Emory WIC FMNP Study used similar directions as the BRFSS directions. The BRFSS directions were: "These next questions are about the foods you usually eat or drink. Please tell me how often you eat or drink each one, for example, twice a week, three times a month, and so forth. Remember, I am only interested in the foods you eat. Include all foods you eat, both at home and away from home". The Emory WIC FMNP Study directions for the mother were: "These next questions are about the fruits and vegetables you ate or drank in the past week, that is the last seven days. Please tell me how often you ate or drank each one, for example, twice per day, once per day, twice a week, and so forth. Remember, I am only interested in the foods you ate. Include all foods you ate both at home and away from home." The Emory WIC FMNP Study directions for the child were: "These next questions are about the fruits and vegetables your oldest child who receives WIC ate or drank in the past week, that is the last seven days. Include all foods he/she ate, both at home and away from home."

Table 15 Modifications of Fruit and Vegetable Questions for Mother's Intake from BRFSS				
Emory WIC FMNP Study Survey			**BRFSS**	
Question Numbers	**Question Wording**	**Possible Responses**	**Source Wording**	**Source Possible Responses**
B2, 1W1, 4W1	**Thinking about the past week, this is the past 7 days,** how often did **you** drink 100% fruit juices such as orange, grapefruit, or tomato? You can tell me either the number of times per day or the number of times per week. Do not include fruit-flavored drinks with added sugar or fruit juice you made at home and added sugar to.	__ Per day __ Per week Never Don't know/unsure Refused	How often do you drink fruit juices such as orange, graefruit, or tomato?	__ Per day __ Per week __ Per month __ Per year Never Don't know / Not sure Refused
B3, 1W2, 4W2	**In the past week,** not counting juice, how often did **you** eat fruit? You can tell me either the number of times per day or the number of times per week. Please think about all forms of fruits including fresh or raw, frozen, canned or cooked.	__ Per day __ Per week Never Don't know/unsure Refused	Not counting juice, how often do you eat fruit?	__ Per day __ Per week __ Per month __ Per year Never Don't know / Not sure Refused
B4, 1W3, 4W3	**In the past week,** how often did **you** eat green salad? You can tell me either the number of times per day or the number of times per week.	__ Per day __ Per week Never Don't know/unsure Refused	How often do you eat green salad?	__ Per day __ Per week __ Per month __ Per year Never Don't know / Not sure Refused
B5, 1W4, 4W4	**In the past week,** how often did **you** eat potatoes, not including French fries, fried potatoes, or potato chips? You can tell me either the number of times per day or the number of times per week.	__ Per day __ Per week Never Don't know/unsure Refused	How often do you eat potatoes not including French fries, fried potatoes, or potato chips?	__ Per day __ Per week __ Per month __ Per year Never Don't know / Not sure Refused
B6, 1W5, 4W5	**In the past week,** how often did **you** eat carrots? You can tell me either the number of times per day or the number of times per week.	__ Per day __ Per week Never Don't know/unsure Refused	How often do you eat carrots?	__ Per day __ Per week __ Per month __ Per year Never Don't know / Not sure Refused
B7, 1W6, 4W6	**In the past week,** not including what you just told me about (green salads, potatoes and carrots), how often did **you** eat other vegetables? You can tell me either the number of times per day or the number of times per week. (Examples of other vegetables include: tomatoes, green beans, corn, cabbage, collard greens and broccoli but you can count any kind of vegetable). Please think about all forms of vegetables including fresh or raw, frozen, canned or cooked.	__ Per day __ Per week Never Don't know/unsure Refused	Not counting carrots, potatoes, or salad, how many servings of vegetables do you usually eat? (Example: A serving of vegetables at both lunch and dinner would be two servings.)	__ Per day __ Per week __ Per month __ Per year Never Don't know / Not sure Refused

Source: [37]

iii) Nutrition Knowledge and Competencies Questions

The majority of the nutrition knowledge and competencies questions used in this research were selected from the Increasing Fruit and Vegetable Intake Through WIC (FAVES) Survey and the Program Impact Report (Tables 16 and 17). Two additional questions included in the Emory WIC FMNP Study surveys were novel as shown in Table 17. The Emory WIC FMNP Study nutrition knowledge and competencies questions and possible responses along with the question sources and original source question wording and responses if modifications were made are shown in Tables 16 and 17 below.

Table 16 Nutrition Knowledge Question Sources

Emory WIC FMNP Study			FAVES Source		
Question Number	**Survey Question Wording**	**Possible Responses**	**Modification of Source**	**Source Wording**	**Source Possible Responses**
B20, 4W16	How many total servings of fruits and vegetables do you think **you** should eat **every day** for good health? *(PAUSE)* That's a combined total of **both** fruits and vegetables?	___ Enter Number DON"T KNOW/NOT SURE REFUSED	No	N/A	N/A
B21, 4W17	How many total servings of fruits and vegetables do you think **your child** (oldest child who receives WIC) should eat **every day** for good health? *(PAUSE)* That's a combined total of **both** fruits and vegetables?	___ Enter Number DON"T KNOW/NOT SURE REFUSED	Yes	How many total servings of fruits and vegetables do you think **you** should eat **every day** for good health? *(PAUSE)* That's a combined total of **both** fruits and vegetables?	___ Enter Number DON"T KNOW/NOT SURE REFUSED

Source:[60]

The FAVES survey was specifically developed for WIC recipients and consisted of a 24-hour dietary recall, an initial questionnaire, and a follow-up questionnaire.[60] The initial questionnaire contained 59 questions divided into three sections: Demographic, USDA Core Food Security Module, and "Knowledge About Fruits and Vegetables."[60] The FAVES questions used and modified in the Emory WIC FMNP Study were from the "Knowledge About Fruits and

Vegetables" section that was excerpted from the California Dietary Practices Survey (CDPS). CDPS focuses on F&V intake and changes over time in diet and physical activity among adults (≥ 18 years of age) in California.[61]

Table 17 Nutrition Competencies Question Sources					
Emory WIC FMNP Study			**Program Impact Report Source**		
Question Number	**Survey Question Wording**	**Possible Responses**	**Modification of Source**	**Source Wording**	**Source Possible Responses**
	Opener: Because of the WIC Farmers' Market Program, I or my family…				
1W26b	Learned a new way to prepare or cook fresh fruits and vegetables	Agree	Yes	They learned a new way to prepare fresh fruits and vegetables	Yes or Agree
		Disagree			No or Disagree
1W26c	Learned a new way to store fresh fruits and vegetables to prevent spoilage	Agree	Yes	They learned a new way to store produce to prevent spoilage	Yes or Agree
		Disagree			No or Disagree

Source: [19]

The Program Impact Report has been previously described, but again briefly it was a national WIC FMNP survey completed by 24,800 WIC FMNP participants.[19]

3) Study Questions

This section includes the study questions for the descriptive analysis and the research analysis.

a) Descriptive Analysis:

Descriptive D1: Describe demographic characteristics at baseline survey, stratified by FMNP participation.

Descriptive D2: Describe previous and current FMNP use at baseline and 1-week follow-up surveys, stratified by FMNP participation.

Descriptive D3: Describe nutrition knowledge at baseline and 4-week follow-up surveys, stratified by FMNP participation.

Descriptive D4: Describe nutrition competencies at the 1-week follow-up survey for FMNP participants only.

Descriptive D5: Describe fruit, vegetable, and total F&V intake for mother and child at baseline, 1-week, and 4-week follow-up surveys, stratified by FMNP participation.

b) Research Analysis:

Question R1: Does learning nutrition competencies due to the FMNP result in an increase in F&V intake for mother and child, comparing intake at: baseline to 1-week follow-up survey and baseline to 4-week follow-up survey.

Question R2: Does maternal nutrition knowledge predict F&V intake of mother and child controlling for FMNP participation, WIC Clinic, and demographic characteristics at baseline.

4) Methods

This section describes the epidemiologic and biostatistical methods for the descriptive and research analyses. The descriptive methods primarily involve statistical tests such as chi-square test comparing demographic characteristics, F&V intake, and nutrition knowledge and competencies between the non-Farmers' Market and Farmers' Market groups. The second research analysis question uses logistic modeling adjusting for potential confounders.

a) Descriptive Analysis

Descriptive D1: Describe demographic characteristics at baseline survey, stratified by FMNP participation.

The demographic characteristics are described in the first descriptive analysis. The characteristics are stratified by FMNP participation and statistical tests indicated significant differences at the alpha level of 0.05 between the non-FM and FM groups. For categorical and dichotomous variables, chi-square tests were performed. The degrees of freedom for the chi-square test were equal to the number of categories for the given variable minus one multiplied by the number of FMNP participation groups minus one. Since there were only two FMNP groups (FMNP vs. non-FMNP), the degrees of freedom were equal to the number of categories minus one for the given test. If the expected cell size was less than five, then a Fisher exact test was used as was the case for the following variables: "Hispanic/Latino Ethnicity," "African American Race," and "Breastfeeding." For continuous variables, "Total WIC Recipients in the House" and "Total People in the House," the Mann-Whitney test was used since these variables were not normally distributed but were similarly shaped.

The characterization of demographic variables is described below.

The “Participant Type” variable was dichotomous since there were two options: non-FMNP or FMNP participant. The participant type depended on the interview date. The month of June was the non-Farmers’ Market at the WIC clinics since the FMNP had not yet begin. The months of July and August were the Farmers’ Market. The participant type was designated at date of interview and treated as an “intention to treat” variable. Therefore, even if the WIC recipient in the FM group did not use her WIC FMNP coupons, she did still receive the WIC FMNP nutrition education and was still considered a FMNP participant.

The “WIC Clinic” variable was dichotomous because there were only two WIC clinics, “Adamsville” and “Kirkwood.”

The “African American Race” variable was asked as *“Which one or more of the following would you say is your race? __ White, __ Black or African American, __ Asian, __ Native Hawaiian or Other Pacific Islander, __ American Indian or Alaska Native.”* Since all participants except one self-reported primary race was African American, the “African American Race” variable was dichotomized into “Yes” and “No.”

The “Hispanic/Latino Ethnicity” variable was asked as *“Are you Hispanic or Latino? __ Yes, __ No.”* Therefore, the ethnicity variable was dichotomized into “Yes” and “No.”

The “Mother’s Age” variable was asked as an open ended question. The mother’s age ranged from 18 to 66 years with a mean of 29.51 (SD 8.36) and a median of 28.00. The three categories shown in Table 18, (18-24, 25-31, and 32+), were chosen since they divided the participants relatively evenly by age and these were common age groups in previous research described in this literature review.[32-34]

Table 18 Mother's Age Categorization		
Age (years)	**N**	**Percent**
18-24	45	30.20
25-31	57	38.36
32+	47	31.54

The "Child's Age" was asked on all three surveys, but only the baseline survey question will be used since the exclusion criteria for child's age applied to the time of the baseline survey. The child's age was asked by *"How old is your oldest child who receives WIC? You can tell me either in months or in years."*

The child's age at baseline ranged from one to four years with a mean of 2.54 (SD 1.07) and a median of 2.00. The four categories shown in Table 19, (1, 2, 3 4), were chosen since they divided the participants relatively evenly by age. These groups also reflect similar foods eaten such as the diet for a one year old is different than a two year old.

Table 19 Child's Age Categorization		
Age (years)	**N**	**Percent**
1	30	20.13
2	45	30.20
3	36	24.16
4	38	25.50

The "Education Level" variable was asked as *"What is the highest grade or year of school you have completed?*

__ *Never attended school or kindergarten only,*

__ *Grades 1 through 8 (elementary),*

__ *Grades 9 through 11 (some high school),*

__ *Grades 12 or GED (high school graduate),*

__ *College 1 to 3 years (some college or tech school),*

__ *College 4 years (college graduate),*

__ *Master's degree,*

__ *Doctoral degree (JD, PhD, MD),*

__ *Post-Doctoral degree."*

All participants responded that their highest educational levels were between Grade 9 and a college graduate (college 4 years). Since 11 participants (7.38%) completed 4 years of college, these participants were combined with those that completed some college or tech school. Additionally, 23 (15.44%) participants indicated completing less than high school, so these participants were grouped with those who completed high school (N = 70, 46.98%). Therefore, the "Education Level" variable was categorized into two categories: "high school or less" and "more than high school" as shown in Table 20.

Table 20 Education Level Categorization

Level	**N**	**Percent**
High school or less	93	62.42
More than high school	56	37.58

The "Marital Status" variable was asked as *"What is your current marital status? Would you say…*

__ *Never been married,*

__ *Member of an unmarried couple,*

__ *Married,*

__ *Separated,*

__ *Divorced,*

__ Widowed.”

Few women (N = 2, 1.34%) indicated that they were a member of an unmarried couple, so these women were grouped with the married women to create the category “Married or member of an unmarried couple” that represented women currently in a relationship. Further, since few women reported being separated (N = 9, 6.04%), divorced (N = 3, 2.01%), or widowed (N = 1, 0.67%), these women were grouped together with women who had never been married to create the category “Never been married, separated, divorced, or widowed” that represented women not currently in a relationship. Therefore, the “Marital Status” variable was a dichotomous variable: “Married or Member of an unmarried couple” and “Never been married, Separated, Divorced, or Widowed.”

The “SNAP and/or TANF Recipient” variable was asked by two questions, one for SNAP and one for TANF, that were combined. The two questions were: *“Are you or anyone in your household enrolled in the Food Stamps or SNAP (that is the Supplemental Nutrition Assistance Program)? __Yes, __ No.”* and *“ Are you or anyone in your household enrolled in the Temporary Assistance to Needy Families (TANF) or welfare cash assistance program? __Yes, __ No.”* If a participant responded “Yes” to one or both of these questions, they were considered a SNAP and/or TANF recipient. If the participant responded “No” to both of these questions, they were not considered a SNAP and/or TANF recipient.

Table 21 SNAP/TANF Recipients (%)

		TANF	
		No	**Yes**
SNAP	**No**	22.45	0.68
	Yes	68.03	8.84

As shown in Table 21, most WIC recipients were also SNAP recipients (75.84%), however few were TANF recipients (9.40%). Therefore, this variable was dichotomized into "Yes" or "No."

The "Number of WIC Recipients in the House" variable was asked by two questions, one for if the mother receives WIC and one for the number of children receiving WIC services. These two questions were combined to create one variable and these questions were: *"Do you receive WIC services for yourself? __ Yes, __ No"* and *"How many children in your household receive WIC services? Would you say (read responses) __ One child, __Two children, __Three children."* If the mother received WIC services as indicated in the former question, she was counted as one WIC recipient. There were 19 mothers (12.75%) who indicated receiving WIC services. The number of children who received WIC services ranged from one to four and the majority of participants had only one child WIC recipient (60.40%). The sum of the responses from the two was used to create the total number of WIC recipients expressed by the "Number of WIC Recipients" variable.

The "Number of People in the House" variable was asked by two questions, one for the number of children in the household and one for the number of adults in the household. These two questions were combined to create this variable and the questions were: *"How many children less than 18 years of age live in your household? __ Number of children, __ None."* and *"Including yourself, how many adults live in your household? __ 1, __ 2, __ 3, __ 4, __5, __6 or more."* The average number of children in the household was 2.42 (SD 1.27) with a median of 2.00 and a range of 1-7. The average number of adults per household was 1.70 (SD 1.00) with a median of 1.00 and a range of 1-6. The sum of the responses from the two questions was used to create the total number of people in the household expressed by the "Number in Household" variable.

The “Breastfeeding Status” variable was dichotomized into “Yes” and “No” based on the question *“Are you now breastfeeding or nursing a child? __ Yes, __ No.”*

Descriptive D2: Describe previous and current FMNP use at baseline and 1-week follow-up surveys, stratified by FMNP participation.

Previous and current FMNP use are described in the second descriptive analysis. The two FMNP use questions are described below.

The questions about previous WIC FMNP coupon use were from the baseline survey. The “Previous WIC FMNP Coupon Use” variable was asked by three questions: *“B1. Have you ever received WIC Farmers’ Market coupons before? __ No, __ Yes [GO TO B1a]”, “B1a. Did you receive Farmers’ Market coupons last year? __ Yes, __ No”, and “B1b. Did you receive Farmers’ Market coupons more than one year ago? __ Yes, __ No.”* These three questions were combined to create three categories for this variable. If the participant responded “no” to question B1, then the participant was classified as “never” using FMNP coupons. If the participant responded “Yes” to B1a and “No” to B1b or “No” to B1a and “Yes” to B1b, then the participant was classified as receiving FMNP coupons “once,” either last year or more than one year ago. If the participant responded “Yes” to both B1a and B1b, then the participant was classified as receiving FMNP coupons “more than once,” last year and more than one year ago.

The “Current Year WIC FMNP Coupon Use” variable was asked by two questions on the one-week follow-up survey: *“Did you receive WIC Farmers’ Market coupons when you were last at the WIC clinic? __ Yes, __ No”* and *“Did you use your coupons for fruits and/or vegetables? Would you say (read responses)…*

__Yes, I used all of them;

__ *Yes, I used some of them;*

__ *No, I didn't use any of them."*

These two questions were combined to create four categories. If the participant responded "No" to the first question, then the participant was classified as "Didn't receive coupons." If the participant indicated "Yes" to the first question and "No, I didn't use any of them" to the second question, then the participant was classified as "Received and used no coupons." These two categories previously described should be separate since WIC recipients who received coupons and did not use them are likely different from those who never received them in the first place. If the participant indicated "Yes" to the first question and "Yes, I used some of them" to the second question, then the participant was categorized as "Received and used some coupons." Lastly, if the participant indicated "Yes" to the first question and "Yes, I used all of them" to the second question, then the participant was classified as "Received and used all coupons."

The FMNP use characteristics are stratified by FMNP participation. For the "Previous WIC FMNP Coupon Use" variable, a chi-square statistical test was used to indicate significant differences at the alpha level of 0.05 between the non-FM and FM groups.

Descriptive D3: Describe nutrition knowledge at baseline and 4-week follow-up surveys, stratified by FMNP participation.

The nutrition knowledge was described by mean (SD), median, range, and percent having knowledge of the five or more total fruits and vegetables recommendations. The percent having knowledge of the recommendations were compared by statistical tests between the non-FM and FM groups by chi-square tests at an alpha level of 0.05. For example, the baseline mother's nutrition knowledge was compared between the FM and non-FM groups. Additionally, any differences in the baseline and 4-week surveys were tested by the McNemar chi-square tests for the mother and child in the non-FM and FM groups. Lastly, statistical differences in nutrition knowledge by WIC clinic were also tested by chi-square tests.

The nutrition knowledge was asked by the same questions in the baseline and four-week follow-up surveys: *"How many total servings of fruits and vegetables do you think* ***you*** *should eat* ***every day*** *for good health? (PAUSE) That's a combined total of* **both** *fruits and vegetables? __ Enter number"* and *"How many total servings of fruits and vegetables do you think* **your child** *(oldest child who receives WIC) should eat* ***every day*** *for good health? (PAUSE) That's a combined total of* ***both*** *fruits and vegetables? __ Enter number."* The responses to these questions were kept separate, one for the mother and one for the child. The responses to both of these questions were dichotomized regarding the five or more total fruits and vegetables recommendations into "know recommendations" and "don't know recommendations."

Descriptive D4: Describe nutrition competencies at the 1-week follow-up survey for FMNP participants only.

The competencies were described by the percentage that agreed or disagreed with the two competency statements. These percentages were compared between the WIC clinics by chi-square tests at an alpha level of 0.05.

The nutrition competencies were asked by two questions at the 1-week follow-up survey to only FMNP participants. Both questions were preceded by the following opening statement, *"Because of the WIC Farmers' Market Program, I or my family…"* The competencies questions were: *"Learned a new way to prepare or cook fresh fruits and vegetables. __ Agree, __Disagree, __Don't Know/Not Sure (do not read)."* and *"Learned a new way to store fresh fruits and vegetables to prevent spoilage. __ Agree, __Disagree, __Don't Know/Not Sure (do not read)."*

The responses to these questions were kept separate because they addressed different competencies. No participants responded "Don't know/Not Sure" to either question. Therefore, the responses to both of these questions were dichotomized into either "Agree" or "Disagree."

Descriptive D5: Describe total F&V intake for mother and child at baseline, 1-week, and 4-week follow-up surveys, stratified by FMNP participation.

The total fruit and vegetable intake for mother and child for non-FM and FM groups at all three surveys included 100% fruit juice, whole fruit, and all vegetables (except fried potatoes). Intake was described by mean (SD), median, range, and the percent meeting the total F&V recommendations of five or more per day. The percent meeting total F&V recommendations were compared between the non-FM and FM groups by chi-square statistical test was used to indicate significant differences at the alpha level of 0.05 between the non-FM and FM groups. Additionally, differences in the percentages meeting recommendations over time: baseline to one-week follow-up surveys and baseline to four-week follow-up surveys were tested by the McNemar chi-square tests for the mother and child. Statistical differences in the percentages by WIC clinic were also tested by chi-square tests.

Lastly, the percentages meeting the total F&V recommendations in the FM group were compared among those who were classified as FM participants by the "intention-to-treat" explanation previously described and those who received and used all their coupons as indicated in the "Current Year FMNP coupon use" variable. This comparison was most important when considering F&V intake. For example, participants who received and used all their FMNP coupons had $30.00 worth of fresh F&V available for consumption. Yet, participants who were considered in the FM group by the "intention-to-treat" explanation but did not use any of their FMNP coupons did not have $30.00 worth of fresh F&V available for consumption. This comparison was not considered for any of the nutrition knowledge or competency questions because regardless of receiving or using the FMNP coupons, all WIC recipients in the FM group did receive the WIC-led nutrition education.

The percentages for the overall FM participants were compared to the FM participants who received and used all their coupons by chi-square tests. McNemar chi-square tests were used to determine any significant differences from baseline to one-week follow-up surveys and baseline to four-week follow-up surveys among this latter group.

The "F&V Intake" variable for the mother was asked by six questions on all three surveys: baseline, one-week, and four-week. The "F&V Intake" variable for the child was asked by the same six questions on all three surveys except instead of the mother reporting her F&V intake from the past seven days, the mother reported her oldest child who received WIC's F&V intake from the past seven days. F&V intake was asked by the following questions: *"Thinking about the past week, this is the past 7 days, how often did you drink 100% fruit juices such as orange, grapefruit, or tomato? You can tell me either the number of times per day or the number of times per week. Do not include fruit-flavored drinks with added sugar or fruit juice you made at home and added sugar to.","In the past week, not counting juice, how often did you eat fruit? You can tell me either the number of times per day or the number of times per week. Please think about all forms of fruits including fresh or raw, frozen, canned or cooked.", "In the past week, how often did you eat green salad? You can tell me either the number of times per day or the number of times per week.", "In the past week, how often did you eat potatoes, not including French fries, fried potatoes, or potato chips? You can tell me either the number of times per day or the number of times per week.", "In the past week, how often did you eat carrots? You can tell me either the number of times per day or the number of times per week.", "In the past week, not including what you just told me about (green salads, potatoes, and carrots), how often did you eat other* *vegetables? You can tell me either the number of times per day or per week. (Examples of other vegetables include: tomatoes, green beans, corn, cabbage, collard greens, and broccoli but you can count any kind of vegetable). Please think about all forms of vegetables including fresh or raw, frozen, canned or cooked."*

The responses to these six questions were reported as the number of times per day or per week. The following three steps were taken to code F&V intake. First, these responses were standardized to the number of fruits or vegetables consumed per day. Second, these responses were summed to create the total F&V consumed daily. Third, this total was compared to the total F&V recommendations of five or more per day. Using the total F&V recommendation, the "F&V Intake" variable was dichotomized into either meeting or not meeting the total F&V recommendations ($\geq$ 5/day).

b) Analysis of Research

Question R1: Does learning nutrition competencies due to the FMNP result in an increase in F&V intake for mother and child, comparing intake at: baseline to one-week follow-up surveys and baseline to four-week follow-up surveys.

Agreement with the two competency statements were compared to changes in F&V intake from baseline to follow-up surveys for the mother and child in the FM group. Due to small sample sizes and some expected cell sizes less than five, Fisher exact tests were used to determine any significant differences in F&V intake based on agreement with the attitude/competency statements.

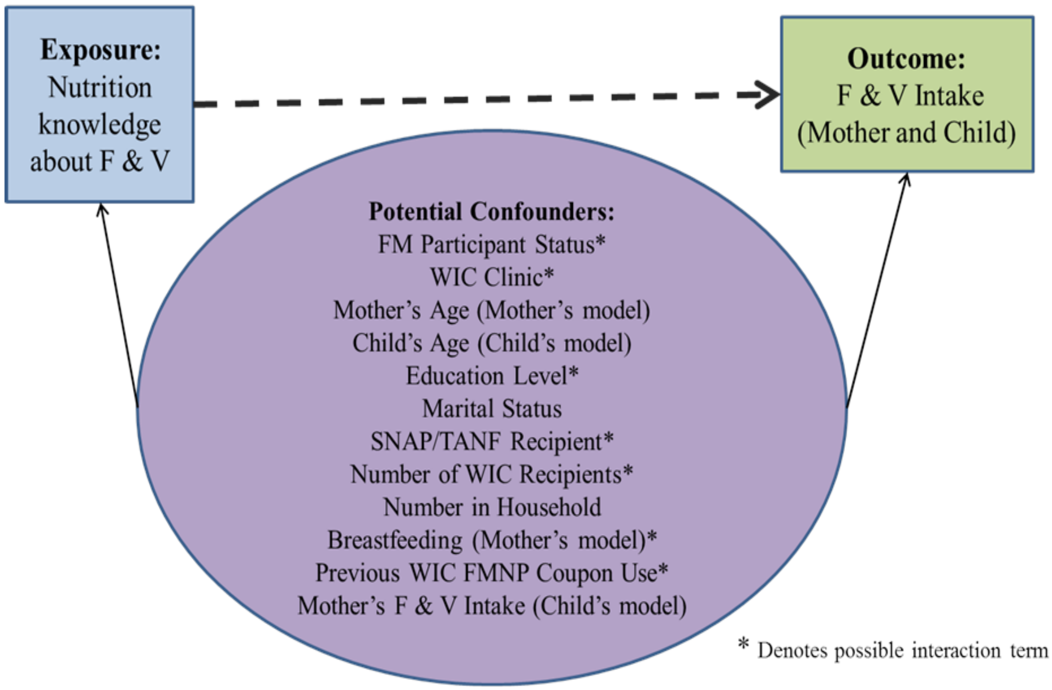
The nutrition competencies were categorized into “Agree” and “Disagree” as described in descriptive question D4. For the mother’s and child’s F&V intake, the percentages meeting the recommendations were used. If the participant changed from not meeting the recommendations at the baseline survey to meeting the recommendations at a follow-up survey, then the participant’s intake was classified as an “Increase.” If the participant’s intake remained the same, either meeting or not meeting the recommendation, or decreased from meeting to not meeting the recommendation from the baseline survey to follow-up surveys, then this participant’s intake was classified as “Same or Decrease.”

Question R2: Does maternal nutrition knowledge predict F&V intake of mother and child controlling for FMNP participation, WIC Clinic, and demographic characteristics at baseline survey.

The second research question is illustrated by the directed acyclic graph (DAG) shown in Figure 2. The exposure of interest is the mother’s nutrition knowledge about the F&V recommendations of five or more total F&V per day in respect to herself and her child. The outcome is the mother’s and child’s F&V intake at baseline. Therefore, there are two models considered for question R2: 1) the mother’s nutrition knowledge for herself and the mother’s F&V intake; and 2) the mother’s nutrition knowledge for her child and the child’s F&V intake. The potential confounders considered in these two models are listed in the DAG with specification for which model, the mother’s or child’s.

Potential interaction terms are noted with an asterisk. I hypothesized that “FM participation status” should be considered as an interaction term because FM participants received different nutrition education and had access to the FMNP when compared to the non-FM participants. I also believed that the “WIC Clinic” variable should be considered an interaction term because the nutrition education sessions and FMNP differed between the two clinics, Adamsville and Kirkwood. The "Education Level" variable was included as a potential interaction term because it was believed that mothers with higher education levels would have higher nutrition knowledge and F&V intake than those with lower education levels. The "SNAP/TANF" variable was included as an interaction term because it was believed that WIC recipients who also were SNAP and/or TANF recipients would possibly receive additional nutrition education and food subsidies. The "Number of WIC Recipients" variable was incorporated as a possible interaction term because it was hypothesized that the higher the number of WIC recipients, the more exposure to WIC's nutrition education sessions. Each WIC recipient has specific days every three months in which they are eligible to pick-up new WIC vouchers. If a family has multiple children and the mother on WIC, they have multiple opportunities to receive WIC-led nutrition education at the WIC clinics. The "Breastfeeding" variable was included as a possible interaction term in the mother's model because it was hypothesized that mothers who were breastfeeding were likely WIC recipients and thus this increased the potential exposure to WIC's nutrition education sessions. Lastly, I included "Previous WIC FMNP Coupon Use" as a potential interaction term because I believed that prior use of FMNP coupons and participation in the WIC FMNP would have led to more exposure to nutrition education about F&V.

Figure 2 Directed Acyclic Graph of Research Question R2



The variable specification for question R2 is found below in Table 22. The variable categorization is the same as has been described in the previous descriptive questions. Two variables described in the demographic characteristics, "African American Race" and "Hispanic/Latino Ethnicity" were not included as potential confounders in this question since nearly all participants were African American and non-Hispanic/Latino ethnicity.

Table 22 Variable Specification (Variable name, type, and categorization) for Question R2		
Variable	**Type**[1]	**Categorization**
Nutrition Knowledge (Mother and Child)	E	Dichotomous (Know recommendations, Don't know recommendations)
F & V Intake (Mother and Child)	D	Dichotomous (Meet recommendations, Don't meet recommendations)
Participant Type	V, W	Dichotomous (FMNP, Non-FMNP Participant)
WIC Clinic	V, W	Dichotomous (Adamsville, Kirkwood)
Mother's Age (Mother's model)	V	Categorical (18-24, 25-31, 32+)
Child's Age (Child's model)	V	Categorical (1, 2, 3, or 4 years)
Education Level	V, W	Dichotomous (< High School or High School, > High School)
Marital Status	V	Dichotomous (Married or Member of an unmarried couple, Never been married or Separated or Divorced or Widowed)
SNAP/TANF Recipient	V	Dichotomous (Yes, No)
Number of WIC Recipients	V, W	Continuous
Number in Household	V	Continuous
Breastfeeding (Mother's model)	V, W	Dichotomous (Yes, No)
Previous WIC FMNP Coupon Use	V, W	Categorical (Never, Once (Either last year or more than 1 year ago), More than once (Last year and more than 1 year ago))
Mother's F & V Intake (Child's model)	V	Dichotomous (Meet recommendations, Don't meet recommendations)
[1] E = Exposure, D = Dependent Variable (Outcome), V = Potential Confounder, W = Potential Interaction Term		

Both models in question R2 were hierarchically well formulated logistic models in which all interaction terms were also included as individual variables also known as lower-order components. For example, inclusion of the interaction term for “Nutrition Knowledge” and “Education Level” meant that “Education Level” and “Nutrition Knowledge” had to also be included separately in the model. Interaction terms were removed prior to any lower-order terms.

The initial full logistic model for question R2for the mother’s Total F&V intake is found below:

Logit P(Mother’s Total F&V Intake, **X**) = α + β1 (Nutrition Knowledge $_i$) + β2 (Participant Type $_i$) + β3 (WIC Clinic $_i$) + β4 (Mother’s Age 1 $_i$) + β5 (Mother’s Age 2 $_i$) + β6 (Education $_i$) + β7 (Marital Status $_i$) + β8 (SNAP/TANF Recipient $_i$) + β9 (Number of WIC Recipients $_i$) + β10 (Number of People in Household $_i$) + β11 (Breastfeeding $_i$) + β12 (Previous WIC FMNP Coupon Use 1 $_i$) + β13 (Previous WIC FMNP Coupon Use 2 $_i$) + β14 (Nutrition Knowledge $_i$ * FM $_i$) + β15 (Nutrition Knowledge $_i$ * WIC Clinic $_i$) + β16 (Nutrition Knowledge $_i$ * Education Level $_i$) +

β17 (Nutrition Knowledge $_i$ * Number of WIC Recipients $_i$) + β18 (Nutrition Knowledge $_i$ * Breastfeeding $_i$) + β19 (Nutrition Knowledge $_i$ * Previous WIC FMNP Coupon Use 1 $_i$) + β20 (Nutrition Knowledge $_i$ * Previous WIC FMNP Coupon Use 2 $_i$)

Where: All variables are as described in Table 22 Question R2 Variable Specification

α = intercept

β = parameter estimates for exposure and covariates

$_i$ = Study Participant

The methods and results of assessment of multicollinearity, interaction terms, confounding, precision, and the final models are described in the Appendix section.

I considered the child's model using similar methods as previously described for the mother in the Appendix section. The initial full logistic model for question R2 for the child's Total F&V intake is found below and the results and final model are described in the Appendix section.

Logit P(Child's Total F&V Intake, **X**) = α + β1 (Nutrition Knowledge $_i$) + β2 (Participant Type $_i$) + β3 (WIC Clinic $_i$) + β4 (Child's Age 1 $_i$) + β5 (Child's Age 2 $_i$) + β6 (Child's Age 3 $_i$) + β7 (Education $_i$) + β8 (Marital Status $_i$) + β9 (SNAP/TANF Recipient $_i$) + β10 (Number of WIC Recipients $_i$) + β11 (Number of People in Household $_i$) + β11 (Previous WIC FMNP Coupon Use 1 $_i$) + β12 (Previous WIC FMNP Coupon Use 2 $_i$) + β13 (Mother's F&V Intake $_i$) + β14 (Nutrition Knowledge $_i$ * FM $_i$) + β15 (Nutrition Knowledge $_i$ * WIC Clinic $_i$) + β16 (Nutrition Knowledge $_i$ * Education Level $_i$) + β17 (Nutrition Knowledge $_i$ * Number of WIC Recipients $_i$) + β18 (Nutrition Knowledge $_i$ * Previous WIC FMNP Coupon Use 1 $_i$) + β19 (Nutrition Knowledge $_i$ * Previous WIC FMNP Coupon Use 2 $_i$)

Where: All variables are as described in Table 22 Question R2 Variable Specification

α = intercept

β = parameter estimates for exposure and covariates

$_i$ = Study Participant

5) Results

Descriptive D1: Describe demographic characteristics at baseline survey, stratified by FMNP participation.

The demographic characteristics are described in Table 23. There were no significant differences in the demographic characteristics between the non-FM and FM groups except for the "Total WIC Recipients in the House" and the "Total People in the House."

There were a total of 69 non-FM participants and 80 FM participants after exclusions. Among the non-FM participants, there were more participants from the Kirkwood clinic (57.97%) and among the FM participants, there were more participants from the Adamsville clinic (53.75%). Nearly all participants, regardless of FM participation, were non-Hispanic/Latino African Americans (N = 147).

The non-FM and FM participants were relatively evenly divided among the mother's age categories with the most participants in the "25-31" years category (Non-FM: 40.59%; FM: 36.25%). The children were evenly divided among the child's age categories; the non-FM group had more children aged four years (33.33%) while the FM group had more children two years of age (31.25%) compared to the other age categories.

Approximately two-thirds of participants on both the non-FM and FM groups received less than a high school education or a high school diploma. Although most of the existing literature used three education categories (less than high school, high school, and more than high school), out study only had 15.44% of the participants having less than a high school education and when three categories were used in the mother's gold standard model, the OR did not vary and the confidence intervals for the education categories were very wide. The majority of participants, regardless of FM participation were currently not in a relationship. About three-fourths of participants in the non-FM and FM groups were also either a SNAP and/or TANF recipient.

Few participants were currently breastfeeding with only 8.70% in the non-FM group and 5.00% among FM participants. The non-FM group had significantly more total WIC recipients in the house (mean = 1.87 (SD 0.97)) compared to the FM group with a mean of 1.42 (SD 0.73) ($p = 0.002$). The non-FM group also had significantly more total people in the house (mean = 4.52 (SD 1.84)) compared to the FM group (3.79 (1.49)) ($p = 0.013$).

Table 23 Demographic Characteristics at Baseline (N=149)					
Characteristic	**Non-FM (N = 69)**		**FM (N = 80)**		**p-value**
	N	**Percent**	**N**	**Percent**	
Clinic					
Adamsville	29	42.03	43	53.75	0.153
Kirkwood	40	57.97	37	46.25	
African American Race	69	100.00	79	98.75	1.000
Mother's Age (years)					
18-24	21	30.43	24	30.00	0.798
25-31	28	40.59	29	36.25	
32+	20	28.99	27	33.75	
Child's Age (years)					
1	10	14.49	20	25.00	0.155
2	20	28.99	25	31.25	
3	16	23.19	20	25.00	
4	23	33.33	15	18.75	
Education Level					
High school or less	45	65.22	48	60.00	0.512
More than high school	24	34.78	32	40.00	
Marital Status					
Married or member of an unmarried couple	9	13.04	15	18.75	0.345
Divorced, Separated, Widowed, Never been married	60	86.96	65	81.25	
SNAP/TANF Recepient	53	76.81	61	76.25	0.680
Breastfeeding	6	8.70	4	5.00	0.514
	Mean (SD)		**Mean (SD)**		**p-value**
Total WIC Recipients in Hous	1.87 (0.97)		1.42 (0.73)		0.002
Total People in House	4.52 (1.84)		3.79 (1.49)		0.013

Descriptive D2: Describe previous and current FMNP use at baseline and 1-week follow-up surveys, stratified by FMNP participation.

The previous and current FMNP use are described in Table 24. There were no statistically significant differences in previous FMNP use between the non-FM and FM groups (p = 0.2328). Nearly 64% of non-FM participants versus 51% of FM participants had previously used FM coupons.

None of the non-FM participants received FMNP coupons for the current year FMNP on their last WIC visit. The majority of FM participants used all of their FM coupons at the current WIC FMNP (82.61%). Ten (14.49%) FM participants who received FMNP coupons did not use any of them and nine of these participants were from the Kirkwood WIC clinic.

Table 24 Previous and Current FMNP Use

	Non-FM (N = 69)		**FM (N = 80)**		**p-value**
	N	**Percent**	**N**	**Percent**	
Previous FM Use (Baseline Survey)					
Never	24	34.78	39	48.75	0.2328
Once (Last year or more than one year ago)	34	49.28	30	37.50	
More than Once (Last year and more than one year ago)	10	14.49	11	13.75	
	Non-FM (N = 63)		**FM (N = 69)**		
	N	**Percent**	**N**	**Percent**	
Current FM Use (1-Week Survey)					
Didn't Receive Coupons	63	100.00	2	2.90	
Received and Used No Coupons			10	14.49	
Received and Used Some Coupons			0	0.00	
Received and Used All Coupons			57	82.61	

Descriptive D3: Describe nutrition knowledge at baseline and 4-week follow-up surveys, stratified by FMNP participation.

The mother's nutrition knowledge about the recommended number of F&V that should be consumed daily is shown in Table 25. The average reported number of total F&V that should be consumed daily for good health in respect to the mother and the child were below the national recommendation of five or more total F&V per day. Overall, these averages slightly decreased from baseline to 4-week follow-up surveys for the mother and child and among both non-FM and FM participants. Also, there was little change in the percentage knowing the F&V recommendations from baseline to 4-week follow-up surveys. Actually, all percentages non-significantly decreased from baseline to 4-week follow-up surveys, except the FM children which stayed the same.

There was a non-significantly higher percentage of FM participants who reported that they or their child should consume five or more total fruits and vegetables per day and therefore they had knowledge of the F&V recommendations compared to non-FM participants. For example, 31.03% of non-FM participants knew the F&V recommendations for the mother at baseline compared to 43.55% of FM participants ($p = 0.1571$).

It is interesting to note that in the non-FM group, the mothers reported that they felt their child should eat more total F&V per day than the mothers reported for themselves. For example, 31.03% of the mother's had knowledge of the recommendation for themselves compared to 37.93% had knowledge for their child. However, the opposite was true for the FM group in which the mothers felt they should eat more total F&V per day than their child.

Table 25 Nutrition Knowledge About Recommended Number of Daily F & V Intake

	N	Mean (SD)	Median	Range	Percent Knowing F & V Recommendations (≥ 5 F & V/Day)
Non-FMNP Group					
Mother					
Baseline	58	4.16 (3.04)	3.00	1-20	31.03
Four-Week	58	3.83 (1.84)	3.00	1-10	29.31
Child					
Baseline	58	4.86 (4.37)	4.00	1-24	37.93
Four-Week	58	4.12 (2.65)	4.00	1-20	36.21
FMNP Group					
Mother					
Baseline	62	4.71 (2.82)	4.00	1-15	43.55
Four-Week	62	4.63 (3.17)	4.00	1-21	40.32
Child					
Baseline	62	4.48 (2.82)	4.00	1-14	38.71
Four-Week	62	4.42 (2.34)	4.00	1-12	38.71

Lastly, there were no significant differences in nutrition knowledge between non-FM and FM groups or baseline to four-week follow-up surveys by WIC clinic as shown in Table 26. The Kirkwood clinic had non-significantly higher nutrition knowledge in the non-FM group, yet the Adamsville clinic had non-significantly higher nutrition knowledge in the FM group.

Table 26 Nutrition Knowledge (Percent Knowing Recommendations) Differences by WIC Clinic

	Non-FM (N = 58)		FM (N = 62)	
	Adamsville	**Kirkwood**	**Adamsville**	**Kirkwood**
	N = 23	N = 35	N = 30	N = 32
Mother				
Baseline	30.43	31.43	50.00	37.50
Four-Week	17.39	37.14	43.33	37.50
Child				
Baseline	30.43	42.86	43.33	34.38
Four-Week	26.09	42.86	43.33	34.38

Descriptive D4: Describe nutrition competencies at the 1-week follow-up survey for FMNP participants only.

More than half of the FM participants agreed that they learned a new way to prepare or cook fresh F&V (56.52%) and learned a new way to store fresh F&V to prevent spoilage (58.70%) due to the WIC FMNP.

As shown in Table 27, there were no statistically significant differences in these competencies of mothers between WIC clinics. However, it should be noted that there were higher percentages of participants who agreed with these statements from the Adamsville clinic compared to the Kirkwood clinic.

Table 27 Learned Competencies Following FMNP by WIC Clinic					
Competency	**Agreement**	**Adamsville (N = 21)**		**Kirkwood (N = 25)**	
		N	**Percent**	**N**	**Percent**
Learned a new way to prepare or cook fresh F & V	Agree	14	66.67	12	48.00
	Disagree	7	33.33	13	52.00
Learned a new way to store fresh F & V to prevent spoilage	Agree	15	71.43	12	48.00
	Disagree	6	28.57	13	52.00

Descriptive D5: Describe total F&V intake for mother and child at baseline, 1-week, and 4-week follow-up surveys, stratified by FMNP participation.

The fruit and vegetable intake for mother and child by FMNP participation status is described in Table 28. The average intake for the mother for all three surveys and in the non-FM and FM groups were below the F&V recommendation of five or more per day. Yet the mean intake for the child for all three surveys, regardless of FM status, was above or near the F&V recommendation.

It is interesting to note that among FM mothers, the mean intake non-significantly increased from 3.66 (SD 2.65) times per day at baseline to 3.71 (2.15) at the one-week follow-up survey to 3.91 (2.73) at the four-week follow-up survey. This trend was not found for the non-FM mothers or FM and non-FM children.

There were no significant differences from baseline to one-week follow-up surveys or baseline to four-week follow-up surveys in the percentages meeting recommendations for the mother or child in the non-FM or FM groups. The percentages remained relatively constant across survey periods except for the non-FM children decreased over time: 50.00% at baseline, 48.21% at one-week, and 42.86% at four-week.

Table 28 100% Fruit Juice, Whole Fruit, and Vegetable Intake of Mother and Child

	Non-FMNP Group					FMNP Group				
	N	Mean (SD) times/day	Median times/day	Range times/day	Percent Meeting Total F & V Recommendations (≥ 5 F & V/Day)	N	Mean (SD) times/day	Median times/day	Range times/day	Percent Meeting Total F & V Recommendations (≥ 5 F & V/Day)
Mother's Intake										
Baseline	55	3.90 (3.04)	3.43	0.29 - 18.00	27.27	49	3.66 (2.65)	3.14	0.00 - 12.43	22.45
One-Week	55	4.31 (3.18)	3.43	0.43 - 12.14	32.73	49	3.71 (2.15)	3.43	0.29 - 10.71	22.45
Four-Week	55	4.01 (2.56)	3.14	0.71 - 11.14	27.27	49	3.91 (2.73)	3.29	0.57 - 13.71	20.41
Child's Intake										
Baseline	56	5.50 (3.44)	4.93	1.29 - 21.43	50.00	49	5.39 (2.91)	4.57	2.00 - 14.29	44.90
One-Week	56	5.00 (2.50)	4.86	0.86 - 10.86	48.21	49	4.99 (2.68)	4.86	0.57 - 13.00	46.94
Four-Week	56	4.94 (2.82)	4.64	1.00 - 15.29	42.86	49	5.03 (2.90)	4.14	0.86 - 13.57	44.90

There was only one significant difference in the percentages meeting recommendations when stratified by WIC clinic as shown in Table 29. The significant difference was between the Kirkwood WIC Clinic and Adamsville WIC Clinic for the mother's four-week F&V intake (p = 0.019). It is interesting to note that F&V intake increased over time among Adamsville FM mothers but decreased for Kirkwood FM mothers. This same trend was not found for FM children.

Table 29 100% Fruit Juice, Whole Fruit, and Vegetable Intake of Mother and Child by WIC Clinic

	Non-FMNP Group						FMNP Group					
	Kirkwood WIC Clinic			Adamsville WIC Clinic			Kirkwood WIC Clinic			Adamsville WIC Clinic		
	N	Percent Meeting Total F & V Recommendations (≥ 5 F & V/Day)	Mean Times/Day (SD)	N	Percent Meeting Total F & V Recommendations (≥ 5 F & V/Day)	Mean Times/Day (SD)	N	Percent Meeting Total F & V Recommendations (≥ 5 F & V/Day)	Mean Times/Day (SD)	N	Percent Meeting Total F & V Recommendations (≥ 5 F & V/Day)	Mean Times/Day (SD)
Mother's Intake												
Baseline	33	24.24	3.95 (3.56)	22	31.82	3.83 (2.11)	26	23.08	3.73 (2.64)	23	21.74	3.60 (2.72)
One-Week	33	30.30	4.04 (3.10)	22	36.36	4.72 (3.32)	26	19.23	3.69 (1.82)	23	26.09	3.73 (2.52)
Four-Week	33	21.21	3.91 (2.37)	22	36.36	4.15 (2.87)	26	7.69*	3.27 (2.57)	23	34.78*	4.63 (2.78)
Child's Intake												
Baseline	34	50.00	5.76 (3.98)	22	50.00	5.10 (2.40)	27	44.44	5.51 (2.72)	22	45.45	5.24 (3.19)
One-Week	34	48.21	5.14 (2.69)	22	45.45	4.78 (2.21)	27	48.15	4.98 (2.53)	22	45.45	4.99 (2.91)
Four-Week	34	42.86	4.97 (3.19)	22	45.45	4.15 (2.87)	27	44.44	4.84 (3.04)	22	45.45	4.69 (2.82)

* $p < 0.05$

Lastly, no significant differences in the percent meeting F&V recommendations were found when the overall "intention-to-treat" FM participants were compared to only those FM participants who received and used all their FMNP coupons. The percent of mother and child FM participants meeting F&V recommendations who received and used all FMNP coupons showed a non-significant increasing trend in the percent meeting recommendations across survey periods as shown in Table 30. This same trend was not found for the overall FM group.

Table 30 Comparison of Percentage Meeting F & V Intake Recommendations Among Overall FM Group and FM Participants Who Received and Used All Coupons

	Overall FM Group		**FM Group who Received and Used All Coupons**	
Survey	**N**	**Percent**	**N**	**Percent**
Mother				
Baseline	49	22.45	38	18.42
One-Week	49	22.45	38	21.05
Four-Week	49	20.41	38	23.68
Child				
Baseline	49	44.90	39	41.03
One-Week	49	46.94	39	43.59
Four-Week	49	44.90	39	48.72

Question R1: Does learning nutrition competencies due to the FMNP result in an increase in F&V intake for mother and child, comparing intake at: baseline to one-week follow-up survey and baseline to four-week follow-up survey.

The relationship between learning a new competency and increasing F&V intake for mother and child are shown in Table 31. There was a significant increase in F&V intake from baseline to one-week follow-up surveys for mothers who agreed with the attitude/competency statement, "Learned a new way to prepare or cook fresh F&V," compared to mothers who disagreed with this statement ($p = 0.0287$). A similar significant increase in F&V intake was found for mothers who agreed with the statement “Learned a new way to store fresh F&V to prevent spoilage” compared to mothers who disagreed with this statement (p = 0.0345). This association was still positive but no longer significant for the mother’s F&V intake from the baseline to four-week follow-up survey.

For mothers who agreed compared to disagreed to both attitude/competency statements, their child non-significantly increased F&V intake from baseline to one-week follow-up surveys and non-significantly decreased F&V intake from baseline to four-week follow-up surveys.

Table 31 Learned Competencies and Increase in F & V Intake

		Mother's Intake						Child's Intake					
		1-Week - Baseline			4-Week - Baseline			1-Week - Baseline			4-Week - Baseline		
Competency	Agreement	Increase	Same or Decrease	p-Value	Increase	Same or Decrease	p-Value	Increase	Same or Decrease	p-Value	Increase	Same or Decrease	p-Value
Learned a new way to prepare or cook fresh F & V	Agree	6	20	0.028	3	23	0.622	5	22	0.682	3	24	0.438
	Disagree	0	20		1	19		2	18		4	16	
Learned a new way to store fresh F & V to prevent spoilage	Agree	6	21	0.035	3	24	0.632	5	23	0.685	3	25	0.417
	Disagree	0	19		1	18		2	17		4	15	

Question R2: Does maternal nutrition knowledge predict F&V intake of mother and child controlling for FMNP participation, WIC Clinic, and demographic characteristics at baseline survey.

The model building results were described in the Appendix section and the overall results to the second research analysis question are displayed in Table 32 with the crude, gold standard adjusted, and most précised adjusted models odds ratios and 95% confidence intervals. All of the odds ratios indicated a positive association between nutrition knowledge and F&V intake, but none of these relationships were statistically significant. Tables 33 and 34 specifically describe the mother’s model and tables 39 and 40 describe the child’s model.

Table 32 Association of Nutrition Knowledge and F & V Intake at Baseline				
		Crude OR (95% CI)	**Gold Standard Adjusted OR (95% CI)**	**Most Precise Adjusted OR (95% CI)**
Mother	Mother Knows Recommended for Mother	1.66 (0.72 - 3.86)	1.69 (0.63 - 4.55)	1.53 (0.59 - 3.93)
	Mother Doesn't Know Recommended for Mother	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)
Child	Mother Knows Recommended for Child	1.70 (0.80 - 3.59)	1.88 (0.79 - 4.48)	1.77 (0.80 - 3.94)
	Mother Doesn't Know Recommended for Child	1.0 (Ref)	1.0 (Ref)	1.0 (Ref)

The gold standard model for the association of the mother's nutrition knowledge for herself and the mother's F&V intake at the baseline survey is shown in Table 33. The model includes the exposure (nutrition knowledge), the variables that were included a priori (FM, WIC Clinic, Mother's Age, Educational Level, and Marital Status), and the potential confounders (SNAP/TANF, Total WIC Recipients in House, Total People in House, Breastfeeding, and Previous FM Use). The distribution (%) of all participants and only those who met the F&V recommendations (the cases) are shown for each variable. The beta coefficients and p-values for these coefficients are shown along with the odds ratios and 95% confidence intervals. None of the beta coefficients or ORs were statistically significant at the alpha level of 0.05.

Mothers who had nutrition knowledge of the five or more F&V per day recommendation had higher F&V intake than those who did not have knowledge (coefficient = 0.53, OR = 1.69). F&V intake was higher among FM participants than non-FM participants (coefficient = 0.53, OR = 1.69) and women at the Kirkwood clinic compared to those at the Adamsville clinic (coefficient = 0.15, OR = 1.16).

F&V consumption was lowest among those women aged 25-31 years (coefficient = -0.33, OR = 0.54), followed by those aged 32 years or older (coefficient = 0.05, OR = 0.79), and lastly those 18-24 years (referent group). Mothers with more than a high school education had lower F&V intake than mothers with a high school diploma or less than a high school education (coefficient =

-0.04, OR = 0.93). Mothers currently in a relationship had lower F&V intake than those not currently in a relationship (coefficient = -0.03, OR = 0.95).

Mothers who were SNAP/TANF Recipients had higher F&V intake than non-SNAP/TANF recipients (coefficient = 0.02, OR = 1.06). The higher the number of WIC recipients in the household, the higher the F&V intake (coefficient = 0.69, OR = 1.99), but the higher the total number of people in the household, the lower reported F&V intake (coefficient = -0.24, OR = 0.78). Breastfeeding mothers had higher F&V intake than non-breastfeeding mothers (coefficient = 0.99, OR = 2.69). Lastly, F&V intake was highest among those who had never been to the WIC FMNP before (referent) and lowest among those who had been to the FMNP once before (coefficient = -0.20, OR = 0.59).

Table 33 Mother's F & V Intake and Nutrition Knowledge (Gold Standard Model)										
Variable		Total (N = 113)		Case (N = 28)		Model Results				
		N	Percent	N	Percent	Coefficient	p-value	OR	95% CI	
Nutrition Knowledge	No	70	61.95	15	53.57	Referent				
	Yes	43	38.05	13	46.43	0.5257	0.2975	1.69	0.63	4.55
FM	No	54	47.79	14	50.00	Referent				
	Yes	59	52.21	14	50.00	0.5257	0.2975	1.69	0.63	4.55
WIC Clinic	Adamsville	50	44.25	11	39.29	Referent				
	Kirkwood	63	55.75	17	60.71	0.1499	0.7774	1.16	0.42	3.16
Mother's Age	18-24	29	25.66	9	32.14	Referent				
	25-31	45	39.82	9	32.14	-0.3301	0.3504	0.54	0.16	1.82
	32+	39	34.51	10	35.71	0.0467	0.8904	0.79	0.25	2.52
Educational Level	High School or Less	66	58.41	16	57.14	Referent				
	More than High School	47	41.59	12	42.86	-0.0367	0.8879	0.93	0.34	2.58
Marital Status	Separated, divorced, widowed, or never been married	92	81.42	23	82.14	Referent				
	Married or member of an unmarried couple	21	18.58	5	17.86	-0.0271	0.9298	0.95	0.23	3.88
SNAP/TANF	No	29	25.66	7	25.00	Referent				
	Yes	84	74.34	21	75.00	0.0267	0.9277	1.06	0.33	3.34
Total WIC Recipients in House		113		28		0.6861	0.0744	1.99	0.94	4.22
Total People in House		113		28		-0.2449	0.1946	0.78	0.54	1.13
Breastfeeding	No	105	92.92	24	85.71	Referent				
	Yes	8	7.08	4	14.29	0.9894	0.2872	2.69	0.44	16.63
Previous FM Use	Never	43	38.05	13	46.42	Referent				
	Once	51	45.13	11	39.29	-0.1967	0.5659	0.59	0.21	1.66
	More than once	19	16.81	4	14.29	-0.1418	0.7471	0.62	0.15	2.51

The mother's most precise model demonstrated similar results to the gold standard model as shown in Table 34. The OR decreased from 1.69 in the gold standard model to 1.53 in the most precise model, but the most precise model remained non-significant (95% CI = 0.59 – 3.93). However, the gold standard and most precise models were similar and gave the same non-significant results. The directions (positive/negative) of the associations for all variables were the same as those previously described for the gold standard model, except the most precise model showed different results for the FM and marital status variables. The most precise model indicated that non-FM participants had higher F& V intake than FM participants at baseline (coefficient = -0.22, OR = 0.80). Also, participants who were currently in a relationship (married or member of an unmarried couple) had higher F&V intake than participants who were not in a relationship (coefficient = 0.003, OR = 1.01).

Further, I considered looking at only those participants in the farmers' market group who received and used all of their coupons (N = 57). I found that the odds ratio for the mother using the gold standard model was 1.826 (0.65 – 5.12). Therefore, the OR was higher than that found in the original gold standard, but the result was still not significant and gave the same conclusion.

Table 34 Mother's F & V Intake and Nutrition Knowledge (Most Precise Model)

		Total (N = 116)		Case (N = 29)		Model Results				
Variable		N	Percent	N	Percent	Coefficient	p-value	OR	95% CI	
Nutrition Knowledge	No					Referent				
	Yes					0.4221	0.3815	1.53	0.59	3.93
FM	No	56	48.28	14	48.28	Referent				
	Yes	60	51.72	15	51.72	-0.2222	0.6232	0.80	0.33	1.94
WIC Clinic	Adamsville	52	44.83	12	41.38	Referent				
	Kirkwood	64	55.17	17	58.62	0.0699	0.8796	1.07	0.43	2.65
Mother's Age	18-24	31	26.72	10	34.48	Referent				
	25-31	46	39.66	9	31.03	-0.4325	0.2038	0.42	0.13	1.31
	32+	39	33.62	10	34.48	-0.0096	0.9765	0.64	0.21	1.9
Educational Level	High School or Less	68	58.62	17	58.62	Referent				
	More than High School	48	41.38	12	41.38	-0.0469	0.8436	0.91	0.36	2.31
Marital Status	Separated, divorced, widowed, or never been married	95	81.90	24	82.76	Referent				
	Married or member of an unmarried couple	21	18.10	5	17.24	0.0025	0.9935	1.01	0.3	2.31
Breastfeeding	No	107	92.24	25	86.21	Referent				
	Yes	9	7.76	4	13.79	1.3206	0.0904	3.75	0.81	17.27

The gold standard model for the association of the mother's nutrition knowledge for her child and the child's F&V intake at the baseline survey is shown in Table 35. The model includes the exposure, (nutrition knowledge), the variables that were included a priori (FM, WIC Clinic, Child's Age, Educational Level, and Marital Status), and the potential confounders (SNAP/TANF, Total WIC Recipients in House, Total People in House, Previous FM Use, and

Mother's F&V Intake). The distribution (%) of all participants and those who met the F&V recommendations (the cases) is shown for each variable.

The beta coefficients and p-values for these coefficients are shown along with the odds ratio and 95% confidence interval. The beta coefficient and OR for the Mother's Intake variable was statistically significant at the alpha level of 0.05 in the gold standard model only. All other coefficients and ORs were not significant in the gold standard or most precise model.

Mothers who had nutrition knowledge of the five or more F&V per day recommendation for their child had children with higher F&V intake than those who did not have knowledge (coefficient = 0.63, OR = 1.88). Child's F&V intake was lower among FM participants than non-FM participants (coefficient = -0.05, OR = 0.95) and children at the Kirkwood clinic compared to those at the Adamsville clinic (coefficient = -0.26, OR = 0.77).

Child's F&V consumption was lowest among children three years of age (coefficient = -0.31, OR = 0.49), followed by those aged four years (coefficient = -0.07, OR = 0.63), then those two years of age (coefficient = -0.02, OR = 0.66), and lastly those who were one year of age (referent group). Mothers with more than a high school education had children with lower F&V intake than mothers with a high school diploma or less than a high school education (coefficient = -0.23, OR = 0.63). Mothers currently in a relationship had children with higher F&V intake than those not currently in a relationship (coefficient = 0.27, OR = 1.73).

Mothers who were SNAP/TANF Recipients had children with lower F&V intake than non-SNAP/TANF recipients (coefficient = -0.11, OR = 0.80). The higher the number of WIC recipients in the household, the higher the child's F&V intake (coefficient = 0.26, OR = 1.29) and the higher the total number of people in the household, the higher the child's reported F&V intake (coefficient = 0.04, OR = 1.04). Child's F&V intake was highest among those who had been to the WIC FMNP more than once (coefficient = 0.13, OR = 1.06) and lowest among those who had been to the FMNP once before (coefficient = -0.21, OR = 0.75). Lastly, the child's F&V intake was significantly higher among children with mother's who met the F&V consumption recommendations compared to children with mother's who did not meet the recommendations (coefficient = 0.62 (p = 0.01), OR = 3.43 (95% CI: 1.28 – 9.17)).

Table 35 Child's F & V Intake and Nutrition Knowledge (Gold Standard Model)

Variable		Total (N = 113)		Case (N = 56)		Model Results				
		N	Percent	N	Percent	Coefficient	p-value	OR	95% CI	
Nutrition Knowledge	No	69	61.06	31	55.36	Referent				
	Yes	44	38.94	25	44.64	0.6302	0.1557	1.88	0.79	4.48
FM	No	55	48.67	28	50.00	Referent				
	Yes	58	51.33	28	50.00	-0.0508	0.9071	0.95	0.41	2.32
WIC Clinic	Adamsville	51	45.13	26	46.43	Referent				
	Kirkwood	62	54.87	30	53.57	-0.2564	0.5603	0.77	0.33	1.83
Child's Age	1	21	18.58	12	21.43	Referent				
	2	34	30.09	17	30.36	-0.021	0.9501	0.66	0.19	2.28
	3	28	24.78	11	19.64	-0.3092	0.4077	0.49	0.13	1.90
	4	30	26.55	16	28.57	-0.0673	0.8534	0.63	0.17	2.34
Educational Level	High School or Less	66	58.41	34	60.71	Referent				
	More than High School	47	41.59	22	39.29	-0.2333	0.3231	0.63	0.25	1.58
Marital Status	Separated, divorced, widowed, or never been married	92	81.42	44	78.57	Referent				
	Married or member of an unmarried couple	21	18.58	12	21.43	0.2739	0.3818	1.73	0.51	5.90
SNAP/TANF	No	29	25.66	15	26.79	Referent				
	Yes	84	74.34	41	73.21	-0.1124	0.6835	0.80	0.27	2.35
Total WIC Recipients in House		113		56		0.2557	0.4454	1.29	0.67	2.49
Total People in House		113		56		0.0356	0.8135	1.04	0.77	1.39
Previous FM Use	Never	44	38.94	24	42.86	Referent				
	Once	50	44.25	22	39.29	-0.2088	0.4711	0.75	0.29	1.93
	More than once	19	16.18	10	17.86	0.1312	0.7327	1.06	0.30	3.77
Mother's Intake	No	84	74.34	35	62.50	Referent				
	Yes	29	25.66	21	37.50	0.6158	0.0142	3.43	1.28	9.17

The child's most precise model demonstrated similar results to the gold standard model as shown in Table 36. The OR decreased from 1.88 in the gold standard model to 1.77 in the most precise model, but the most precise model remained non-significant (95% CI = 0.80 – 3.94). The directions (positive/negative) of the associations for all variables were the same as those previously described for the gold standard model. However, the gold standard and most precise models were similar and gave the same non-significant results.

Table 36 Child's F & V Intake and Nutrition Knowledge (Most Precise Model)										
Variable		**Total (N = 117)**		**Case (N = 59)**		**Model Results**				
		N	**Percent**	**N**	**Percent**	**Coefficient**	**p-value**	**OR**	**95% CI**	
Nutrition Knowledge	No	72	61.54	33	55.93	Referent				
	Yes	45	38.46	26	44.07	0.5730	0.1593	1.77	0.80	3.94
FM	No	56	47.86	29	49.15	Referent				
	Yes	61	52.14	30	50.85	-0.1323	0.7341	0.88	0.41	1.88
WIC Clinic	Adamsville	51	47.86	26	44.07	Referent				
	Kirkwood	66	52.14	33	55.93	-0.1062	0.7921	0.90	0.41	1.98
Child's Age	1	22	18.8	13	22.03	Referent				
	2	36	30.77	19	32.20	0.1138	0.7173	0.74	0.24	2.31
	3	28	23.93	11	18.64	-0.4647	0.1775	0.42	0.12	1.40
	4	31	26.50	16	27.12	-0.0594	0.8574	0.63	0.20	2.01
Educational Level	High School or Less	69	58.97	36	61.02	Referent				
	More than High School	48	41.03	23	38.98	-0.1671	0.4362	0.72	0.31	1.66
Marital Status	Separated, divorced, widowed, or never been married	96	82.05	47	79.66	Referent				
	Married or member of an unmarried couple	21	17.95	12	20.34	0.3310	0.2133	1.94	0.68	5.50
SNAPTANF	No	29	24.79	15	25.42	Referent				
	Yes	88	75.21	44	74.58	-0.0373	0.8804	0.93	0.35	2.45

6) Discussion

All participants were low-income and the mother and/or the child were at nutritional risk and were thus WIC recipients. All the mothers were non-pregnant and the majority or participants were African American, non-Hispanic, not breastfeeding, not currently in a relationship, and were SNAP/TANF recipients. Therefore, the Emory WIC FMNP Study participants were relatively homogeneous and included women of a specific demographic that had not been well-represented in existing literature. The homogeneity of my study sample may explain why some of the results for the second analysis research question were in contrast to out predictions.

Descriptive D1: Describe demographic characteristics at baseline survey, stratified by FMNP participation.

As I hypothesized, there were few differences in the demographic characteristics at the baseline survey between the non-FM and FM groups. It was interesting that the average number of WIC recipients in the house and the total number of people in the house were significantly higher in the non-FM group compared to the FM group. These differences were accounted for as potential confounders in the second analysis research question.

Descriptive D2: Describe previous and current FMNP use at baseline and 1-week follow-up surveys, stratified by FMNP participation.

There were no significant differences in previous FMNP use between the non-FM and FM groups. Approximately half (48.75%) of FM participants had never previously been to the WIC FMNP.

Even though most FM participants received and used all of the FMNP coupons at the current year WIC FMNP, it is interesting that ten participants received coupons but did not use any of them and nine of these ten participants were from the Kirkwood WIC clinic. I expected nearly all Adamsville WIC recipients to use all of their FMNP coupons and the Kirkwood clinic to have lower FMNP coupon use due to the previously described differences in the FMNP administration at each WIC clinic. Therefore, my results suggest that if the FMNP coupons are not used on the same day they are received, they are not likely to be used.

Descriptive D3: Describe nutrition knowledge at baseline and 4-week follow-up surveys, stratified by FMNP participation.

The average number of F&V that the mother believed should be consumed daily for good health for herself and her child at both the baseline and four-week follow-up surveys were below the F&V recommendations of five or more F&V per day. The percent who had knowledge of the F&V recommendations was non-significantly higher among FM participants than non-FM participants. I hypothesize that the reason the percentages knowing the F&V recommendations was slightly higher for the FM group compared to the non-FM group has to do with the WIC-led nutrition education material and the interview timing. The WIC-led nutrition education material for the FM group was on fruits and vegetables and the FMNP and for the non-FM group was both milk (e.g. low-fat vs. whole fat milk and intake) and some F&V information. While the Emory WIC FMNP Study interviewers attempted to complete every survey before the WIC-led nutrition education session, this was not always possible. Sometimes the interview was stopped for the WIC recipient to attend the education session and then resumed and at other times the interview had to be completed after the education session. Therefore, the baseline survey values for nutrition knowledge could have possibly been just learned at the nutrition education session and therefore my baseline survey may not have truly represented a "baseline" value for all participants.

Also, there were no significant differences in nutrition knowledge between non-FM and FM groups or baseline to four-week surveys by WIC clinic. The percentage with knowledge of the F&V recommendations was higher among the Kirkwood clinic for the non-FM group, but higher at the Adamsville clinic for the FM group. The Adamsville clinic had more limited WIC-led nutrition education in respect to length of the session and material covered compared to the

Kirkwood clinic. Therefore, I expected to find higher nutrition knowledge at the Kirkwood clinic, not the Adamsville clinic for the FM group.

Compared to other WIC studies previously described in this literature review, my study did not show the same increases in nutrition knowledge following a nutrition education intervention as did other WIC studies in this review.[33,34] For example, the Maryland WIC 5 A Day Promotion Program study found that the intervention group demonstrated a greater increase in correct nutrition knowledge of the F&V recommendations (baseline: 41%, follow-up: 57%) compared to the control group (baseline: 41%, follow-up: 46%) with a statistically significant difference of the knowledge change in the two groups ($p < 0.0001$).[32] However, the Maryland WIC 5 A Day Promotion Program was more extensive than the usual WIC-led nutrition education. Among the WIC FMNP studies include in this literature review, only one assessed nutrition knowledge as knowledge as the five a day recommendation. Anderson et al. demonstrated that participation in the nutrition education, but not receiving the FMNP coupon, was significantly associated with nutrition knowledge, and competencies ($p < 0.01$).[39] However, this study did not specifically show the results for only nutrition knowledge. Thus, there is little data on the impact of the WIC-led nutrition education during the FMNP on nutrition knowledge. Unfortunately, my study's results are limited by my interview timing as previously described. I believe this limitation led to results indicating no change in nutrition knowledge across survey periods.

Descriptive D4: Describe nutrition competencies at the 1-week follow-up survey for FMNP participants only.

Regarding the nutrition competencies learned from the WIC FMNP, there were no statistically significant differences in these competencies between WIC clinics, yet more Adamsville participants non-significantly agreed with these statements than Kirkwood participants. Again due to the differences by WIC clinic in the WIC-led nutrition education and the WIC FMNP administration differences (e.g. limited WIC recipient-farmer interaction and no opportunity to select own F&V from the farmers' market at the Adamsville clinic), I expected to find the opposite result.

Compared to the WIC studies described in the literature review, my study results were similar in that I also saw an increase in competencies throughout across survey periods. For example, the Market Basket Booklet study found that among participants who used the booklet, 68% felt much or somewhat more confident in storing F&V appropriately.[36]

Among the two WIC FMNP studies that assessed nutrition competencies, my study findings were similar in that the WIC FMNP increased nutrition competencies. For example, Anderson et al. indicated that nutrition education had a significant and positive effect on the attitude of "how much bother it is to prepare fruits and vegetables" ($p < 0.05$).[39] Additionally, the "Program Impact Report for the 2002 WIC Farmers' Market Nutrition Program" found that among overall U.S. FMNP participants, 53% "learned a new way to prepare fresh fruits and vegetables" and 47% "learned a new way to store produce to prevent spoilage" following the FMNP.[19] The results for Georgia were lower with 45% for the former statement and 41% for the latter statement.[19] My study results for Georgia were higher at 56.5% for learning a new way to prepare fresh F&V and 58.7% for learning a new way to store F&V. This difference in percentages may be due to a difference in the specific Georgia WIC clinics sampled for my study versus the national study or due to the changes in the WIC FMNP from 2002 for the national study to 2009 for my study.

Descriptive D5: Describe fruit, vegetable, and total F&V intake for mother and child at baseline, 1-week, and 4-week follow-up surveys, stratified by FMNP participation.

It was interesting that F&V intake remained relatively unchanged and even slightly decreased from the baseline survey to the one-week and four-week follow-up surveys for both the mother and child.

I predicted that the F&V intake for the non-FM group would remain relatively constant across survey periods. This was true for the mother, but not for the child. I hypothesize that the non-FM child's intake decreased from baseline to follow-up surveys due to an interviewer bias. I believe that mothers may have felt more inclined to report healthier dietary intake during the in-person baseline interview at the WIC clinic and may not have felt this inclination during the follow-up phone interviews since they were not in-person.

Further, I expected the F&V intake to significantly increase for the FM group from baseline to follow-up surveys for both the mother and child and this was not demonstrated by the results. I predicted that FM recipients would consume the F&V from the farmers' market in addition to their usual F&V they purchased and ate from a supermarket or grocery store. However, based on the results, I hypothesize that the FM participants possibly replaced any F&V they usually purchased at the grocery store with those that they received at the WIC farmers' market and thus their F&V intake remained relatively unchanged.

Other WIC and WIC FMNP studies which examined F&V intake found conflicting results as some found an increase [29,31-35,39], others a decrease [36], and some studies found F&V intake to remain constant [26,27,30,37,38] over the study period. Therefore, the Emory WIC FMNP Study contributes to the existing literature as a study that found relatively no change from baseline to follow-up surveys or any significant differences between the non-FM and FM groups.

It is most interesting to note the increase in the mean daily servings of F&V and the percentage meeting the F&V 5-a-Day recommendations at the Adamsville WIC Clinic among FM participants. I saw a decrease in both the mean daily servings and the percent meeting the recommendations among Kirkwood WIC clinic FM participants. I hypothesize that the method of FMNP coupon distribution and use are the reasons for these differences. At the Adamsville WIC clinic, FM participants were required to use all of their coupons at once at the farmers' market located on site at the clinic, whereas at the Kirkwood WIC clinic, FM participants had a two-week time frame to use their coupons at any farmers' market that accepted FMNP coupons. The requirement to use the coupons on the day they were received seemed to ensure that the coupons were used and the results suggest that the F&V were consumed by the mothers.

Question R1: Does learning nutrition competencies due to the FMNP result in an increase in F&V intake for mother and child, comparing intake at: baseline to 1-week follow-up survey and baseline to 4-week follow-up survey.

More than half of the FM participants agreed that they learned new nutrition competencies because of the WIC FMNP and these learned competencies significantly increased F&V intake for the mother from the baseline to the one-week survey. There were also positive, but non-significant relationships for the mother's baseline to four-week follow-up survey and the child's baseline to one-week follow-up survey indicating that an increase in nutrition knowledge non-significantly increased F&V intake. However, this association was found to be non-significantly negative for the child's baseline to four-week survey.

The Emory WIC FMNP study is the first to compare these learned competencies with a change in F&V intake, for the mother and child, following the WIC FMNP. The Program Impact Report included descriptive results of these learned competencies, but did not examine their relationship with F&V consumption.

Question R2: Does maternal nutrition knowledge predict F&V intake of mother and child controlling for FMNP participation, WIC Clinic, and demographic characteristics at baseline.

My results suggest that baseline nutrition knowledge predicts baseline F&V intake for both mother and child, adjusting for potential confounders. Both the gold standard and most precise models were not statistically significant for mother or child. Yet, my results suggest that having nutrition knowledge of the five or more total F&V per day recommendations does seem to increase F&V intake of mother and child compared to not having nutrition knowledge.

When the effect of the potential confounders on the relationship of nutrition knowledge and F&V intake were considered individually, my predictions on the effects were true for some confounders but not true for others. For example, I expected mothers who were SNAP/TANF recipients to have higher F&V intake because they receive more food subsidies than SNAP/TANF non-recipients. This prediction was true for the mother's gold standard model, but not for the child's gold standard model. The most interesting potential confounder that did not meet my expectation was "Education Level." I expected women with more than a high school education would have higher F&V intake, but I found the opposite result for the mother's and child's gold standard and most precise models. I hypothesized that women with a higher education level would have better nutrition knowledge and possible more financial means to purchase healthier food options like F&V for themselves and their families. Yet, in this low-income population, education level appears to not have the same effect as in the general population.

Compared to the WIC studies, the Emory WIC FMNP study found similar results in that having nutrition knowledge was associated with higher F&V intake. For example, Havas et al. estimated by multiple regression modeling that those with this nutrition knowledge consumed 0.87 more F&V servings per day than those who lacked this knowledge, adjusting for potential confounders ($p = 0.0001$).[33] Although my study results were not statistically significant, I did examine nutrition knowledge and F&V intake regarding the mother and child, which had not been previously found in the existing literature.

7) Strengths/Limitations

Project 1 has at least five strengths. First, it examined the F&V intake of both the mother and the child. The Emory WIC FMNP study was the first WIC FMNP study to report the child's F&V intake. Second, this research was the first to evaluate the Georgia WIC FMNP, specifically the program's impact on F&V intake of both mother and child and on nutrition knowledge and competencies about F&V. Third, the Emory WIC FMNP study participants were all African American postpartum WIC recipients and thus my study primarily included a specific population that has not been represented in the existing literature. Fourth, this project advances my understanding of factors that influence F&V consumption in the WIC population by examining the impact of the WIC FMNP on both F&V intake of the mother and child and the mother's nutrition knowledge and competencies about F&V. Lastly, my study used nutrition knowledge, attitude, and competency questions and F&V questions (BRFSS) that have been used in previous research and thus allows for comparison of results.

Project 1 has at least four limitations. First, my baseline data might not have truly been baseline data due to my interview timing as previously described. I could improve the next study by completing all baseline surveys before the WIC-led nutrition education session. Second, my sample size was relatively small, however I did have high follow-up rates for this population at approximately 80%. Third, my F&V intake measurement tool, BRFSS, assessed the frequency of intake but I am uncertain of the portion or serving sizes consumed by study participants. Fourth, there was no distinction between F&V that were consumed from the WIC farmers' market and those purchased from a grocery store or supermarket on the follow-up surveys. Including this distinction in the surveys might have helped us better understand why F&V intake remained relatively constant over the study period.

8) Study Implications

Project 1's results indicate that approximately fifty-percent of the WIC participants had nutrition knowledge about the F&V recommendations. These findings could support WIC-led nutrition education programs to emphasize or incorporate the F&V recommendations into the educational material. This study also found that nutrition competencies improved following the WIC FMNP. Therefore, this suggests that during the FMNP, the WIC-led nutrition education is covering F&V storage to prevent spoilage and is providing examples of how to prepare/cook fresh F&V.

Overall, fruit and vegetable intake was low in this study and the WIC FMNP did not significantly increase F&V consumption. However, F&V intake was found to be non-significantly associated with the mother's nutrition knowledge for mother and child at baseline and F&V consumption was found to be significantly associated with learning new competencies following the WIC FMNP. Further research is needed as to why F&V consumption did not change across survey periods and to confirm my study's F&V intake associations with nutrition knowledge and competencies.

9) Appendix: Chapter 2

Model Building/Results Section

The initial full model was run in SAS using PROC LOGISTIC. First I considered multicollinearity by using the collinearity macro. I set the condition index (CI) at 20 and the variance composition proportion (VDP) at 0.5. When I ran the model with the collinearity matrix, the CI was 18.516 and the only VDPs that were greater than 0.5 were the intercept and the exposure. Therefore, there are no collinearity issues and I moved on to assess interaction.

The Chunk test was used to carry out statistical testing for the entire set or "chunk" of interaction terms [62]. The interaction terms considered in the Chunk test were: Nutrition Knowledge*FM, Nutrition Knowledge*WIC Clinic, Nutrition Knowledge* Education Level, Nutrition Knowledge *Number of WIC Recipients, Nutrition Knowledge*Breastfeeding, Nutrition Knowledge* Previous WIC FMNP Coupon Use 1, Nutrition Knowledge* Previous WIC FMNP Coupon Use 2. The null hypothesis for this test was H0: $\beta14 = \beta15 = \beta16 = \beta17 = \beta18 = \beta19 = \beta20$. The Chunk test uses the Likelihood Ratio (LR) test which compares the full model containing all interaction terms to the reduced models containing no interaction terms [62]. The LR test involved a chi-square statistic with seven degrees of freedom for the difference in the number of parameters in the full and reduced models. The reduced or no interaction model is found below:

Logit P(Mother's Total F&V Intake, **X**) = $\alpha + \beta1$ (Nutrition Knowledge $_i$) + $\beta2$ (Participant Type $_i$) + $\beta3$ (WIC Clinic $_i$) + $\beta4$ (Mother's Age 1 $_i$) + $\beta5$ (Mother's Age 2 $_i$) + $\beta6$ (Education $_i$) + $\beta7$ (Marital Status $_i$) + $\beta8$ (SNAP/TANF Recipient $_i$) + $\beta9$ (Number of WIC Recipients $_i$) + $\beta10$

(Number of People in Household $_i$) + β11 (Breastfeeding $_i$) + β12 (Previous WIC FMNP Coupon Use 1 $_i$) + β13 (Previous WIC FMNP Coupon Use 2 $_i$)

The – 2 log L for the full model was 108.301 and the -2 log L for the reduced model (without interaction terms) was 115.805. Therefore the Chunk test was LR = -2 log L (reduced) – (-2 Log L (full)) = 115.805 – 108.301 = 7.504. This chi-square value is not significant (p = 0.3783) at an alpha level of 0.05. Therefore, all interaction terms should be removed based on the Chunk test results. However, I carried out backwards elimination by the LR test and the Wald test for each interaction term one at a time to confirm these results.

Returning to the full starting model, the least significant interaction term was Nutrition Knowledge*Breastfeeding. The Wald test calculates a z-statistic by dividing the coefficient of the interaction term by its standard error (SE). Therefore, I divided the β (Nutrition Knowledge*Breastfeeding) by the SE (Nutrition Knowledge*Breastfeeding) variable. So, the Wald test = 0.8171 / 2.0867 = 0.3916. Since 0.3916 is less than 1.96, the Wald test is not significant.

For the LR test, I removed the Nutrition Knowledge*Breastfeeding interaction term and for this reduced model, the -2 log L was 108.457. Therefore, the LR test = 108.457 – 108.301 = 0.156. Thus, the LR test was not significant (p = 0.6928) either. Since both the Wald and LR test were not significant I removed the Nutrition Knowledge*Breastfeeding interaction term and considered this model the full model.

The testing of the significance of the remaining interaction terms are shown in Table B1 by the Wald Test and LR Test.

Table B1 Question R2 Interaction Term Assessment by Wald and LR Tests, Mother's Model									
Interaction Term to be Considered for Removal		**Wald Test**			**LR Test**				
		B	**SE**	**z-statistic**	**- 2 log L (reduced)**	**- 2 log L (full)**	**LR**	**DF**	**p-value**
Nutrition Knowledge*FM		0.6299	1.1089	0.568	108.784	108.457	0.317	1	0.5674
Nutrition Knowledge*Total WIC		0.4275	0.6665	0.6414	109.205	108.784	0.421	1	0.5164
Nutrition Knowledge*Education Level		-0.5442	0.5342	-1.0187	110.256	109.205	1.051	1	0.3052
Nutrition Knowledge*Previous FM Use	Previous FM Use 1	-1.3311	0.7815	-1.7033	113.563	110.256	3.307	2	0.1913
	Previous FM Use 2	1.39	0.9984	1.3922					
Nutrition Knowledge*Clinic		-1.5189	1.0338	-1.4692	115.805	113.563	2.242	1	0.1343

Since all Wald test z-statistics were between -1.96 and 1.96, none were significant. None of the LR tests were significant either. Therefore, the results of the Chunk test, Wald tests, and LR tests led us to drop all interaction terms.

Therefore my gold standard model is shown below:

Logit P(Mother's Total F&V Intake, **X**) = $\alpha + \beta 1$ (Nutrition Knowledge $_i$) + $\beta 2$ (Participant Type $_i$) + $\beta 3$ (WIC Clinic $_i$) + $\beta 4$ (Mother's Age 1 $_i$) + $\beta 5$ (Mother's Age 2 $_i$) + $\beta 6$ (Education $_i$) + $\beta 7$ (Marital Status $_i$) + $\beta 8$ (SNAP/TANF Recipient $_i$) + $\beta 9$ (Number of WIC Recipients $_i$) + $\beta 10$ (Number of People in Household $_i$) + $\beta 11$ (Breastfeeding $_i$) + $\beta 12$ (Previous WIC FMNP Coupon Use 1 $_i$) + $\beta 13$ (Previous WIC FMNP Coupon Use 2 $_i$)

Next I considered confounding and precision as shown in Table 24. A priori I decided to include FM participation, WIC Clinic, Mother's Age, Education Level, and Marital Status in the model and thus these variables were not considered for confounding or precision. Therefore, the following variables were considered for confounding and precision: SNAP/TANF Recipient, Total WIC Recipients, Total People in House, Breastfeeding, and Previous FM Use. I removed these five variables one at a time and then in every group combination. There were a total of 31 models compared as shown in Table B2. For assessment of confounding, all OR estimates were compared to within 10% (1.52 – 1.86) of the gold standard estimate (OR = 1.69). If the estimate was not within 10% of the gold standard, this model did not adequately control for confounding and therefore these models were not considered further for precision. Among the ORs that were within 10% of the gold standard, the widths of the 95% confidence intervals were compared to the width of the gold standard confidence interval (width = 3.92). There were numerous models with more precise confidence intervals than the gold standard, but the most precise model (highlighted in gray) with the smallest confidence interval width was the model that only included the breastfeeding variable in addition to the variables that were kept a priori.

Table B2 Assessment of Confounding and Precision for Association of Mother's F & V Intake and Nutrition Knowledge					
		OR Estimate	**Within 10% of Gold Standard**	**95% Confidence Interval**	**Width of CI**
Gold Standard		1.69	1.52 - 1.86	0.63 - 4.55	3.92
Variables Removed One at a Time					
Variable	**Meaning of Variable**	**OR Estimate**	**Within 10% of Gold Standard**	**95% Confidence Interval**	**Width of CI**
FM	Farmers' Market	Keep a priori			
Clinic	WIC Clinic				
B37aC3	Mother's Age				
B39c2	Education Level				
B40a2	Marital Status				
SNAPTANF	SNAP or TANF	1.68	Yes	0.63 - 4.49	3.86
TotWIC	Total # of WIC Recipients	1.52	No		
TotHouse	Total # of People in Household	1.67	Yes	0.62 - 4.48	3.86
B36	Breastfeeding	1.95	No		
B1PrevFM	Previous FM Use	1.74	Yes	0.65 - 4.65	4.00
Variables Removed By Subgroup					
SNAPTANF, TotWIC		1.50	No		
SNAPTANF, TotHouse		1.63	Yes	0.61 - 4.36	3.75
SNAPTANF, B36		1.92	No		
SNAPTANF, B1PrevFM		1.71	Yes	0.64 - 4.55	3.91
TotWIC, TotHouse		1.53	Yes	0.59 - 3.99	3.40
TotWIC, B36		1.68	Yes	0.67 - 4.26	3.59
TotWIC, B1PrevFM		1.57	Yes	0.61 - 4.06	3.45
TotHouse, B36		1.92	No		
TotHouse, B1PrevFM		1.69	Yes	0.63 - 4.55	3.92
B36, B1PrevFM		2.01	No		
SNAPTANF TotWIC, TotHouse		1.50	No		
SNAPTANF, TotWIC, B36		1.65	Yes	0.66 - 4.13	3.47
SNAPTANF, TotWIC, B1PrevFM		1.52	No		
SNAPTANF, TotHouse, B36		1.87	No		
SNAPTANF, TotHouse, B1PrevFM		1.64	Yes	0.61 - 4.37	3.76
SNAPTANF, B36, B1PrevFM		1.97	No		
TotWIC, TotHouse, B36		1.68	Yes	0.67 - 4.26	3.59
TotWIC, B36, B1PrevFM		1.74	Yes	0.69 - 4.37	3.68
TotWIC, TotHouse, B1PrevFM		1.58	Yes	0.61 - 4.11	3.50
TotHouse, B36, B1PrevFM		1.97	No		
SNAPTANF, TotWIC, TotHouse, B36		1.65	Yes	0.66 - 4.13	3.47
SNAPTANF, TotWIC, TotHouse, B1PrevFM		**1.53**	**Yes**	0.59 - 3.93	**3.34**
SNAPTANF, TotWIC, B36, B1PrevFM		1.68	Yes	0.68 - 4.19	3.51
SNAPTANF, TotHouse, B36, B1PrevFM		1.90	No		
TotWIC, TotHouse, B36, B1PrevFM		1.74	Yes	0.69 - 4.38	3.69
SNAPTANF, TotWIC, TotHouse, B36, B1PrevFM		1.68	Yes	0.67 - 4.20	3.53

The model results including the beta coefficient, p-value, OR, and 95% CI were reported for both the gold standard and most precise models. The total number of participants and number of "cases" or participants who met the F&V intake recommendations for each variable category were also described.

The initial full child's model is shown below:

Logit P(Child's Total F&V Intake, **X**) = α + β1 (Nutrition Knowledge $_i$) + β2 (Participant Type $_i$) + β3 (WIC Clinic $_i$) + β4 (Child's Age 1 $_i$) + β5 (Child's Age 2 $_i$) + β6 (Child's Age 3 $_i$) + β7 (Education $_i$) + β8 (Marital Status $_i$) + β9 (SNAP/TANF Recipient $_i$) + β10 (Number of WIC Recipients $_i$) + β11 (Number of People in Household $_i$) + β11 (Previous WIC FMNP Coupon Use 1 $_i$) + β12 (Previous WIC FMNP Coupon Use 2 $_i$) + β13 (Mother's F&V Intake $_i$) + β14 (Nutrition Knowledge $_i$ * FM $_i$) + β15 (Nutrition Knowledge $_i$ * WIC Clinic $_i$) + β16 (Nutrition Knowledge $_i$ * Education Level $_i$) + β17 (Nutrition Knowledge $_i$ * Number of WIC Recipients $_i$) + β18 (Nutrition Knowledge $_i$ * Previous WIC FMNP Coupon Use 1 $_i$) + β19 (Nutrition Knowledge $_i$ * Previous WIC FMNP Coupon Use 2 $_i$)

Where: All variables are as described in Table 22 Question R2 Variable Specification

α = intercept

β = parameter estimates for exposure and covariates

$_i$ = Study Participant

The initial full model as run in SAS using PROC LOGISTIC. First I considered collinearity by using the collinearity macro. I set the condition index (CI) at 20 and the variance composition proportion (VDP) at 0.5. When I ran the model with the collinearity matrix, the CI was 18.482

and the only VDPs that were greater than 0.5 were the intercept and the exposure. Therefore, there are no collinearity issues and I moved on to assess interaction.

I first used the Chunk test including the following interaction terms: Nutrition Knowledge*FM, Nutrition Knowledge*WIC Clinic, Nutrition Knowledge* Education Level, Nutrition Knowledge *Number of WIC Recipients, Nutrition Knowledge* Previous WIC FMNP Coupon Use 1, Nutrition Knowledge* Previous WIC FMNP Coupon Use 2. The null hypothesis for this test was H0: β14 = β15 = β16 = β17 = β18 = β19. The Chunk test used the Likelihood Ratio (LR) test with a chi-square statistics with six degrees of freedom to compare the full model containing all interaction terms to the reduced model containing no interaction terms. The reduced or no interaction model is found below:

Logit P(Child's Total F&V Intake, **X**) = α + β1 (Nutrition Knowledge $_i$) + β2 (Participant Type $_i$) + β3 (WIC Clinic $_i$) + β4 (Child's Age 1 $_i$) + β5 (Child's Age 2 $_i$) + β6 (Child's Age 3 $_i$) + β7 (Education $_i$) + β8 (Marital Status $_i$) + β9 (SNAP/TANF Recipient $_i$) + β10 (Number of WIC Recipients $_i$) + β11 (Number of People in Household $_i$) + β11 (Previous WIC FMNP Coupon Use 1 $_i$) + β12 (Previous WIC FMNP Coupon Use 2 $_i$) + β13 (Mother's F&V Intake $_i$)

The – 2 log L for the full model was 134.269 and the -2 log L for the reduced model (without interaction terms) was 141.994. Therefore the Chunk test was LR = -2 log L (reduced) – (-2 Log L (full)) = 141.994 – 134.269 = 7.725. This chi-square value is not significant (p = 0.2589) at an alpha level of 0.05. Therefore, all interaction terms should be removed based on the Chunk test results. However, I carried out backwards elimination by the LR test and the Wald test for each interaction term one at a time to confirm these results.

Returning to the full starting model, the least significant interaction term was Nutrition Knowledge*FM. The Wald test calculates a z-statistic by dividing the coefficient of the interaction term by its standard error (SE). Therefore, I divided the β (Nutrition Knowledge*FM) by the SE (Nutrition Knowledge*FM) variable. So, the Wald test = 0.0780 / 0.9572 = 0.0814. Since 0.0814 is less than 1.96, the Wald test is not significant.

For the LR test, I removed the Nutrition Knowledge*FM interaction term and for this reduced model, the -2 log L was 134.275. Therefore, the LR test = 134.275 – 134.269 = 0.006. Thus, the LR test was not significant (p = 0.9382) either. Since both the Wald and LR test were not significant I removed the Nutrition Knowledge*FM interaction term and considered this model now the new full model.

The testing of the significance of the remaining interaction terms are shown in Table B3 by the Wald Test and LR Test.

Table B3 Question R2 Interaction Term Assessment by Wald and LR Tests, Child's Model

Interaction Term to be Considered for Removal		Wald Test			LR Test				
		B	SE	z-statistic	- 2 log L (reduced)	- 2 log L (full)	LR	DF	p-value
Nutrition Knowledge*Clinic		-0.2596	0.9221	-0.2815	134.355	134.275	0.08	1	0.7773
Nutrition Knowledge*Total WIC		-0.2413	0.6257	-0.3856	134.502	134.355	0.147	1	0.7014
Nutrition Knowledge*Previous FM Use	Previous FM Use 1	0.4935	0.636	-1.7033	140.255	134.502	5.753	2	0.0563
	Previous FM Use 2	1.0719	0.8297	1.291					
Nutrition Knowledge*Education		0.5912	0.4531	1.304	141.994	140.255	1.739	1	0.1872

Since all Wald test z-statistics were between -1.96 and 1.96, none were significant. None of the LR tests were significant either. Therefore, the results of the Chunk test, Wald tests, and LR tests led us to drop all interaction terms.

Therefore my gold standard model is shown below:

Logit P(Child's Total F&V Intake, $\mathbf{X}$) = $\alpha + \beta 1$ (Nutrition Knowledge $_i$) + $\beta 2$ (Participant Type $_i$) + $\beta 3$ (WIC Clinic $_i$) + $\beta 4$ (Child's Age 1 $_i$) + $\beta 5$ (Child's Age 2 $_i$) + $\beta 6$ (Child's Age 3 $_i$) + $\beta 7$ (Education $_i$) + $\beta 8$ (Marital Status $_i$) + $\beta 9$ (SNAP/TANF Recipient $_i$) + $\beta 10$ (Number of WIC Recipients $_i$) + $\beta 11$ (Number of People in Household $_i$) + $\beta 11$ (Previous WIC FMNP Coupon Use 1 $_i$) + $\beta 12$ (Previous WIC FMNP Coupon Use 2 $_i$) + $\beta 13$ (Mother's F&V Intake $_i$)

Next I considered confounding and precision as shown in Table B4. A priori I decided to include FM participation, WIC Clinic, Child's Age, Education Level, and Marital Status in the model and thus these variables were not considered for confounding or precision. Therefore, the following variables were considered for confounding and precision: SNAP/TANF Recipient, Total WIC Recipients, Total People in House, Previous FM Use, and Mother's F&V Intake. I removed these five variables one at a time and then in every group combination. There were a total of 31 models compared as shown in Table 26. For assessment of confounding, all OR estimates were compared to within 10% (1.69 – 2.07) of the gold standard estimate (OR = 1.88). If the estimate was not within 10% of the gold standard, this model did not adequately control for confounding and therefore these models were not considered further for precision. Among the ORs that were within 10% of the gold standard, the widths of the 95% confidence intervals were compared to the width of the gold standard confidence interval (width = 3.70). There were numerous models with more precise confidence intervals than the gold standard, but the most precise model (highlighted in gray) with the smallest confidence interval width was the model that only included the SNAP/TANF variable in addition to the variables that were kept a priori.

Table B4 Assessment of Confounding and Precision for Association of Child's F & V Intake and Nutrition Knowledge					
		OR Estimate	**Within 10% of Gold Standard**	**95% Confidence Interval**	**Width of CI**
Gold Standard		1.88	1.69 - 2.07	0.79 - 4.48	3.70
Variables Removed One at a Time					
Variable	**Meaning of Variable**	**OR Estimate**	**Within 10% of Gold Standard**	**95% Confidence Interval**	**Width of CI**
FM	Farmers' Market	Keep a priori			
Clinic	WIC Clinic				
B10CRc	Child's Age				
B39c2	Education Level				
B40a2	Marital Status				
SNAPTANF	SNAP or TANF Recipient	1.92	Yes	0.82 - 4.49	3.67
TotWIC	Total # of WIC Recipients	1.67	No		
TotHouse	Total # of People in Household	1.87	Yes	0.78 - 4.46	3.68
B1PrevFM	Previous FM Use	1.93	Yes	0.81 - 4.57	3.76
MWFVDB	Mother's F & V Intake	1.99	Yes	0.87 - 4.55	3.68
Variables Removed by Subgroup					
SNAPTANF, TotWIC		1.75	Yes	0.76 - 4.02	3.26
SNAPTANF, TotHouse		1.91	Yes	0.82 - 4.47	3.65
SNAPTANF, B1PrevFM		1.96	Yes	0.85 - 4.55	3.71
SNAPTANF, MWFVDB		2.01	Yes	0.89 - 4.52	3.62
TotWIC, TotHouse		1.63	No		
TotWIC, B1PrevFM		1.71	Yes	0.74 - 3.96	3.22
TotWIC, MWFVDB		1.80	Yes	0.80 - 4.03	3.23
TotHouse, B1PrevFM		1.92	Yes	0.81 - 4.55	3.74
TotHouse, MWFVDB		1.99	Yes	0.87 - 4.55	3.67
B1PrevFM, MWFVDB		2.00	Yes	0.88 - 4.54	3.66
SNAPTANF, TotWIC, TotHouse		1.71	Yes	0.75 - 3.93	3.18
SNAPTANF, TotWIC, B1PrevFM		1.78	Yes	0.78 - 4.06	3.28
SNAPTANF, TotWIC, MWFVDB		1.85	Yes	0.84 - 4.10	3.26
SNAPTANF, TotHouse, B1PrevFM		1.96	Yes	0.84 - 4.54	3.70
SNAPTANF, TotHouse, MWFVDB		2.01	Yes	0.89 - 4.52	3.62
SNAPTANF, B1PrevFM, MWFVDB		2.01	Yes	0.90 - 4.49	3.59
TotWIC, TotHouse, B1PrevFM		1.67	No		
TotWIC, TotHouse, MWFVDB		1.77	Yes	0.79 - 3.95	3.16
TotWIC, B1PrevFM, MWFVDB		1.80	Yes	0.81 - 4.00	3.19
TotHouse, B1PrevFM, MWFVDB		2.00	Yes	0.88 - 4.54	3.66
SNAPTANF, TotWIC, TotHouse, B1PrevFM		1.75	Yes	0.77 - 3.98	3.21
SNAPTANF, TotWIC, TotHouse, MWFVDB		1.83	Yes	0.83 - 4.05	3.22
SNAPTANF, TotWIC, B1PrevFM, MWFVDB		1.84	Yes	0.84 - 4.06	3.22
SNAPTANF, TotHouse, B1PrevFM, MWFVDB		2.01	Yes	0.90 - 4.49	3.59
TotWIC, TotHouse, B1PrevFM, MWFVDB		**1.77**	**Yes**	0.80 - 3.94	**3.14**
SNAPTANF, TotWIC, TotHouse, B1PrevFM, MWFVDB		1.83	Yes	0.83 - 4.02	3.19

The model results including the beta coefficient, p-value, OR, and 95% CI were reported for both the gold standard and most precise models. The total number of participants and number of "cases" or participants who met the F&V intake recommendations for each variable category were also described.

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Chapter 3: Project 2 Actual and Perceived Nutrition Environments of Fresh, Canned, and Frozen Fruits and Vegetables

1) Motivation and Purpose of Project 2

This section describes the motivations, aims, and specific objectives for Project 2 of this dissertation. Project 2's contributions of this research and the skills developed during analysis of the Emory WIC FMNP Study are also discussed.

a) Motivations

Fruits and vegetables (F&V) provide essential nutrients and diets rich in F&V have been shown to prevent certain types of cancer and reduce risks for cardiovascular diseases, Type II diabetes, and obesity.[1-4] Despite the importance of F&V, consumption of recommended amounts of F&V is low in the United States [5-7] and intake is generally lower among low-income individuals.[6,8] Yet, prior to F&V consumption, the food or nutrition environment influences the access, availability, quality, and price of fruits and vegetables for purchase in food stores for consumption.

The F&V nutrition environment can be described on a store-level by actual characteristics seen by the consumer when present in the store such as fruit and vegetable availability, quality of fresh varieties, and price.[9] The F&V nutrition environment can also be described on an individual-level by the consumer's perceptions of the availability, quality, and affordability of fruits and vegetables found in a specific store or in stores within a defined area.[9] Previous research has primarily focused on the store-level or actual nutrition environment[10-21] with few studies examining the individual-level or perceived environment.[19,20,22,23] To my knowledge, only one study has compared the actual and perceived nutrition environments; however this study assessed availability of healthy foods using combined measures including F&V availability, F&V quality, and availability of low-fat foods.[24] My study adds comparisons of the actual and perceived nutrition environments by including separate measures specifically for F&V availability, quality, and price/affordability. The present study compared the perceived nutrition environment as reported by WIC Farmers' Market Nutrition Program participants to the actual measured nutrition environment of food stores where participants shopped.

Previous research of the F&V actual nutrition environment has indicated lower availability and poorer quality of F&V in primarily African American neighborhoods compared to predominantly white neighborhoods.[10] While one study found no differences in nutrition environment perceptions by race/ethnicity[19], another study indicated higher perceived affordability ratings among participants with higher incomes compared to lower incomes.[23] Further understanding of the actual and perceived nutrition environments among African Americans and low-income participants of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) was of interest to this project. To my knowledge, there have been no F&V nutrition environment studies including only WIC recipients.

Most actual nutrition environment research has focused on F&V availability measures[10-21] and few studies have measured quality [10,11,19-21] and price.[11,15,19-21] Measures of quality and price are important components of the actual nutrition environment; for example, even if F&V are available they may not be purchased if they are of poor quality or highly priced. Individuals on more limited incomes and those in areas with fresh F&V of poor quality are more likely to purchase canned or frozen F&V and their assessment is needed in addition to fresh varieties. Examination of differences between fresh versus canned/frozen F&V for both actual and perceived nutrition environments were of interest in this project.

b) Aims and Specific Objectives

The aim of project 2 is to compare fresh versus canned/frozen F&V for the actual and perceived nutrition environment measures among participants of the Emory WIC FMNP Study.
Specific objectives of project 2 are to:

First, described demographic characteristics of participants at the baseline survey and characteristics of stores assessed by the Nutrition Environment Measures Survey for Stores (NEMS-S).

Second, examine how the perceived nutrition environment measures of availability, quality, and affordability for fresh F&V vary from those for canned/frozen F&V.

Third, examine how the actual consumer nutrition environment measures of availability, quality, and price for fresh F&V vary from those for canned/frozen F&V.

Fourth, examine how the agreement between the perceived and actual nutrition environment measures differ for fresh F&V compared to canned/frozen F&V.

c) Study Contributions

Project 2 of this dissertation will provide at least five contributions to research examining the F&V nutrition environment. First, this is the first study to examine agreement between the perceived and actual nutrition environment measures for fresh and canned/frozen F&V. Second, while previous studies did include some low-income participants, there has been no study including only WIC recipients. Third, although availability of F&V is the most common measure, more studies need to assess quality and price measures. Fourth, all actual and perceived nutrition environment publications have assessed fresh fruits and vegetables, but only half of the actual and none of the perceived nutrition environment studies have measured canned and frozen F&V. Fifth, many studies have examined the actual nutrition environment, but few have assessed the perceived nutrition environment.

d) Skills Developed

I was involved in the Emory WIC FMNP Study during all phases of the study including: organization, questionnaire development, NEMS-S assessment tool development, data collection at WIC clinics and NEMS-S stores, and data entry stages of baseline survey data and NEMS-S data. I also participated in project team meetings and I led the NEMS-S training meeting and NEMS-S pilot phase. I gained experience designing questionnaires and incorporating perceived nutrition environment questions. I participated in nearly all baseline survey interviews at both WIC clinic and in all NEMS-S assessments. I was the only data enterer for the WIC surveys for the Non-FMNP and FMNP groups (baseline (n=172) and for the NEMS-S stores (n=18).

2) Literature Review

a) Overview of Nutrition Environment

This section provides an overview of the nutrition environment such as the types of nutrition environments and advances in the nutrition environment field.

The environment in which a person lives, works, attends school, and plays can have both positive and negative effects on the individual's health and well-being.[25,26] The expanding obesity epidemic, especially in children, has prompted increased interest in environmental factors influencing obesity such as availability of healthy food.[27] Food availability is part of the consumer nutrition environment, a component of the nutrition or food environment concept [28]. The nutrition environment has been conceptualized as five different types: community, consumer, organizational, informational, and perceived.[9] Government and industry/business practices and policies variables influence environmental variables (e.g. zoning and siting that leads to physical placement and therefore access to food stores, availability of food items), which impact individual variables (e.g. perceived nutrition environment) that effect eating behaviors.[9]

The environmental variables of community nutrition and organizational nutrition, and the individual variable of perceived nutrition environment are of primary interest in Project 2. These nutrition environments will be described in more detail later, but briefly, the community type of nutrition environment describes the type and location of food outlets and thus measures “access”.[9] While the consumer type corresponds to characteristics of the nutrition environment seen by the consumer when present in the store such as availability of healthy and unhealthy food options, quality of fresh F&V, and price of food selections.[9] The perceived nutrition environment refers to the consumer’s perceptions of their access to food stores and the availability, quality, and affordability of food options within a defined area.[9]

The study of the nutrition environment has been a growing area of research with an increase in the number of publications measuring the food environment from 1990 (n=1 article) to 2006 (n=26 articles).[27] Studies of specific interest regarding nutrition environment have focused on disparities in access, availability, quality, and price of healthy foods in neighborhoods or areas with populations of primarily minority racial/ethnicity and lower-income levels.[26,29,30] For example, the number of supermarkets greatly varied between different racial/wealth neighborhoods; there were four times the number in predominantly white compared to mostly

African American neighborhoods and there were three times the number in high-wealth compared to low-wealth neighborhoods.[29] Further, one review article concluded that better access to supermarkets and food stores with good availability of healthy food options have been shown to lead to consumption of healthier foods.[30]

While the nutrition environment field has advanced with multiple methods of examining the community, consumer, and perceived nutrition environments, the lack of "gold standard" measurements has limited comparison of results.[31] Some have argued that a "gold standard" might not be ideal when studying the nutrition environment of a specific racial/ethnic population because of cultural food preferences and use of ethnic food markets.[26] In addition, researchers have expressed caution in interpreting the findings of the actual nutrition environment due to lack of validity and reliability assessments of measurement tools.[27,32]

b) Literature Review Search Terms

This section describes the literature review search terms and exclusions that were used to identify the studies included in Project 2's literature review.

Research included in this literature review focuses on the nutrition environment. Many search terms were used and similar or interchangeable terms were included such as "nutrition environment" and "food environment" and "WIC" and "low-income women." To reduce repetition of listed search terms, similar words as stated above will be enclosed in parenthesis.

Publications included in this review were found by the following search terms in PubMed on October 6, 2010 with restricting to articles in English and involving Humans":

- "Nutrition (food) environment and WIC (low-income women)",
- "Nutrition (food) environment and fruit and vegetable availability and WIC (low-income women)",
- "Nutrition (food) environment and fruit and vegetable quality and WIC (low-income women)",
- "Nutrition (food) environment and fruit and vegetable cost and WIC (low-income women)",
- "Nutrition (food) environment and fruit and vegetable affordability and WIC (low-income women)",
- "Nutrition (food) environment and fruit and vegetable availability",
- "Nutrition (food) environment and fruit and vegetable quality",
- "Nutrition (food) environment and fruit and vegetable cost",
- "Nutrition (food) environment and fruit and vegetable affordability",
- "Fruit and vegetable nutrition (food) environment and perceptions",
- "Store type and nutrition (food) environment",

These searches yielded a total of 497 articles. After duplicate articles were identified, 273 distinct publications remained. Thirteen of the 273 articles were included in this literature review. The remaining articles (N = 224) were excluded for the following 11 reasons: 1) did not describe the nutrition environment; 2) study was not in the United States; 3) described home, school, or work nutrition environments; 4) did not discuss fruit and vegetable (e.g. alcohol, snack foods) nutrition environment; 5) only included elderly populations; 6) only identified food stores (community nutrition environment) and/or did not include grocery stores ; 7) only provided qualitative (text) results with no statistics; 8) review or conference summary article; 9) described results of an intervention, that is study did not assess usual nutrition environment, 10) only described scale development; 11) abstract and article not available.

Exclusion criteria numbers three, five, and six require more explanation. For criterion three (described home, school, or work nutrition environment), these excluded articles only described the nutrition environment within or surrounding a home, school, or work place; however, the included articles all described the neighborhood or community environment. Among the publications excluded for exclusion criteria five (only included elderly populations), these articles did not include children or young adults and thus the results would be difficult to compare to that of the WIC population. Although some of the literature review search terms included the phrase, “WIC”, there were no articles including WIC recipients identified in these searches. Lastly, for criterion six (only identified food stores (community nutrition environment) and/or did not include grocery stores), these excluded articles only described how food stores names and locations were identified, but did not do an internal survey of the actual F&V for sale in the store. Although the community nutrition environment must be defined to describe the consumer and perceived nutrition environments, simply describing the community nutrition environment was not adequate for the article to be included in this literature review. All included publications described the community nutrition environment in addition to the consumer and/or the perceived nutrition environments.

There was inclusion of one additional article by Zenk et al.[22] This publication was used as a source for the perceived nutrition environment questions used in the Emory WIC FMNP study. Although this article was not found using the literature search terms, it was referenced in several of the publications identified in the literature search.

An overview of the 14 articles is summarized in Table 1. These studies were located in numerous United States locations, but none were in Georgia. All publications were cross-sectional, except one study that was longitudinal with two store surveys completed two weeks apart [21] . There were food store surveys and participant interviews completed in-person or by telephone. Approximately half of the studies involved participant surveys and thus enrolled respondents with a sample size ranging from 102 to 2,511 individuals.[13,14,19,20,22,23] Some publications referred to the U.S. Census Bureau for sociodemographic characteristics of residents of a specific county or area.[10,15,17,18] Among the publications that completed food store surveys, the number of stores ranged from 18 to 419.[10-22] Nearly all studies examined the consumer nutrition environment [10-18], but few assessed the perceived nutrition environment.[19,20,22,23] The details about what aspects of the consumer and perceived nutrition environments and whether the actual or perceived nutrition environments were assessed are shown in Table 1.

Table 1 Overview of Studies Included in Project 2's Literature Review

			Sample Size		Environment Meausres	
First Author, Year	**Location**	**Survey Type**	**Respondents**	**Stores**	**Consumer (Actual)**	**Perceived**
Sloane, 2003	Los Angeles, CA	Store	Census	330	Yes	No
Zenk, 2005	Detroit, MI	Respondent	266	45	No	Yes
Block, 2006	Chicago, IL	Store	No enrollment	134	Yes	No
Bodor, 2007	New Orleans, LA	Respondent and Store	102	18	Yes	No
Liese, 2007	Orangeburg County, SC	Store	Census	77	Yes	No
Boyington, 2009	North Carolina	Respondent	2,511	0	No	Yes
Bustillos, 2009	Brazos Valley, TX	Store	No enrollment	44	Yes	No
Farley, 2009	Los Angeles, CA and Southeastern Louisianna	Store	No enrollment	419	Yes	No
Hosler, 2009	Columbia and Greene counties, NY	Store	Census	182	Yes	No
Rose, 2009	Southeastern Louisianna	Respondent and Store	1,243	307	Yes	No
Zenk, Lachance, 2009	Detroit, MI	Respondent and Store	919	NA	Yes	Yes
Zenk, Schulz, 2009	Detroit, MI	Respondent and Store	919	NA	Yes	Yes
Grigsby-Toussant, 2010	Chicago, IL	Store	Census	225	Yes	No
Zenk, 2010	Chicago, IL	Store (2 surveys)	No enrollment	157	Yes	No

Demographic characteristics such as sex, age, race/ethnicity, education level, and income level were limited to studies that surveyed participants and publications that referred to Census data.

The percent of participants who were female ranged from approximately half (52.3%) to all participants (100.0%).[13,14,19,20,22,23] The average age of participants was in the late 40s and no children were included in the study populations.[13-15,17,19,20,22,23] Although receipt of WIC services by participants was not assessed in any study, the older age group of the study populations indicates that it is unlikely that many participants were WIC recipients. The percentage of African American participants ranged from 2.6 to 100.0%.[10,11,13,14,18-20,22] The percentage of participants with at least a high school education ranged from 63.1 to 91.0%.[13,15,19,20,22,23] The median annual income ranged from $6,044 to $61,010 [11,15,18] and the percentage below the poverty-index ratio ranged from 6.9% to 50.0%.[10,14,17,21]

c) Community Nutrition Environment

This section describes how the community nutrition environment was defined by store name and location identification and verification.[9]

There were two steps taken to define the community nutrition environment; first to identify stores by name and location and second to verify this information. Identification of food store names and locations involved several different types of sources including use of: commercial databases (e.g. InfoUSA)[11], local- or state-level government lists[12-15,18,21], public directories (e.g. Yellow Pages) [17], respondent reported [22], direct observation [12,18,21], and other methods listed, but not described in the publication.[10,16] Additionally, location information was gathered and further enhanced by geocoding (e.g. ArcGIS)[11,13-15,19,20] and 911-enhanced TIGER road files.[15]

After store names and locations were identified, they were verified by “ground-truthing methods” of driving around the area of interest to verify the identity and location of food outlets included in the study.[11-18,21] Another method of verifying stores was calling the food outlet by telephone.[17]

All studies included in this review categorized the food stores by specific store types which included: grocery stores, supermarkets, convenience stores, liquor stores, and drug stores. Various methods of food store categorization included the Food Marketing Institute [18,21,22], industry definitions (e.g. North American Industry Classification System)[11,16,17], local- or state-level government lists[13,14], store manager report[15], public directories (e.g. Yellow Pages)[17,18,21], and store characteristics (e.g. size, chain store identification, # parking places).[12,16,18-21] Publications with small numbers of stores included in the study tended to categorize stores into fewer types; for example, Bodor et al. included 18 stores divided into only two store types: small food stores and supermarkets.[14]

Just as there have been multiple methods of identifying, locating, and verifying food stores, there have also been numerous ways of defining the geographic area that corresponds to the community nutrition environment. Examples from the literature review include: stores within and/or bordering census tracts/block groups[12,14,18-21], counties[13,15-17], communities[11], food outlets within a specific distance from residence[13,19,20], and primary food outlet where food is purchased for the family.[22,23]

Given the multiple methods of defining the nutrition environment, it is difficult to compare results between studies.

d) Consumer Nutrition Environment

This section describes aspects of the consumer nutrition environment including assessment tools used for measuring availability, quality, and price as reported in the publications included in the literature review, NEMS-S as an example of a reliable and accurate assessment tool for *measuring the actual nutrition environment, factors associated with the consumer nutrition environment, and limitations of the current literature in this area.*

After defining the community nutrition environment, 12 of the 14 studies assessed the consumer nutrition environment by measures of availability, variety, quality, and/or price of fruits and vegetables within actual food stores. All studies that examined the consumer nutrition environment assessed availability by specific fruits and vegetables[10,11,15-21] or by shelf space.[12-14] Table 2 summaries the assessment tools, number of F&V examined, and categories of F&V (e.g. fresh, frozen, canned/juice) included in the availability measures. When assessing which F&V were for sale in food stores, the majority of studies used the term "availability" [10-15,17,18,21]; however two publications used "variety" to describe the same measurement concept.[19,20]

Every study, except the publications that measured shelf space by measuring wheels (a device that measures the distance covered when the wheel is rolled across the floor), used different availability assessment tools. Only four studies published a list of the actual F&V that were surveyed for availability in the food stores.[15,16,18,21] The number of F&V assessed ranged from 4 to 108. All publications assessed fresh fruits and vegetables and about three-fourths of the studies assessed frozen and/or canned F&V as shown in Table 2.

Table 2 Consumer Nutrition Environment: Availability/Variety Measures					
First Author, Year	**Assessment Tool**	**Number of F & V Items**	**Categories of F & V**		
			Fresh	**Frozen**	**Canned/Juice**
Sloane, 2003	"Healthy Food Assessment"	NA	Yes	No	Yes
Block, 2006	USDA's Thrifty Food Plan recipies and culturally relevant foods	24	Yes	Yes	Yes
Bodor, 2007	Measuring wheel for shelf space	All available	Yes	Yes	Yes
Liese, 2007	NA	4	Yes	No	No
Bustillos, 2009	USDA's MyPyramid, 2005 Dietary Guidelines for Americans, and expert opinion	51	Yes	Yes	Yes
Farley, 2009	Measuring wheel for shelf space	All available	Yes	Yes	Yes
Hosler, 2009	Dietary Guidelines for Americans and Healthy People 2010	NA	Yes	No	No
Rose, 2009	Measuring tape for shelf space	All available	Yes	Yes	Yes
Zenk, Lachance, 2009	NA	80	Yes	No	No
Zenk, Schulz, 2009	NA	80	Yes	No	No
Grigsby-Toussant, 2010	Adapted from exisiting lists and culturally relevant foods	59	Yes	Yes	Yes
Zenk, 2010	Adapted from exisiting lists	108	Yes	Yes	Yes

Of the 12 studies that examined the consumer nutrition environment, five of the publications measured quality of fresh fruits and vegetables as shown in Table 3.[10,11,19-21] All publications used similar quality assessment tools that examined color, texture, and damage.[10,11,19-21]. Most of the studies assessed quality on fewer F&V than were examined for availability. The quality measures were either categorized dichotomously[10,11] (e.g. satisfactory/poor) or on a four-point scale of percentages of F&V that did not meet high quality standards.[19-21]

Table 3 Consumer Nutrition Environment: Quality Measures			
First Author, Year	**Assessment Tool/Wording**	**Number of F & V Items**	**Categorization**
Sloane, 2003	"color, texture, consistency, damage, and cleanliness"	7	Yes/No
Block, 2006	"produce that was truly unacceptable due to evidence of rotting such as mould, soft dark flesh or slime"	14	Satisfactory/Poor
Zenk, Lachance, 2009	USDA quality standards "external appearance and condition: color, texture, form, and damage or defects"	20	4-point scale ranging from (0-4%) to (50-100%)
Zenk, Schulz, 2009	USDA quality standards "external appearance and condition: color, texture, form, and damage or defects"	20	4-point scale ranging from (0-4%) to (50-100%)
Zenk, 2010	USDA quality standards "external appearance and condition: color, texture, form, and damage or defects"	8	4-point scale ranging from (0-4%) to (50-100%)

Only five of the consumer nutrition environment publications examined price or cost of F&V as shown in Table 4. Two of the studies recorded the price of the cheapest fresh F&V[11,15] and three publications indicated that they documented the price of each F&V with no specifications.[19-21] As with measures of quality, there were fewer F&V assessed for price or cost than for availability. Prices of select F&V were reported as mean prices and then some were compared by store type[11,15] and some were standardized (z-scores).[19,20]

Table 4 Consumer Nutrition Environment: Price Measures			
First Author, Year	**Assessment Tool/Wording**	**Number of F & V Items**	**Categorization**
Block, 2006	Cheapest item in specified size	14	Mean prices were compared to those at chain supermarkets
Liese, 2007	Cheapest item	4	Average price by store type
Zenk, Lachance, 2009	Price per pound/item	20	Mean standardized price (z-score) and reverse coded
Zenk, Schulz, 2009	Price per pound/item	20	Mean standardized price (z-score) and reverse coded
Zenk, 2010	Price per pound/item	13	Mean price

These consumer nutrition environment measures were often evaluated for F&V that could be easily identified and surveyed by trained surveyors in a manner that would not disrupt the food store's normal functioning or consumers purchasing food items. Nearly all publications indicated that surveyors completed training[11-16,18-21] and the number of surveyors ranged from one to three. Before the F&V availability, quality, and price data were collected, most studies gained approval from the food store manager by letter or verbal response.[12,15,16,18,21] Few studies reported conducting a pilot phase to test the assessment tool and protocol.[16,21]

Most researchers assessed reliability measures of their surveyors by interclass correlation coefficients and Spearman rank correlation coefficients.[12,13,15,18,21] For example, inter-surveyor reliability for the availability measure ranged from 0.75 to 1.00.[12,13,15,18,21] The inter-surveyor reliability for the price measure was lower and ranged from 0.20 to 0.98.[15,21] The average inter-surveyor reliability for the quality measure was 0.72.[21] No studies published validity measures for the consumer nutrition environment assessment tools.

i) Research Findings

The research findings of studies that assessed the consumer nutrition environment in this literature review are divided into three groups: 1) comparison of store types, 2) description/comparison of neighborhoods/areas, and 3) comparison at different time periods. These three groups are used to describe the availability, quality, and price results.

Research that examined the consumer nutrition environment by comparing store types found that on average, F&V availability was higher at supermarkets compared to other store types such as small food stores, grocery stores, and/or convenience stores.[11,12,14-16] Table 5 provides select results from two studies that examined the differences between shelf space of fruits and vegetables between supermarkets and small food stores. Both studies found that the mean shelf space was higher in the supermarkets compared to the small food stores for fresh, frozen, and canned F&V.[12,14]

Table 5 Consumer Nutrition Environment Availability of F & V by Shelf Space (Mean (SD) meters) by Store Type			
First Author, Year	**F & V Type**	**Supermarket**	**Small food store**
Bodor, 2007		N = 3	N = 15
	Fresh fruit	64.8 (14.4)	1.6 (1.9)
	Canned fruit	8.1 (2.8)	1.4 (0.8)
	Frozen fruit	1.8 (0.7)	0.0 (0.1)
	Fresh vegetables	56.3 (5.3)	1.9 (1.8)
	Canned vegetables	30.5 (17.9)	4.8 (2.8)
	Frozen vegetables	12.2 (3.8)	1.0 (1.1)
Farley, 2009		N = 49	N = 130
	Fresh fruit	42.0 (20.6)	1.0 (2.5)
	Canned fruit	6.9 (4.3)	1.2 (1.1)
	Frozen fruit	1.7 (2.2)	0.02 (0.1)
	Fresh vegetables	42.0 (17.2)	1.9 (3.0)
	Canned vegetables	13.5 (8.2)	2.5 (1.9)
	Frozen vegetables	10.3 (7.9)	0.3 (0.7)

Further, Block et al. found that the number of fresh, canned, and frozen F&V items were higher in supermarkets compared to independent grocery stores.[11] For example, 98.6% of the fresh F&V surveyed in the chain supermarkets were available, compared to only 29.3% in independent grocery stores.[11] Further, Bustillos reported significant differences in the variety or the number of fresh fruits ($p<0.01$), 100% fruit juices ($p<0.001$), and fresh vegetables available ($p<0.001$) between supermarkets and grocery stores.[16] On the other hand, Liese et al. found that the availability of total fresh, canned, frozen, and juice F&V items were similar between supermarkets and grocery stores.[15]

Although supermarkets tended to have better availability of F&V than grocery stores, it is interesting to note that the price of fresh F&V were found to be lower in grocery stores than in supermarkets. For example, Block et al. demonstrated that 64.3% of the fresh F&V in the independent grocery store were less expensive than in the supermarket.[11] Also, Liese et al.

indicated that the average costs of cucumbers, oranges, and tomatoes were higher at supermarkets and apples were more expensive at grocery stores.[15]

Studies in the second group examined the consumer nutrition environment by a description or a comparison of neighborhoods or areas. Overall, these studies found that F&V availability, quality, and price did vary by urban/rural areas[17], increasing distance from household[13], and culturally specific neighborhoods.[10,18] Hosler et al. found that availability of fresh fruits (excluding lemons and limes) and dark green or orange colored vegetables were higher in semi urbanized and rural heartland areas ($p<0.05$) compared to inner-city areas in upstate New York.[17] It is interesting to note that a higher percentage of food stores in inner-city areas participated in WIC (13.0%) compared to the semi urbanized (9.8%) and rural heartland (5.4%) areas, yet this difference was not statistically significant.[17] Rose et al. measured F&V shelf space and found that mean shelf space for F&V increased as distance from the household increased from 0.5m of F&V shelf space at 100m from the household to 1452.9m of shelf space at 5km from the household.[13]

Sloane et al. found that there was significantly lower availability of fresh F&V in food stores in an area in which primarily African Americans resided (70.4%) compared to a contrast area where few African Americans lived (93.8%) ($p=0.05$).[10] There was also poorer quality of fresh apples, grapes, strawberries, lettuce, green beans, avocados, and celery in the primarily African American neighborhood. Further, the availability of 100% fruit juice was lower in the primarily African American area compared to the contrast area, but this was not significant.[10] Grigsby-Toussaint et al. also compared F&V availability of two culturally-specific areas, African American neighborhoods and Latino neighborhoods in Chicago, IL.[18] They compared the two neighborhoods on availability of 25 commonly consumed fresh F&V (e.g. apples, carrots), 16 F&V culturally specific to African Americans (e.g. collard greens), and 18 F&V specific to the

Latino culture (e.g. avocado).[18] Grigsby-Toussaint et al. found that there were few statistically significant differences (e.g. oranges and cucumber) in the availability of commonly consumed fresh F&V between the grocery stores in African American and Latino neighborhoods.[18] When the culturally specific fruits and vegetables were compared among the neighborhoods, approximately one third of the African American- or Latino-specific F&V were significantly more available in their respective area compared to the opposite cultural area.[18] It is interesting to note that only three of the African American specific fruits and vegetables (black-eyed peas, kidney beans, and pinto beans) were available in more than 50% of grocery stores in the African American neighborhoods.[18]

Only Zenk et al. assessed the consumer nutrition environment for the third group, at two different time periods approximately 2 weeks apart.[21] This study found that the consumer nutrition environment was relatively constant over a short time period. They measured availability of 108 fresh, frozen, and canned fruits and vegetables and prices of 13 fresh fruits and vegetables.[21] They found statistically significant differences ($p<0.05$) in availability of canned peaches, pineapple, pears, and green beans and frozen corn between the two time periods.[21] There were no significant differences in the prices of the fresh F&V items between the two time periods.[21]

In summary, fruit and vegetable availability and fresh fruit price were higher at supermarkets compared to other food store types such as grocery stores or small food stores. Availability of F&V was lower in inner town areas and primarily African American neighborhoods. Lastly, food store availability and prices of F&V were relatively constant over a 2-week time period.

ii) Factors Associated

No study included in this literature review examined sociodemographic characteristics associated with the consumer nutrition environment of F&V availability, quality, and price except race/ethnicity characteristic.

iii) Nutrition Environment Measures Survey for Stores (NEMS-S)

The consumer nutrition environment assessment tools used in the studies included in this literature review primarily used checklists of specific fruits and vegetables; however, none of the publications used the Nutrition Environment Measures Survey for Stores (NEMS-S) measurement tool. NEMS-S will be explained in detail as an adapted version of NEMS-S was used in the WIC FMNP Study.

Glanz et al. recognized a need for a reliable and accurate measurement tool since previous measures did not report validity or reliability measures.[28] NEMS-S was created by Glanz et al. as an observational tool to assess the consumer nutrition environment in food stores and was originally tested in the Atlanta metropolitan area.[28] Stores were identified and located by various methods including retail food county lists, Georgia Regional Transportation Authority, and store directories found online and in the Yellow Pages.[28] Stores that were not open to the public (e.g. Sam's) and stores that carried a restricted variety of food items such as specialty food stores (e.g. meat markets or bakeries) were not included.[28] Glanz et al. identified and located 24 grocery stores and 64 convenience stores.[28]

The NEMS-S assessment tool measured availability, quality (only fresh F&V), and price of "healthy" vs. "regular" options for ten indicator food categories: fresh fruit, fresh vegetables, milk, ground beef, hot dogs, frozen dinners, baked goods, beverages (soda/juice), whole grain breads, and chips.[28] Fresh F&V selections were determined by the most common fruits and vegetables consumed in the U.S. The F&V availability measure was assessed by presence of the food option in the food store. The quality measure was defined as being unacceptable if the majority of the produce item was "clearly bruised, old looking, overripe, or spotted". Price was measured by the cost in dollars per item, pound, bag, or box depending on how the food item was listed in the assessment tool. Further, NEMS-S recognizes the ability to add new food items to the measurement tool with ease and encourages use of the tool in varying locations, cultural communities, and in differing studies focusing on specific food items.

To complete the NEMS-S measurement tool, two trained raters sought approval from the store manager and then they moved through the store recording consumer nutrition environment information for an average of 41.8 minutes (SD 14.4 minutes).[28] After NEMS-S data collection was complete, a composite consumer nutrition environment was calculated. Fruit and Vegetable price measures were then standardized to price per piece or per pound and the other food items compared prices for "healthy" versus "regular" options. Next, the main three components of the consumer type of nutrition environment (availability, quality, and price) were combined to create a composite food environment score ranging from -8 to 50 points. This composite score was calculated by the availability score allocating points for the number of varieties of the food category available and higher points for availability of healthier options; the price score allocating more points when healthier food items were a more reduced price than regular options and a negative point for the reverse pricing; the quality score allocating points to fresh produce of acceptable quality.

When grocery stores were compared to convenience stores, the availability of fruit and vegetables as measured by NEMS-S were significantly higher for the former (grocery store = 87.50 vs.

convenience store = 3.07 for fruit, p<0.01 and 91.67 vs. 3.28 for vegetables, p<0.01).[28] NEMS-S's calculated composite scores were higher for grocery stores (22.58 (SD 9.39) compared to that for convenience stores (5.85 (3.21), p<0.01).

Since Glanz et al. were striving for a reliable measurement tool raters would visit the stores independently, but on the same day between the hours of 9:00am and 4:00pm to assess inter-rater reliability of availability of all food items which ranged from 0.83 to 1.00 kappa statistics and 92%-100% agreement.[28] The inter-rater reliability of the quality measure for fresh produce was between 85.7% -100% agreement with kappa statistics ranging from 0.6-1.0 with many unable to be calculated. One of these raters would return to the same stores within one month to assess test-retest reliability which was found to have a kappa statistics between 0.75 and 1.00 and % agreement of 90.2%-100%. The test-retest reliability of the quality measure for fresh produce yielded similar percent agreement and kappa statistics. The inter-rater reliability and test-retest reliability of the price measure for fresh F&V were not published.

iv) Limitations

There are at least five limitations in the existing literature on the consumer nutrition environment. First, there is no "gold standard" for measuring the consumer nutrition environment. There is a need for studies to use the same assessment tool for better comparison of results. Second, most publications do not include a list of all fresh, canned, or frozen fruits and vegetables that were included in the food store surveys. Inclusion of the specific F&V would also allow for better comparison of results, especially if the same assessment tool was not used. Third, all studies assessed fresh fruits and vegetables, but only half measured canned and frozen F&V. Those on more limited incomes, those with less ability to store fresh F&V, and those in areas with fresh

F&V of poor quality are more likely to purchase canned or frozen F&V and their assessment is needed. Fourth, every study measured availability of F&V, but few assessed quality or price. Measures of quality and price are important components of the consumer nutrition environment; for example, even if F&V are available they may not be purchased if they are of poor quality or too expensive. Fifth, while these studies did include some low-income participants, there has been no study including specifically WIC recipients. It is important to examine the actual nutrition environment for WIC recipients in order to compare to previous research that found less F&V availability[10] and poorer fresh F&V quality[10,11] in lower versus higher income neighborhoods.

e) Perceived Nutrition Environment

This section describes aspects of the perceived nutrition environment including availability, quality, and affordability as reported in the studies included in the literature review.

Four of the 14 studies included in the literature review assessed the perceived nutrition environment by measures of availability, variety, quality, and/or affordability of fruits and vegetables.[10,19,20,23]

i) Assessments

All four publications examined the perceived availability, quality, and affordability.[10,19,20,23] The wording and scoring used in the perceived nutrition environment assessment tools is shown in Table 6. Half of the publications assessed the perceived nutrition environment pertaining to one store where the participants did most their food shopping[22,23] and the other half considered the neighborhood community nutrition environment.[19,20] The assessment tool wording for the availability, quality, and affordability were similar in all publications and every study only assessed these perceived measures for fresh F&V, but not canned or frozen options.

The perceived nutrition environment assessment tool scoring varied among studies, but all were based on a scale as shown in Table 6. The publications that examined the perceived environment corresponding to a specific food store scored the availability and quality measures on a scale ranging from “excellent” to “poor” and the affordability measures from “very affordable” to “not affordable.”[22,23] A scale based on degree of satisfaction was used for the publications that assessed the perceived environment of the neighborhood.[19,20]

<table>
<tr><th colspan="5">Table 6 Perceived Nutrition Environment Assessment Tool Wording and Scoring</th></tr>
<tr><th rowspan="2">First Author, Year</th><th rowspan="2">Community Nutrition Environment</th><th colspan="3">Tool Wording and Scoring</th></tr>
<tr><th>Availability/Variety</th><th>Quality</th><th>Affordability</th></tr>
<tr><td>Zenk, 2005</td><td>Store they purchased most food for themselves and their families</td><td colspan="2">Rating of selection/quality of fresh produce (4-point Likert scale (1 = "Poor", 4 = "Excellent"))</td><td>Rating of affordability of fresh produce (4-point Likert scale (1 = "Very affordable", 4 = "Not at all affordable"); reverse coded)</td></tr>
<tr><td>Boyington, 2009</td><td>Store they do most of their grocery shopping</td><td>Rating of the variety of fresh F & V ("Excellent" to "Not applicable")</td><td>Rating of the quality of fresh F & V ("Excellent" to "Not applicable")</td><td>Rating of the affordability of fresh F & V ("Very affordable" to "Not applicable")</td></tr>
<tr><td>Zenk, Lachance, 2009</td><td rowspan="2">Neighborhood (10-15 minute walk/5 minute drive from home)</td><td>Rating of the variety of fresh produce</td><td>Rating of the quality of fresh produce</td><td>Rating of the affordability of fresh produce</td></tr>
<tr><td>Zenk, Schulz, 2009</td><td colspan="3">4-point Likert scale (1 = "Not at all satisfied", 4 = "Very satisfied"); mean of all three measures</td></tr>
</table>

ii) Research Findings

The results of the perceived nutrition environment studies are summarized based on the corresponding community nutrition environments: 1) specific store, or 2) the neighborhood. First, Zenk et al. found that both the average availability/quality rating of fresh produce (mean = 3.27 (SD 0.71)) and the affordability of fresh F&V rating (mean = 3.18 (SD 0.58)) were high for the store where women living in eastside Detroit primarily purchase food.[22] Further, selection/quality ratings were significantly higher ($p<0.10$) and affordability ratings were significantly lower (p<0.001) for women shopping at supermarkets compared to independent stores.[22] Boyington et al. also assessed the perceived nutrition environment of a specific store, but did not publish overall findings. Instead they reported how the perceived nutrition environment was associated with sociodemographic factors which are described below in the following section. Second, the publications that assessed the perceived environment of the neighborhood found that the overall mean satisfaction with the fruit and vegetable availability, quality, and affordability was 2.9 (SE 0.03) indicating a moderately high satisfaction.[19,20]

iii) Factors Associated

The association between sociodemographic variables and the perceived nutrition environment were described by Boyington et al. and Zenk et al.[19,23] Both publications found that F&V perceptions for a specific store and neighborhood significantly increased with increasing age of respondent.[19,23] Boyington et al. demonstrated that this was true for availability (p<0.001), quality (p=0.002), and affordability (p=0.003). For example, 39.7% of participants 60 years of age or older reported excellent F&V availability compared to only 28.6% of those 45 years of age or less.[23] Zenk et al. found that results of satisfaction with neighborhood availability of fresh F&V with males and females were similar (p=0.139).[19] There were no significant differences in any perception measures when stratified by racial/ethnicity groups.[19] When income level was considered, Zenk et al. found no significant differences in perceived satisfaction with neighborhood F&V environment, but Boyington at al. indicated that participants with an annual income level of $30,000 or greater reported more excellent perceived affordability (26.0%) compared to those with incomes less than $30,000 (17.6%) (p<0.001).[23] Lastly, both publications demonstrated that the perceived environment was significantly associated with education, yet they found conflicting results.[19,23] Boyington et al. demonstrated that participants with at least a high school diploma were significantly more likely to report excellent affordability compared to those with less than a high school diploma ($p<0.001$).[23] Yet, Zenk et al. indicated that those with lower education levels had higher perceived satisfaction with the neighborhood fresh F&V environment than those with at least some college education (less than high school $p = 0.017$, high school degree $p = 0.040$).[19]

iv) Limitations

There are at least four limitations with the perceived nutrition environment research included in this literature review. First, there were few studies that assessed the perceived nutrition environment and more research is needed in this area of the nutrition environment field. Second, there was potential for the perceived nutrition environment not corresponding to the community nutrition environment defined by the researchers for the publications that assessed the neighborhood fresh F&V environment. For example, the participant could report perceived measures for a food store outside of the area defined by the study as the “neighborhood” of a 10-15 minute walk or 5 minute drive from the residence. Third, the perceived measures always corresponded to fresh F&V, but not canned or frozen F&V. Fourth, while these studies did include some low-income participants, there has been no study including specifically WIC recipients and perceptions of these recipients is important, especially the affordability perception due to their limited income.

f) Association of the Consumer and Perceived Nutrition Environments

This section states how no studies included in this literature review examined the relationship between the perceived and actual nutrition environments.

To my knowledge, no research included in this literature review assessed the agreement between the perceived and actual nutrition environments measures of availability, quality, and affordability/price for specifically fruits and vegetables.

g) WIC Eligibility Requirements and Benefits

The WIC eligibility requirements and benefits were previously described in Chapter 2: Project 1 Maternal Nutrition Knowledge, Attitudes, and Competencies and Fruit and Vegetable Intake of Mother and Child and will therefore not be repeated here.

3) Emory WIC FMNP Study NEMS-S Assessment

As with Project 1, Project 2 was part of the Emory WIC FMNP Study and so the Emory WIC FMNP Study description will not be repeated here. However, the NEMS-S component of the Emory WIC FMNP Study was not previously described and thus is discussed in this section.

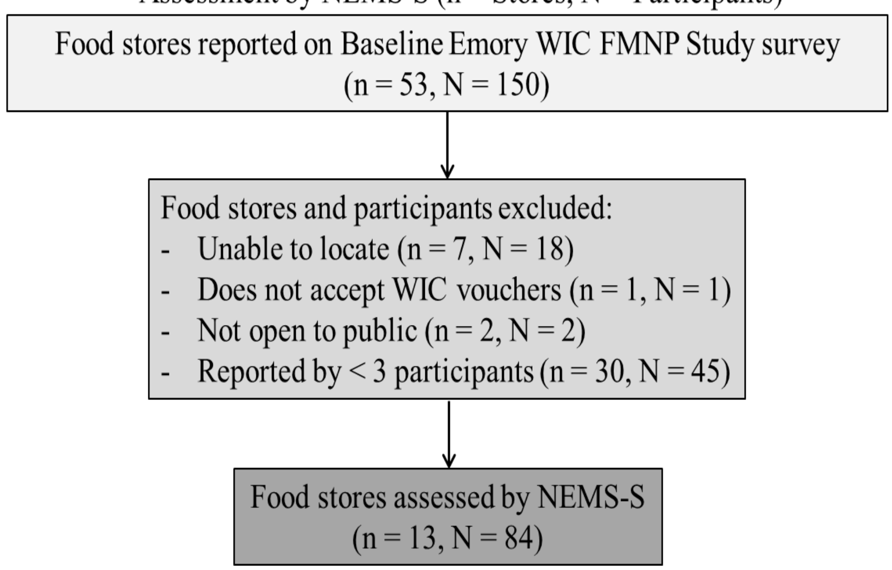
a) Data Collection and Question Sources

Data for Project 2 was collected using the Emory WIC FMNP Study's baseline surveys completed in the Adamsville and Kirkwood WIC Clinics and using a modified version of the NEMS-S assessment tool in food stores in the metropolitan Atlanta area. Briefly, the baseline survey gathered information such as socio-demographic characteristics and F&V consumption for mother and child as previously described in Project 1. The baseline survey also collected information on the community nutrition environment (name and location of a specific food outlet WIC recipients reported primarily purchasing food for themselves and their families), the WIC recipients' perceived nutrition environment about the specific reported food store, and mode of transportation to the reported food store. The NEMS-S assessment tool was used in the reported food stores and gathered information on the consumer nutrition environment.

i) Community Nutrition Environment

An overview of how the food stores, the community nutrition environment, were assessed is shown in Figure 1 and each step is described in more detail below.

Figure 1 Diagram of Store Selection Process for Consumer Nutrition Environment Assessment by NEMS-S (n = Stores, N = Participants)



The baseline survey asked the name and location of the food store WIC recipients reported primarily purchasing food for themselves and their family by the questions "I'd like you to think about the place where you purchase most of the food that you buy for yourself and your family. What is the name of that place? Where is it located?". The source for this question was from a study by Zenk et al.[22] The Emory WIC FMNP Study asked for up to three additional food store names and locations where food was purchased by the WIC recipient; however, only the primary store listed first was included in this analysis.

The primary reported food store names and locations were identified by street number, street name, city, and ZIP code by use of www.mapquest.com, store websites (e.g. www.kroger.com), and Rand McNally paper map of the streets of Greater Atlanta. Reported food store names were numerically coded (e.g. Kroger = 1, Publix = 2, Wal-Mart = 3). Figure 1 shows seven stores and 18 participants who reported these stores were excluded because these stores could not be located given the address information provided by the participant. For example, there were two Kroger stores located on Cascade Road. The Kroger store and participant were included if a cross street, landmark, or area information were provided as to distinguish one Kroger location from the other on Cascade Road; however, if simply "Cascade Road" was reported then this Kroger stores and participant were considered "unable to locate." Further, an additional store was excluded because it did not accept WIC vouchers and two more stores were excluded because they were not open to the public (e.g. required membership such as Sam's Club).

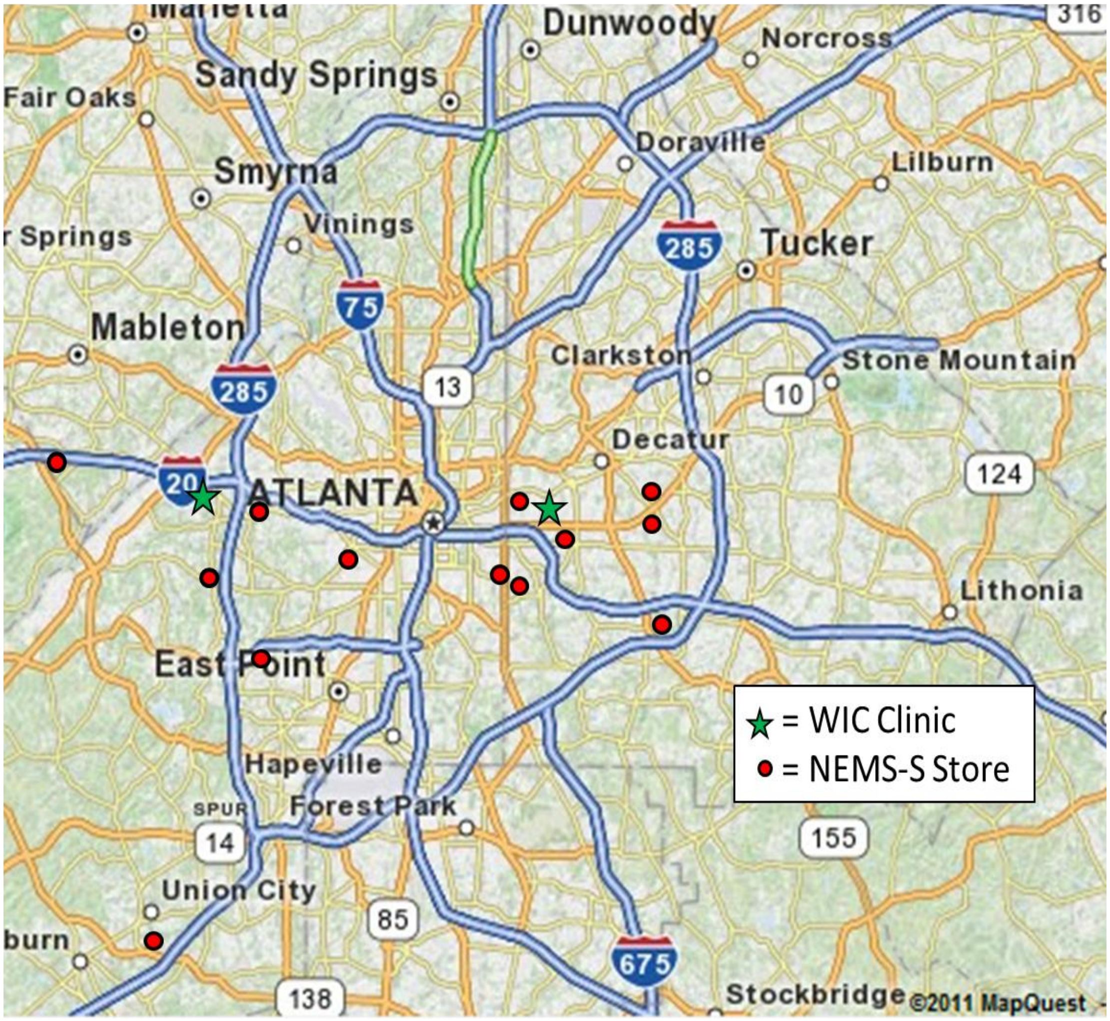
Further, food stores in which two or fewer WIC recipients reported as the primary store were not assessed by NEMS-S due to funding and time constraints as shown in Figure 1. For these stores, the number of stores by store name were: Kroger (12 stores), Publix (4), Wal-Mart (2), Wayfield Foods (3), Save-A-Lot (1), Big Bear (1), Aldi Foods (1), Food Depot (5), and Whole Sale Food Outlet (1). Thus, the majority of these store names were the same store names as those assessed by NEMS-S (Wal-Mart, Kroger, Publix, Wayfield Foods).

The stores in which three or more women reported as their primary store were assessed by NEMS-S. Among these 13 stores, the names and locations were further verified by "ground-truthing" by two study members driving around the Atlanta area confirming this information. All store names and locations matched study records during "ground truthing."

The final store list included five store names: Wal-Mart, Kroger, Publix, IGA Supervalue, and Wayfield Foods. There were a total of 13 store name and location combinations. There were six Kroger stores, four Wal-Marts, and one each for Publix, Wayfield Foods, and IGA Supervalue. These 13 stores and locations corresponded to 84 (56.0%) of the 150 WIC participants completing the baseline survey.

Additionally, Figure 2 shows the locations of the WIC Clinics (1 green stars) and NEMS-S stores (13 red dots) on a map of the metropolitan Atlanta area. Of the 13 stores assessed by NEMS-S, seven were reported by participants at the Adamsville WIC clinic (green star on left) and 10 for the Kirkwood clinic (green star on right); however, four stores were reported by participants at both clinics.

Figure 2 Map of WIC Clinic and NEMS-S Store Locations in Metropolitan Atlanta Area



ii) Perceived Nutrition Environment

The perceived nutrition environment regarding fruits and vegetables was asked by five questions on the baseline survey. These questions were modified from questions included in a study by Zenk et al.[22] as shown in Table 7.

Table 7 Perceived Nutrition Environment Source Wording and Modifications

Emory WIC FMNP Study		**Zenk et al. Study**	
Question Wording	**Possible Responses**	**Source Wording**	**Source Responses**
Opener: How would you rate the (say primary store name and location) in terms of…		*Opener: How would you rate that store in terms of…*	
The selection of fresh fruits and vegetables available (can clarify with: that is, whether there is a wide range of items to choose from so that you can usually find what you want to purchase there).	Excellent (1) Good (2) Fair (3) Poor (4)	The selection of fresh fruits and vegetables available, that is, whether there is a wide range of items to choose from so that you can usually find what you want to purchase there	Excellent (1) Good (2) Fair (3) Poor (4)
The selection of canned or frozen fruits and vegetables	Excellent (1) Good (2) Fair (3) Poor (4)		
The quality of fresh fruits and vegetables	Excellent (1) Good (2) Fair (3) Poor (4)	The quality of fresh fruits and vegetables	Excellent (1) Good (2) Fair (3) Poor (4)
The cost or affordability of the fresh fruits and vegetables	Very affordable (1) Somewhat affordable (2) Not very affordable (3) Not at all affordable (4)	How would you rate the cost or affordability of the fresh fruits and vegetables at the place where you buy most of your food.	Very affordable (1) Somewhat affordable (2) Not very affordable (3) Not at all affordable (4)
The cost or affordability of the canned or frozen fruits and vegetables	Very affordable (1) Somewhat affordable (2) Not very affordable (3) Not at all affordable (4)		

The Emory WIC FMNP Study added questions on availability and price for canned or frozen F&V that were not included in the Zenk et al. study. All of these questions had responses on a 4-point Likert scale.

iii) Consumer Nutrition Environment

e) Development of Adapted Version of NEMS-S

The consumer food environment was assessed by measuring the availability, quality, and price of food items for purchase at the included stores by an adapted version of NEMS-S. Since the WIC FMNP Study focused on fruit and vegetable consumption along with food items in the new WIC food package, the WIC FMNP Study assessed 8 food categories: fresh fruit, fresh vegetables, canned fruit, canned vegetables, frozen fruit, frozen vegetables, milk, and whole grains including bread, pasta, rice, and oatmeal. The methods of adapting the milk and whole grain food categories in the WIC FMNP Study's version of NEMS-S will not be described in detail here as they are beyond the scope of this research focusing on fruits and vegetables.

There were four sources used to create the modified version of NEMS-S used in the Emory WIC FMNP Study: 1) the original NEMS-S[28], 2) cultural/regional preferences and F&V commonly consumed by 1 – 5 year olds, 3) a modified NEMS-S by Amy Hillier at the University of Pennsylvania, and 4) a modified NEMS-S used by the Child Health Initiative for Lifelong Eating & Exercise study (CHILE). The original NEMS-S's only assessed fresh F&V selections that were determined by the most common fresh fruits and vegetables consumed in the U.S.[28]. Four fresh F&V were added to the WIC FMNP Study's adapted NEMS-S measurement tool based on regional/cultural preferences and foods commonly consumed by children 1-5 years of age, such as plums and okra. Since the original NEMS-S only included fresh F&V, the other NEMS-S assessment tools by Hillier and CHILE were included to provide examples of canned and frozen F&V. Therefore, as shown in Table 8, there were a total 58 fresh, canned, and frozen F&V included in the Emory WIC FMNP Study's version of NEMS-S.

The perceived nutrition environment assessment tool scoring varied among studies, but all were based on a scale as shown in Table 7. The publications that examined the perceived environment corresponding to a specific food store scored the availability and quality measures on a scale ranging from "excellent" to "poor" and the affordability measures from "very affordable" to "not affordable."[22,23] A scale based on degree of satisfaction was used for the publications that assessed the perceived environment of the neighborhood.[19,20]

Table 8 Fresh, Canned, and Frozen F & V Available in All NEMS-S Stores and Included in Availability and Quality Measures

	Fresh Fruits	**Fresh Vegetables**	**Canned Fruits**	**Canned Vegetables**	**Frozen Fruits**	**Frozen Vegetables**
	Apples	Broccoli	Applesauce	Carrots	Blueberries	Broccoli
	Bananas	Cabbage	Fruit Cocktail	Collard Greens	Mangoes	Carrots
	Blueberries	Carrots	Mandarin Oranges	Corn	Peaches	Cauliflower
	Cantaloupe	Cauliflower	Peaches	Green Beans	Pineapple	Collard Greens
	Grapes	Collard Greens	Pears	Peas (green)	Strawberries	Corn (kernels)
	Grapefruit	Corn	Pineapple	Spinach		Green beans
	Honeydew	Cucumbers		Tomatoes (whole)		Lima Beans
	Oranges	Green Beans		Turnip Greens		Peas (green)
	Peaches	Lettuce (iceberg)				Spinach
	Pears	Okra				Squash
	Pineapple	Spinach				
	Plums	Squash				
	Strawberries	Sweet Peppers				
	Watermelon	Tomatoes				
		Zucchini				
Total Number of items per category	14	15	6	8	5	10

b) Training of NEMS-S Surveyors

Each project member had completed CITI-certification before data were collected. Each study member received a half-day training on August 3, 2009 on the background on NEMS-S, how NEMS-S was adapted for the WIC FMNP Study, the protocol, directions of how to complete NEMS-S measures for each food item (e.g. fresh fruits, canned vegetables, milk, whole grains, etc.), the food stores the study planned to include, and the schedule of data collection by store. Following NEMS-S training, study members and the project manager visited a nearby food store to pilot and practice the adapted NEMS-S version for the WIC study. This food store was not reported as a primary place WIC recipients purchased food for themselves and their family, but it was the same store name of actual stores and in the general vicinity of stores included in the actual study. The store was visited on August 3, 2009 (Monday) at 4:00pm since the actual NEMS-S assessments were completed on various weekdays and between 9:00am-5:00pm. As the study members moved through the store completing the survey, adjustments were noted on how to improve the NEMS-S measurement tool and food items were dropped/added as determined by foods included in the current WIC package, the new upcoming WIC package, time restrictions for completing NEMS-S per store, and the foods most commonly eaten by the community culturally and by children 1-5 years of age.

c) NEMS-S Assessment Description

Availability of fresh, canned, and frozen F&V was measured by indicating if the specific item was available or not. For fresh F&V in which multiple types were available, the WIC FMNP Study NEMS-S specified which type was to be assessed and if this type was not available, the specific type that was available such as “Granny Smith apple” was recorded instead. For canned fruits, the size of the can in ounces was recorded and the type of canning liquid was indicated such as “water, juice, light syrup, or heavy syrup.” For frozen fruits and vegetables, the size of the bag or box was recorded in ounces and the survey requested information regarding “whole” or “chopped” versions such as for broccoli and spinach.

Quality was measured for fresh fruits and vegetables and recorded as “acceptable” or “unacceptable.” The quality assessment was the same as used in the original NEMS-S and was defined as being unacceptable if the majority of the produce item was “clearly bruised, old looking, overripe, or spotted”[28]. If the fruit or vegetable was considered unacceptable, remarks of why the fruit or vegetable was considered unacceptable were often reported in the “Comments” section.

Price was assessed by recording the price in dollars of the specific fresh, canned, or frozen fruit or vegetable. If a sale and regular price were available, only the regular price was recorded as the actual price and the sale price was included in the “Comment” section of the NEMS-S survey. If more than one F&V item were for sale for a given price such as “2 for $1.00” or “”3 lbs. for $0.99”, then the quantity (e.g. “3”) and the unit (e.g. “lbs.”) were also recorded on NEMS-S to accompany the cost. From here forward, the WIC FMNPS Study’s adapted NEMS-S tool will be referred to as simple “NEMS-S.”

Two trained surveyors completed NEMS-S measures in the 13 stores and all stores were visited on weekdays (Thursday, August 6, 2009 (3 stores); Friday, August 7, 2009 (5 stores); Monday, August 10, 2009 (4 stores); and Thursday, August 13th (1 store). NEMS-S assessments were started between the hours of 9:00am and 5:00pm.

Before the NEMS-S survey was started, the surveyors asked for approval from the store manager and provided a letter describing the purpose of the survey and listing the project manager's contact information if there were any future questions. One store name in particular required approval at headquarters and each store manager was contacted before arrival of surveyors. Obtaining approval from a few store locations was more timely and thus the spread of days between the first and last NEMS-S survey.

The trained surveyors first recorded the start time and then often started the NEMS-S assessment with the food category they first approached and continued throughout the store until the instrument was complete. While each surveyor recorded answers on separate NEMS-S measurement tools, they were together for each food category and did on the spot checking of discrepancies, missing items or prices, and totals. Discrepancies did not occur frequently and they were resolved by returning to the F&V item in question to re-examine the different finding. While responses still varied in completeness and inclusion of sale prices, most of the answers were similar and unfortunately there can be no evaluation of inter-rater reliability of the NEMS-S tool due to the described method of measuring the actual consumer nutrition environment.

After completing the assessment of food availability, quality, and price, the number of cash registers were counted, the cleanliness/organization questions were answered, and the finish time was recorded. The total number of cash registers included registers operated by store employees (normal checkout), by purchasers (self-checkout), and by pharmacists (pharmacy). Cash registers at customer service were not counted as most of these were not to be used for purchase of food or non-food items. Store cleanliness/organization was assessed by two questions: grocery carts with trash in them (Yes/No) and how many leaves/fruits/vegetables are on the ground near the produce section (#).

d) Data Entry

For each NEMS-S store, the data recorded by both surveyors was entered into two separate datasets. Then another dataset was created by combining both surveyor datasets into a more complete dataset used in analysis. If one surveyor left a blank (missing) response category, the answer from the other surveyor was recorded in the combined dataset. If both surveyors left blanks, then the combined dataset was coded as missing for this response; however, in the case of the AM or PM of the end time, the AM or PM that corresponded to the end time in respect to the start time was recorded. Further, if the total number of food items in a food category was left blank by both surveyors, then the number of items in which data was recorded on as available was entered into the combined dataset. If a different response was recorded by each surveyor, then the average of the two was recorded in the combined dataset. This was often applied for the affordability measure. If one surveyor recorded one response, but the other recorded another, then they were often standardized to one response in the combined dataset. For example, if one surveyor checked that the strawberry unit was piece, but wrote in the comments “1 lb. package” and the other surveyor checked “lb.,” then the combined dataset value was “lb.” Lastly, if one surveyor indicated that a fresh produce item was “unacceptable” while another reported “acceptable,” then the comments section were viewed to distinguish which should be recorded in the combined dataset.

4) Study Questions

What are the demographic characteristics of study participants at the baseline survey and what are the characteristics of the NEMS-S stores?

How do the perceived nutrition environment measures of availability/variety, quality, and affordability for fresh F&V vary from those for canned/frozen F&V?

Regarding availability, I hypothesize that a high percentage of participants perceive “excellent” availability for both fresh and canned/frozen F&V since the stores that were reported were primarily grocery stores/supermarkets or mass-merchandisers. Since, my measure of availability examines availability as the absolute physical presence of an item, regardless of quantity of items, or variety of fruits and vegetables, I have listed “availability/variety.” However, from here forward, I will only state “availability” for simplicity. For quality, I hypothesize that the majority of participants will perceive “excellent” or “good” quality for fresh F&V since again all stores are grocery stores/supermarkets or mass-merchandisers. Regarding affordability, I hypothesize that more participants perceive canned/frozen F&V as “very affordable” than fresh F&V since fresh varieties are often more expensive than canned/frozen items.

How do the actual consumer nutrition environment measures of availability/variety, quality, and price for fresh F&V vary from those for canned/frozen F&V?

Regarding availability, I hypothesize similarly high availability of nearly every item for both fresh and canned/frozen F&V since all food stores surveyed were large grocery stores or mass-merchandizers. As for quality, I believe nearly all fresh F&V items to be of “acceptable” quality since all food stores surveyed were large grocery stores or mass-merchandizers. Regarding price, I hypothesize higher prices for fresh F&V items compared to canned and frozen F&V items.

How does the agreement between the perceived and actual nutrition environment measures differ for fresh F&V compared to canned/frozen F&V?

In general, I hypothesize higher agreement between the perceived and actual availability and quality measures than for the perceived affordability and actual price measures. When stratified by fresh and canned/frozen F&V, I believe there to be similar agreement between the perceived availability and actual availability for fresh and canned/frozen F&V. Further, I hypothesize lower agreement between perceived affordability and actual price for fresh F&V than for the agreement for canned/frozen F&V.

5) Methods

This section describes the epidemiologic and biostatistical methods for the descriptive and research analyses.

What are the demographic characteristics of study participants at the baseline survey and what are the characteristics of the NEMS-S stores?

The demographic participant characteristics (WIC clinic, mother's age, child's age, education, and SNAP/TANF recipient) were categorized using the same methods as in Project 1, Chapter 2 and therefore will not be repeated here. Household size and the number of WIC recipients in the home were reported as medians and interquartile ranges (IQR).

The NEMS-S store characteristic of store type was dichotomized into grocery store/supermarket versus mass-merchandiser. The grocery stores/supermarkets were Kroger, Publix, IGA Supervalue, and Wayfield Foods and the mass-merchandiser was Wal-Mart. Previous literature has used similar store types, although most studies have separated smaller grocery stores from larger supermarkets.[11,15,22] However, I chose to categorize all non-mass-merchandisers as grocery stores due to my small sample size of NEMS-S stores. The NEMS-S store characteristic of cleanliness was reported as two measures: 1) number of stores with trash in shopping carts, and 2) number of leaves, fruits, and/or vegetables on floor in fresh F&V section. The number of stores with trash in shopping carts was reported as a percentage and the number of leaves/fruit/vegetables in the produce section was reported as median and IQR. The number of cash registers in the NEMS-S store was reported as median and IQR. Lastly, the NEMS-S assessment time was reported as median and IQR in minutes.

Frequencies were computed in SAS using the PROC FREQ procedure. Average and range statistics were computed in SAS using the PROC UNIVARIATE procedure.

How do the perceived nutrition environment measures of availability/variety, quality, and affordability for fresh F&V vary from those for canned/frozen F&V?

The responses to the perceived nutrition environment statements were 4-point Likert scales as shown in Table 11. Since few participants responded with “Fair” or “Poor” to the availability and quality measures and “Not very affordable” or “Not at all affordable” to the affordability questions, these responses were combined. Therefore, all perceived measures were “Excellent, Good, Fair/Poor” and “Very affordable, Somewhat affordable, Not very/Not at all affordable.” The frequencies were computed in SAS using PROC FREQ.

How do the actual consumer nutrition environment measures of availability/variety, quality, and price for fresh F&V vary from those for canned/frozen F&V?

The consumer nutrition environment was assessed by NEMS-S. F&V availability was determined by the percentage of the number of F&V items available out of the number of items assessed in each category (fresh, canned/frozen) for each NEMS-S store. I determined quality by the percentage of the number of "acceptable" quality items out of the number of items available for each NEMS-S store. For actual price, I only included F&V items that were available in all NEMS-S stores because the missing items would lower price averages as shown in Table 9. Actual price was measured by four steps shown in Figure 3 for the fresh fruit category from one of the NEMS-S stores. First I standardized the price of each item to per ounce. This calculation for canned and frozen F&V varieties was simply the price divided by the number of ounces contained in the can or frozen bag. This calculation for fresh F&V varieties can be explained by two methods: 1) for prices recorded as per *pound* (e.g. apples), pounds were converted into ounces and the price was divided by this number of ounces; 2) for prices recorded as per *item* (e.g. watermelon), the average weight (grams) of a medium sized item was found using the Nutrient Data Laboratory Search the USDA National Nutrient Database for Standard Reference[33] and then grams were converted to ounces and the price was divided by this number of ounces. Second, I summed the price (per ounce) of fruits and vegetables for each F&V category (e.g. fresh, canned/frozen) for each NEMS-S store. Third, I divided each summed F&V category by the number of items in that category to get the average price of one of these items. The average price of one ounce of an item in the category was used instead of a total price of one ounce of all items because there were different numbers of items included in each category (16 fresh F&V items and 24 canned/frozen F&V items); therefore, more items included in the measure did not necessarily reflect a higher average price. For example, for NEMS-S store 1, \$0.6857 was the total price of one ounce of each of the nine fruits included in the measure and so this total divided by nine was \$0.0762, the average price of a fruit in NEMS-S store 1. Fourth, I took the average of each category across NEMS-S stores. For example, the mean (SD) price of a fresh fruit item for all NEMS-S stores was \$0.086 (0.010) (Table 12). Further, the F&V columns reflect the average price for all NEMS-S stores of one ounce of the fruit or vegetable item in the category. Thus, the prices found in the F&V column are values between the average fruit price and average vegetable price.

Table 9 Fresh, Canned, and Frozen F & V Available in All NEMS-S Stores and Included in Price Measures

	Fresh Fruits	Fresh Vegetables	Canned Fruits	Canned Vegetables	Frozen Fruits	Frozen Vegetables
	Apples	Broccoli	Applesauce	Carrots	Blueberries	Broccoli
	Bananas	Cabbage	Fruit Cocktail	Collard Greens	Peaches	Collard Greens
	Cantaloupe	Collard Greens	Mandarin Oranges	Corn	Strawberries	Corn (kernels)
	Grapefruit	Cucumbers	Peaches	Green Beans		Green beans
	Oranges	Lettuce (iceberg)	Pears	Peas (green)		Lima Beans
	Peaches	Squash	Pineapple	Spinach		Peas (green)
	Pears	Tomatoes		Tomatoes (whole)		Spinach
	Plums			Turnip Greens		
	Watermelon					
Total Number of items per category	9	7	6	8	3	7

Figure 3 Diagram Explanation of Price Calculation Steps

Fresh Fruit Category			
NEMS-S Store 01			
Item	**Price ($)**	**Unit**	**Price ($)/Ounce**
Apples	0.99	Pound	0.061875
Bananas	0.69	Pound	0.043125
Cantaloupe	2.00	Piece	0.102816
Grapefruit	0.89	Piece	0.098559
Oranges	0.49	Piece	0.106144
Peaches	1.29	Pound	0.080625
Pears	1.39	Pound	0.086875
Plums	1.19	Pound	0.070000
Watermelon	4.99	Piece	0.031311
			Total price for one ounce of each item ($) = 0.685704
			Average price of one fresh fruit item (Total /9 items)($) = 0.076189

Step 1

Step 2

Step 3

Step 4 Using all NEMS-S stores, take the mean of the average prices of one fresh fruit item (Step 3).

Additionally, I explored price comparisons for specific fruit and vegetable items that were available in two or more F&V categories. For example, prices per ounce were reported for a fruit that was available in fresh and canned categories.

How does the agreement between the perceived and actual nutrition environment measures differ for fresh F&V compared to canned/frozen F&V?

I examined agreement between perceived and actual nutrition environment measures by three different methods: 1) by comparing dichotomized perceived and actual measures, 2) by comparing three-levels for perceived measures with dichotomized actual measures, and 3) by comparing three-levels for perceived with three-levels (tertiles) for actual measures.

Perceived measures were dichotomized into the highest rating ("excellent" for availability and quality; "very affordable" for affordability) versus other ratings ("<excellent" for availability and quality, "not very affordable" for affordability). The three-levels of perceived measures were those shown in Table 2 ("excellent, good, fair/poor" for availability and quality; "very affordable, somewhat affordable, not very/not at all affordable" for affordability).

Actual measures were dichotomized into highest quartile versus other quartiles for availability and quality and lowest quartile versus other quartiles for price. For availability, the highest quartiles for both fresh and canned/frozen F&V were 97% or more of the items were available out of those assessed. For quality, the highest quartile was 97% or more of the items available were of "acceptable" quality. For price, the lowest quartile for average fresh F&V was less than or equal to $0.0827 and for canned/frozen F&V was less than or equal to $0.0734. Tertiles were used for the three-levels of actual measures. Sensitivity and specificity calculations and 95% confidence intervals were included in the dichotomized measures and kappa statistics and 95%

confidence intervals were used in all measures to describe the agreement between the perceived and actual measures.

Further, I explored variations in agreement between perceived and actual measures by stratifying by education level: “high school or less” versus “more than high school”. Previous research has shown that among participants with a high school education or more, they were more likely to report excellent perceived F&V affordability than participants with less than a high school education.[23] However, another study found that those with lower education levels had higher perceived satisfaction with the neighborhood fresh F&V environment than those with at least some college education (less than high school $p = 0.017$, high school degree $p = 0.040$).[19] Kappa statistics and 95% confidence intervals were reported in all measures to describe the agreement between the perceived and actual measures.

Additionally, I explored differences in agreement between perceived and actual measures by stratifying by store type: “grocery” versus “mass-merchandiser”. Previous research found higher perceived F&V selection/quality at supermarkets compared to other food stores.[22] Kappa statistics and 95% confidence intervals were reported in all measures to describe the agreement between the perceived and actual measures.

6) Results

What are the demographic characteristics of study participants at the baseline survey and what are the characteristics of the NEMS-S stores?

The baseline survey demographic characteristics of 84 participants and NEMS-S store characteristics of 13 stores are shown in Table 10. More study participants were from the

Kirkwood WIC clinic (60%) compared to the Adamsville WIC clinic (40%). All participants self-identified as African American and the most common age category was 25-31 years (38%). Approximately two-third of the participants had a high school or less education (68%) and the majority of participants received additional food assistance through SNAP and/or TANF (83%). In each household, on average, there were approximately four people and one WIC recipient.

Among the 13 NEMS-S stores, two thirds of the stores (69%) were grocery stores and one-third (31%) were mass-merchandizers. The number of cash registers ranged from seven to 34 with a median of 13 and an IQR of 12-23 registers. Regarding store cleanliness, half (54%) of the stores had trash in the shopping carts and the median number of leaves or F&V pieces on the floor in the fresh produce section was three. Eight surveys were started in the morning and five in the afternoon with the earliest survey beginning at 9:10am and the latest at 4:20pm. Each store survey took between 35 and 65 minutes to complete with a median of 45 minutes.

Table 10 Demographic Characteristics of Participants at Baseline and NEMS-S Store Characteristics		
Study Participants (N=84)		
Characteristic	**N**	**Percent**
Clinic		
Adamsville	34	40.5
Kirkwood	50	59.5
African American Race	84	100.0
Mother's Age (years)		
18-24	27	32.1
25-31	32	38.1
32+	25	29.8
Education Level		
High school or less	57	67.9
More than high school	27	32.1
SNAP/TANF Recepient	70	83.3
	Median	**IQR**
Number of People in Household	4	3-5
Number of WIC Recipients in House	1	1-2
NEMS-S Stores (N=13)		
Characteristic	**N**	**Percent**
Store Type		
Grocery Store	9	69.2
Mass-Merchandizer	4	30.8
Number of Stores with Trash in Shopping Carts	7	53.8
	Median	**IQR**
Number of Cash Registers	13	12-23
Number of Leaves on Floor in F&V Section	3	2-5
NEMS-S Assessment Time (minutes)	45	40-55

How do the perceived nutrition environment measures of availability/variety, quality, and affordability for fresh F&V vary from those for canned/frozen F&V?

Overall, most participants perceived availability and quality was “excellent” or “good” and affordability as “very” or “somewhat” affordable (Table 11). More participants perceived the availability of fresh F&V as “excellent” (45%), yet a higher percentage of participants (60%) perceived the availability of canned/frozen F&V as “good.” Participants perceived the fresh F&V

as “very affordable” (44%) or “somewhat affordable” (45%), however, the majority of participants perceived canned/frozen F&V as “very affordable” (60%).

Table 11 Perceived F & V Nutrition Environment: Availability, Quality, Affordability (%)				
Perceived Measure	Fresh		Canned/Frozen	
	N	%	N	%
Availability				
Excellent	38	45	28	33
Good	32	38	50	60
Fair/Poor	14	17	6	7
Quality				
Excellent	34	40		
Good	35	42		
Fair/Poor	15	18		
Affordability				
Very affordable	37	44	50	60
Somewhat affordable	38	45	30	36
Not very/Not at all affordable	9	11	4	5

How do the actual consumer nutrition environment measures of availability/variety, quality, and price for fresh F&V vary from those for canned/frozen F&V?

There was high availability of all surveyed F&V items (Table 12). All canned fruit and vegetable items were available and nearly all fresh and frozen items were available (median percent available: fresh = 97%, frozen = 87%). The majority of fresh F&V items were considered to be of acceptable quality out of items available (median percent acceptable quality = 96%). The average price per ounce of each F&V category was highest for frozen items followed by fresh items followed by canned items as the lowest. However, when the canned and frozen categories are combined into canned/frozen for later comparison with perceived affordability canned/frozen measures, the average price per ounce per item of $0.086 is similar to the fresh average of $0.082.

Further, fruits of all varieties, fresh, canned, and frozen, were more expensive than vegetables. For example, the average price per ounce of canned fruits on the survey was \$0.072 (SD 0.007) compared to vegetables at \$0.052 (0.005).

Table 12 Actual F & V Nutrition Environment for NEMS-S Stores: Availability, Quality, Price										
Actual Measure	Fresh			Canned			Frozen			Canned/Frozen
	Fruits	Vegetables	F&V	Fruits	Vegetables	F&V	Fruits	Vegetables	F&V	F&V
Availability (percent of available items out of assessed items)										
Number of items assessed	14	15	29	6	8	14	5	10	15	29
Median percentage	100	93	97	100	100	100	80	90	87	93
IQR percentage	93-100	93-100	93-100	100-100	100-100	100-100	80-100	90-100	87-100	93-100
Quality (percent of acceptable quality items out of available items)										
Number of items assessed	14	15	29							
Median percentage	93	93	96							
IQR percentage	92-100	93-100	93-97							
Price (per ounce/per item) ($)										
Number of items assessed	9	7	16	6	8	14	3	7	10	24
Mean (SD) price	0.086 (0.010)	0.076 (0.007)	0.082 (0.007)	0.072 (0.007)	0.052 (0.005)	0.061 (0.005)	0.199 (0.040)	0.090 (0.016)	0.122 (0.021)	0.086 (0.011)
Range price	0.061 - 0.105	0.062 - 0.087	0.064 - 0.092	0.060 - 0.079	0.047 - 0.066	0.053 - 0.069	0.148 - 0.250	0.068 - 0.111	0.096 - 0.146	0.071 - 0.098

Additionally, when I compared the average prices per ounce of specific fruit and vegetable items that were available in more than one category, I found that apples, oranges, peaches, pears, broccoli, and tomatoes were available in fresh and/or canned and/or frozen varieities (Table 13). Average prices per ounce of canned and frozen varieties were lower than prices for fresh F&V, except for peaches in which fresh was the least expensive and canned and frozen were more expensive. The lower average prices for fresh fruits may be due to the timing of the NEMS-S assessment during the summer months when peaches were in season.[34]

Table 13 Price Comparisons Among Fresh, Canned, and Frozen F&V Varieties (Mean (SD)) ($)

F&V Item	Fresh	Canned	Frozen
Apples	0.087 (0.012)	0.062 (0.009) [1]	Not surveyed
Oranges	0.126 (0.023)	0.064 (0.006) [2]	Not surveyed
Peaches	0.067 (0.019)	0.081 (0.011)	0.182 (0.046)
Pears	0.104 (0.013)	0.085 (0.010)	Not surveyed
Broccoli	0.116 (0.018)	Not surveyed	0.079 (0.013)
Tomatoes	0.096 (0.018)	0.046 (0.016)	Not surveyed

[1] Applesauce, [2] Mandarin Oranges

How does the agreement between the perceived and actual nutrition environment measures differ for fresh F&V compared to canned/frozen F&V?

Overall, all kappa values of agreement are considered poor (kappa = 0.40). There were no differences in conclusions when perceived and actual measures were dichotomized or divided into three-levels. Further, as the number of levels increased, sample sizes in each cell decreased and some were zero. Therefore, the dichotomized results are shown here (Table 14) and the results with three-levels are presented in Appendix C in tables C1 – C6.

Agreement between perceived availability (“excellent” versus “<excellent”) and actual availability (≥97% of items available versus <97% of items available) was slightly lower for fresh F&V (kappa = 0.10 (95% CI: -0.11 – 0.32) than canned/frozen F&V (kappa = 0.13 (95% CI: -0.09 – 0.35) (Table 14). For both fresh and canned/frozen F&V availability, participants who shopped at stores with lower availability (<97% of items available) were more likely to perceive “less than excellent” availability (specificity: fresh = 0.59, canned/frozen = 0.70) than participants who shopped at stores with high availability (≥97% of items available) and perceived “excellent” availability (sensitivity: fresh = 0.51, canned/frozen = 0.43).

The agreement between perceived quality (“excellent” versus “<excellent”) and actual quality (≥97% of acceptable quality items versus <97% of acceptable quality items) was kappa = 0.14 (95% CI: -0.05 – 0.34) (Table 14). Among the participants who shopped at stores with ≥97% of acceptable quality items, nearly half of these women perceived “excellent” quality (sensitivity = 0.45 (95% CI: 0.30-0.60)); yet among participants who purchased food at stores with <97% of acceptable quality items, over two-thirds of these women perceived “<excellent” quality (specificity = 0.70 (95% CI: 0.52-0.84)).

Agreement between actual price and perceived affordability was the lower for fresh F&V (kappa = 0.072 (95% CI: -0.132 – 0.275) than for canned/frozen F&V (kappa = 0.171 (95% CI: 0.010 – 0.331) (Table 14). Among participants who shopped at stores with lower average prices per ounce, half of these participants perceived the fresh F&V as “very affordable” (sensitivity = 0.50) and three-fourths of these women perceived the canned/frozen F&V as “very affordable” (sensitivity = 0.77)

Table 14 Agreement of Perceived and Actual F&V Nutrition Environment Availability, Quality, and Affordability/Price Measures

		Fresh				Canned/Frozen			
		Actual Availability [1]				Actual Availability [1]			
		≥97%	<97%	Total		≥97%	<97%	Total	
Perceived Availability	Excellent	18	20	38	Sensitivity = 0.51 (95% CI: 0.34-0.68)	10	18	28	Sensitivity = 0.43 (95% CI: 0.24-0.65)
	< Excellent	17	29	46	Specificity = 0.59 (95% CI: 0.44-0.73)	13	43	56	Specificity = 0.70 (95% CI: 0.57-0.81)
	Total	35	49	84	kappa = 0.10 (95% CI: -0.11-0.32)	23	61	84	kappa = 0.13 (95% CI: -0.09-0.35)
		Actual Quality [2]							
		≥97%	<97%	Total					
Perceived Quality	Excellent	21	10	31	Sensitivity = 0.45 (95% CI: 0.30-0.60)				
	< Excellent	26	24	50	Specificity = 0.70 (95% CI: 0.52-0.84)				
	Total	47	34	81	kappa = 0.14 (95% CI: -0.05-0.34)				
		Actual Price [3]				Actual Price [3]			
		≤$0.0827	>$0.0827	Total		≤$0.0734	>$0.0734	Total	
Perceived Affordability	Very affordable	12	25	37	Sensitivity = 0.50 (95% CI: 0.30-0.70)	17	33	50	Sensitivity = 0.77 (95% CI: 0.54-0.91)
	Not very affordable	12	35	47	Specificity = 0.58 (95% CI: 0.45-0.71)	5	29	34	Specificity = 0.47 (95% CI: 0.34-0.60)
	Total	24	60	84	kappa = 0.07 (95% CI: -0.13-0.28)	22	62	84	kappa = 0.17 (95% CI: 0.01-0.33)

[1] Percentage of items available out of items assessed was dichotomized into upper 25th percentile (≥97%) versus lower percentiles (<97%); [2] Percentage of acceptable quality items out of items available was dichotomized into upper 25th percentile (≥97%) versus lower percentiles (<97%); [3] Mean price of items was dichotomized into lower 25th percentile (≤$0.0827 for fresh; ≤$0.0734 for canned/frozen) versus upper percentiles (>$0.0827 for fresh; >$0.0734 for canned/frozen)

When I examined how agreements between perceived and actual measures varied by education level (more than high school versus high school or less), I found that participants with higher education levels showed higher agreement than those with lower education levels (Table 15). For example, the agreement between perceived affordability and actual price of fresh F&V was kappa = -0.02 (95% CI: -0.27 -0.22) for participants with a high school education or less was kappa = 0.25 (95% CI: -0.12 – 0.62) for those with more than a high school education. Moderate agreement, kappa = 0.41 – 0.60, was found for canned/frozen availability (kappa = 0.58 (95% CI: 0.26 – 0.90)) and affordability/price (0.50 (95% CI: 0.16 – 0.84)) measures.

Table 15 Perceived and Actual Agreements by Education Level		
Perceived and Actual Agreement	**Fresh F & V**	**Canned/Frozen F & V**
	High School or Less	
Availability	kappa = 0.05 (95% CI: -0.21, 0.31)	kappa = -0.06 (95% CI: -0.30, 0.17)
Quality	kappa = 0.10 (95% CI: -0.14, 0.33)	
Affordability/Price	kappa = -0.02 (95% CI: -0.27, 0.22)	kappa = 0.07 (95% CI: -0.09, 0.23)
	More than High School	
Availability	kappa = 0.21 (95% CI: -0.17, 0.58)	kappa = 0.58 (95% CI: 0.26, 0.90)
Quality	kappa = 0.23 (95% CI: -0.13, 0.59)	
Affordability/Price	kappa = 0.25 (95% CI: -0.12, 0.62)	kappa = 0.50 (95% CI: 0.16, 0.84)

When I examined how agreements vary by store type (grocery store/supermarket versus mass-merchandiser), kappa statistics were not available for all measures due to zero cells and therefore limited results are presented (Table 16).

Table 16 Perceived and Actual Agreements by Store Type		
Perceived and Actual Agreement	**Fresh F & V**	**Canned/Frozen F & V**
	Grocery Store/Supermarket	
Availability	kappa = 0.11 (95% CI: -0.13, 0.36)	kappa = 0.08 (95% CI: -0.12, 0.27)
Quality	kappa = 0.14 (95% CI: -0.05, 0.34)	
Affordability/Price	kappa = 0.09 (95% CI: -0.17, 0.34)	Kappa cannot be calculated*
	Mass-merchandiser	
Availability	kappa = 0.15 (95% CI: -0.20, 0.50)	kappa = 0.04 (95% CI: -0.21, 0.28)
Quality	kappa = 0.27 (95% CI: -0.14, 0.68)	
Affordability/Price	kappa = 0.17 (95% CI: -0.03, 0.36)	Kappa cannot be calculated**
*No stores in upper price category; **No stores in lower price category.		

7) Discussion

This section provides a discussion for each research question.

What are the demographic characteristics of study participants at the baseline survey and what are the characteristics of the NEMS-S stores?

All study participants were African American with household low-incomes that financially qualified their family to receive WIC benefits. The Emory WIC FMNP Study participants were relatively homogeneous and included women of a specific demographic that had not been well-represented in existing literature. The majority of the NEMS-S stores were considered "grocery stores" and were considered relatively clean.

How do the perceived nutrition environment measures of availability/variety, quality, and affordability for fresh F&V vary from those for canned/frozen F&V?

My findings of the majority of participants reporting "excellent" or 'good" perceptions of availability and quality are likely due to all food stores being chain grocery stores/supermarkets or a mass-merchandiser. It is interesting to note that perceived availability of canned/frozen F&V was lower than for fresh F&V. It is possible that availability was thought to represent prominence and location of store space (meaning that compared to canned/frozen items fresh F&V are often displayed in a larger and more prominent section at the front of a food store).

A previous study of individual perceptions of affordability of fresh F&V found that higher income participants were significantly more likely to report "excellent" affordability than those with lower incomes.[23] Another study that similarly examined the perceived nutrition environment for availability, quality, affordability found that individuals reported high fresh F&V availability (selection) and quality, yet low affordability of these foods.[22]

How do the actual consumer nutrition environment measures of availability/variety, quality, and price for fresh F&V vary from those for canned/frozen F&V?

In general, my measures of the actual nutrition environment demonstrated high availability of F&V and “acceptable” quality of most fresh F&V. The common “unacceptable” quality fresh items were oranges, strawberries, pears, okra, broccoli, and corn. Quality may be due to seasonality of certain F&V since my NEMS-S assessments were completed in August when summer fruits and vegetables were in peak growing season. Further, it is interesting to note that when the average price per ounce of canned and frozen F&V were combined to correspond to the perceived affordability question for canned/frozen F&V, their price variations were masked and were similar to that for fresh F&V. In this analysis I used average price estimates for canned and frozen F&V combined into a single category. This was done to allow a comparison of actual and perceived affordability because the corresponding participant survey questions did not distinguish between canned and frozen F&V. For this reason price variations across frozen and canned items were masked and the resulting averages were (perhaps somewhat misleadingly) similar to those for fresh F&V. Additionally, combining the average prices for fruits and for vegetables conceals the differences between the higher prices for fruits and lower prices for vegetables.

Previous research of the actual nutrition environment found that on average F&V availability was higher at supermarkets compared to smaller retailers such as grocery stores and convenience stores.[11,12,14-16] Nevertheless studies have also shown that the prices of fresh F&V tend to be lower in smaller grocery stores than in supermarkets.[11,15]

How does the agreement between the perceived and actual nutrition environment measures differ for fresh F&V compared to canned/frozen F&V?

I found poor agreement between the actual and perceived nutrition environment measures of availability, quality, and price/affordability. I hypothesized: 1) higher agreement for the availability and quality measures than for the affordability/ price measures and 2) lower agreement for affordability/price measures for fresh items than the corresponding agreement for canned/frozen F&V.

Previous research comparing perceived availability of healthy foods in food stores within 1 mile of participants' homes to the actual availability of healthy foods measured by an adapted version of NEMS-S found that participants residing in areas with higher actual availability perceived high availability about 80% of the time whereas participants living in areas of lower actual availability reported low availability only about half of the time.[24] In general, I found the opposite results with higher specificities than sensitivities, yet this may be due to 1) how nutrition environment measures were categorized in that my study used upper quartiles vs. other quartiles while Moore et al. used means, and 2) I examined only fruits and vegetables whereas Moore at al. included F&V and other low-fat foods (e.g. milk, meat, and frozen meals). Further, Moore et al. found variation in comparisons of nutrition environments by annual household income with higher sensitivities and specificities among those with incomes <$12,000 than compared to participants with incomes ≥$50,000.

Third, when I stratified my agreement results by education level I found higher agreements between the perceived and actual nutrition environment measures among those with higher education levels. I believe that participants with more education had more accurate perceptions of their actual nutrition environment.

8) Strengths/Limitations

My study has several strengths. First, the distinguishing feature of my study is the focus on agreement between measures of perceived and actual nutrition environment for fresh and canned/frozen F&V. Second, while previous studies did include some low-income participants, there has been no study of only WIC recipients. Third, my study examined actual measures of availability and quality for 58 items and price for 40 F&V items. Availability of F&V has been the most common measure in existing literature and price measures have included only 20 or fewer items. Fourth, related to price/affordability, I included fresh and canned/frozen F&V, whereas previous literature has mainly focused on fresh varieties.

Despite these strengths, this study has at least four limitations; yet I do not believe these limitations had a significant impact on the results. First, I was unable to separate the canned/frozen perceived environment measures of availability and affordability. Second, survey question wording did not allow us to distinguish perceived measures separately for fruits and for vegetables; perceptions may vary for fruits versus vegetables. Third, my method of data collection in the stores did not permit evaluation of inter-rater reliability of my NEMS-S assessment tool. Although each surveyor completed a separate independent survey, surveyors worked together when evaluating each food category (e.g. fresh F&V) and performed on-the-spot checking of discrepancies. Fourth, due to funding and time constraints, my study population size and the number of NEMS-S stores included were relatively small. However, I do not believe this influenced my results since comparisons of the full Emory WIC FMNP study population of participants and their reported NEMS-S stores did not statistically significantly vary from the reduced sample included in this analysis by demographic characteristics or store type.

9) Study Implications

The poor agreement between the perceived and actual nutrition environments indicates the need for better nutrition education. Working with consumers on aspects of availability, acceptable quality, and price per ounce may alter perceptions and possibly influence F&V purchases. Since all forms of fruits and vegetables count towards daily intake totals, more understanding of the purchasing decisions of individuals for frozen and canned products could aid both in-store marketing and education approaches. Better agreement between the perceived and actual nutrition environments would benefit future surveys and surveillance where individual perceptions of the nutrition environment may serve as a proxy for the actual environment; this is especially true for larger, national scale studies with limited resources for measuring the actual environment. Further, my agreement results possibly indicate that the assessment tool is not capturing produce that consumers are wanting/using. Although my adapted version of NEMS-S was created from other NEMS-S tools, mine may need revisions more focused on the WIC population.

My study findings encourage additional research to examine the agreement of perceived and actual nutrition environment measures of availability, quality, and affordability/price. Specifically, a better understanding of the relationship between these environments would be aided by analyses that consider data for fresh, canned, and frozen F&V varieties and for fruits from vegetables separately. Due to the wording of the baseline survey questions for perceived measures, I are unable to distinguish perceptions for canned and frozen F&V or separate perceptions for fruits from vegetables. Additionally, it would be important to examine levels of agreement between measures of perceived and actual nutrition environments among higher-income individuals and to assess the differences and similarities of results across socioeconomic strata. Further, the perceived F&V nutrition environment among WIC recipients warrants re-examination following the 2009 changes to the WIC food package that now includes vouchers for fruits and vegetables valued at \$6-\$10/month. Use of this additional food subsidy for F&V will allow purchase of F&V via voucher and may alter F&V perceptions.

10) Appendix: Chapter 3

Question 4 Agreement between Perceived and Actual Nutrition Environment Measures by Three Levels

The agreement between the perceived and actual nutrition environment measures was further examined by dividing the measures into three levels. Tables C1, C2, and C3 display agreement results with three levels for the perceived measures and two levels for the actual measures. Tables C4, C5, and C6 show agreement results with three levels for the perceived measures and for the actual measures.

Table C1 Agreement of Perceived and Actual F & V Nutrition Environment Availability Measures

		Fresh			Canned/Frozen		
		Actual Availability [1]			**Actual Availability** [1]		
		≥0.97%	<0.97%	Total	≥0.97%	<0.97%	Total
Perceived Availability	Excellent	18	20	38	10	18	28
	Good	11	21	32	13	37	50
	Fair/Poor	6	8	14	0	6	6
	Total	35	49	84	23	61	84
		kappa = 0.08 (95% CI: -0.08, 0.24)			kappa = 0.11 (95% CI: -0.07, 0.30)		

Table C2 Agreement of Perceived and Actual Fresh F & V Nutrition Environment Quality Measures

		Actual Quality [2]		
		≥0.97%	<0.97%	Total
Perceived Quality	Excellent	21	10	31
	Good	16	19	35
	Fair/Poor	10	5	15
	Total	47	34	82
		kappa = 0.11 (95% CI: -0.04, 0.25)		

Table C3 Agreement of Perceived Affordability and Actual Price F & V Nutrition Environment Measures

		Fresh			Canned/Frozen		
		Actual Price [3]			**Actual Price** [3]		
		≤$0.0827	>$0.0827	Total	≤$0.0734	>$0.0734	Total
Perceived Affordability	Very affordable	12	25	37	17	33	50
	Somewhat affordable	9	29	38	5	25	30
	Not very/Not at all affordable	3	6	9	0	4	4
	Total	24	60	84	22	62	84
		kappa = 0.06 (95% CI: -0.11, 0.22)			kappa = 0.16 (95% CI: 0.01, 0.30)		

[1] Percentage of items available out of items assessed was dichotomized into upper 25th percentile (≥97%) versus lower percentiles (<97%); [2] Percentage of acceptable quality items out of items available was dichotomized into upper 25th percentile (≥97%) versus lower percentiles (<97%); [3] Mean price of items was dichotomized into lower 25th percentile (≤$0.0827 for fresh; ≤$0.0734 for canned/frozen) versus upper percentiles (>$0.0827 for fresh; >$0.0734 for canned/frozen)

Table C4 Agreement of Perceived and Actual F & V Nutrition Environment Availability Measures

		Fresh				Canned/Frozen			
		Actual Availability [1]				Actual Availability [1]			
		≥97%	93% ≤ Percent Available < 97%	< 93%	Total	≥97%	% ≤ Percent Available < 97	< 93%	Total
Perceived Availability	Excellent	32	6	0	38	13	9	6	28
	Good	21	5	6	32	18	25	7	50
	Fair/Poor	11	2	1	14	0	4	2	6
	Total	64	13	7	84	31	38	15	84
		kappa = 0.09 (95% CI: -0.04, 0.22)				kappa = 0.13 (95% CI: -0.04, 0.29)			

Table C5 Agreement of Perceived and Actual Fresh F & V Nutrition Environment Quality Measures

		Actual Quality [2]			
		≥97%	93% ≤ Percent Acceptable Quality < 97%	< 93%	Total
Perceived Quality	Excellent	21	8	2	31
	Good	16	8	11	35
	Fair/Poor	10	1	4	15
	Total	47	17	17	81
		kappa = 0.11 (95% CI: -0.05, 0.28)			

Table C6 Agreement of Perceived Affordability and Actual Price F & V Nutrition Environment Measures

		Fresh				Canned/Frozen			
		Actual Price [3]				Actual Price [3]			
		≤ $0.0835	$0.0835 < Price ≤ $0.0841	> $0.0841	Total	≤ $0.0795	$0.0795 < Price ≤ $0.0951	> $0.0951	Total
Perceived Affordability	Very affordable	17	12	8	37	17	15	18	50
	Somewhat affordable	13	11	14	38	8	12	10	30
	Not very/Not at all affordable	3	1	5	9	0	2	2	4
	Total	33	24	27	84	25	29	30	84
		kappa = 0.08 (95% CI: -0.07, 0.23)				kappa = 0.08 (95% CI: -0.05, 0.21)			

[1] Percentage of items available out of items assessed was categorized into upper 33rd percentile (≥97%), 33rd (97%) to 66th percentile (93%) and lower 33rd percentile (< 93%); [2] Percentage of acceptable quality items out of items available was categorized into upper 33rd percentile (≥97%), 33rd (97%) to 66th percentile (93%) and lower 33rd percentile (< 93%); [3] Mean price of items was categorized into lower 33rd percentile (≤ $0.0835 for fresh; ≤ $0.0795 for canned/frozen), 33rd ($0.0835 for fresh; $0.0795 for canned/frozen) to 66th percentile ($0.0841 for fresh; ≤ $0.0951 for canned/frozen) and upper 33rd percentile (>$0.0841 for fresh; > $0.0951 for canned/frozen)

Kappa Explanation

Kappa measures agreement between two sets of measures and adjusts for the amount of agreement that could be expected due to chance alone. A weighted kappa is for more than two categories and assigns less weight to agreements as categories are further apart. Below is an example of how to calculate the kappa estimates using the perceived and actual availability data from Table 14.

		Actual Availability		
		≥97%	<97%	Total
Perceived Availability	Excellent	18	20	38
	< Excellent	17	29	46
	Total	35	49	84

K = (Po – Pe) / (1 – Pe)

Where: Po = percent observed agreement = (a + d)/n

Pe = percent expected agreement = [(n1/n)*(m1/n)] + [(n0/n)*(m0/n)]

Therefore, when I enter in the numbers from the above table excerpt, I find:

Po = (18+29)/84 = 0.56

Pe = [(35/84)*(38/84)]+[(49/84)*(46/84)] = 0.51

K = (0.56-0.51)/(1-0.51) = 0.10

This kappa of 0.10 matches the results that were found using SAS.

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Chapter 4: Project 3 Examination of Prenatal and Postnatal Fruit and Vegetable Intake by WIC/Poverty-Level Status

1) Motivation and Purpose of Project 3

This section describes the motivations, aims, and specific objectives for Project 3 of this dissertation. Project 3's contributions of this research and the skills developed during analysis of the IFPS II data are also discussed.

a) Motivations

Fruits and vegetables provide essential nutrients for growth and development [1,2] and diets rich in F&V during pregnancy are important for the health of the mother and fetus and during postpartum are important for the breastfed infant. To my knowledge, only one other study has described prenatal and postnatal fruit and vegetable intake among the same participants[3]; all other studies have examined either prenatal[4-7] or postnatal.[8-11] A subsample of the Infant Feeding Practice Study II (IFPS II) participants who completed monthly questionnaires promptly (early-responders) had the opportunity to complete a prenatal and/or postnatal dietary history questionnaire (DHQ). This F&V intake data have not yet been reported and it is uncertain if a selection bias resulted due to the method of selecting eligible participants.

In the general U.S. population, F&V consumption tends to be lower among low-income individuals.[12-15] Low-income (≤185% of the poverty index ratio (PIR) determined by comparing household income and family size to the U.S. Census Bureau Federal Poverty thresholds to calculate the percent of PIR for each household[16]) pregnant and postpartum women are financially eligible to be a recipient of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Using 2003 data, it was estimated that 7.7 million women and children participated in WIC out of 13.5 million who were financially eligible.[17] WIC provides vouchers for specific food items and nutrition education. Using national data of pregnant women from 1998-94 (NHANES III), WIC recipients had slightly lower F&V intake than women >185% of poverty, but higher intake than non-WIC recipients <185% of poverty.[7] I was interested in the understanding of F&V intake during pregnancy and postpartum among women by poverty status (≤185% and >185% of poverty) and WIC participation among those ≤185% of poverty. There is a need for examination of the relationship between F&V consumption and WIC/poverty status among postpartum women and with more recent data among pregnant women.

Further, changes in F&V intake from pregnancy to postpartum has never been examined by WIC/percent of poverty status. Pregnant women (11%) and postpartum women (14%) make-up approximately 25% of the WIC population.[18] Postpartum WIC recipients are divided among breastfeeding (7%) and non-breastfeeding recipients (7%).[18] Breastfeeding mothers require additional caloric needs and are recommended to consume more F&V than non-breastfeeding mothers.[19] Additional examination of F&V intake by breastfeeding status was of interest in this project.

b) Aims and Specific Objectives

The aims of project 3 are to describe prenatal and postpartum F&V consumption by WIC/poverty status and by 3-month postpartum breastfeeding status among IFPS II participants.

Specific objectives of project 3 are to:

First, describe prenatal and postnatal fruit and vegetable intake by WIC/poverty status.

Second, examine the relationship between prenatal and postnatal fruit and vegetable intake and WIC/poverty status.

Third, describe how IFPS II participants who completed dietary history questionnaires (DHQs) compare to participants who did not complete DHQs in terms of demographic characteristics and health practices.

c) Study Contributions

Project 3 of this dissertation will provide at least six contributions to research examining F&V intake. First, this is the first study to examine the IFPS II's fruit and vegetable intake data, including any potential bias in data collection methods. Second, this research is the second study, to my knowledge, that has examined prenatal and postnatal fruit and vegetable intake for the same participant.[3] Most studies have considered either prenatal[4-7] or postnatal[8-11] intake only. Third, this project advances my understanding of the relationship between WIC participation/poverty status and prenatal and postnatal fruit and vegetable intake. Fourth, my study used a 149- item DHQ which included many foods and I analyzed the fruit and vegetable intake data as fresh, canned, and frozen F&V, juices, and foods that contain fruits and vegetables. This is similar to other prenatal and postnatal F&V research that has used 100+-item FFQs and thus allows for comparability of results. Fifth, the IFPS II was a large national survey whereas much of the previous research on prenatal and postnatal F&V intake has not been on the national scale. Sixth, this project stratified postnatal F&V intake by breastfeeding status which is important due to the additional caloric needs and higher F&V recommendations of breastfeeding versus non-breastfeeding postpartum women.

d) Skills Developed

I gained experience using a large, national, repeated surveys dataset, the Infant Feeding Practices Study II. I learned to examine fruit and vegetable intake data that was collected by a 149-item dietary history questionnaire; this varied from the 6-item BRFSS F&V module that was used in the Emory WIC FMNP Study (projects 1 and 2).

2) Literature Review

Project 3's study population includes IFPS II pregnant and postpartum women stratified into WIC/poverty status who completed monthly questionnaires and some completed one or both dietary history questionnaires (DHQs). F&V intake during pregnancy and postpartum has already been described in Chapter 1 and are not repeated here. WIC eligibility requirements and benefits for pregnant and postpartum women have been previously described in Chapter 2 and are not repeated here. This section describes the limitations and knowledge gaps in existing literature and the characteristics of participants who complete questionnaires, specifically dietary history questionnaires.

a) Limitations of Research on F&V Intake During Pregnancy and Postpartum

There are at least six limitations in the existing literature on F&V intake during pregnancy and the postpartum period. First, to the best of my knowledge, only one other study has described prenatal and postnatal fruit and vegetable intake among the same participants[3]; all other studies have examined either prenatal[4-7] or postnatal[8-11] separately. Second, this is the first project to describe prenatal and postnatal fruit and vegetable consumption for the participants of the Infant Feeding Practices Survey II. The one other study that described intake at both time periods however retrospectively assessed the prenatal intake 1.5 months postpartum, thus these results could be affected by recall bias. Third, only older data (1988-94) of the examination between WIC/poverty status and F&V intake is available[7] and more recent data is needed. Fifth, few studies were national studies and my study has the ability to examine intake by variation in region of residence.[5-7]

b) WIC Eligibility Requirements and Benefits Available to Pregnant and Postpartum Women

The WIC eligibility requirements and benefits available to pregnant and postpartum women were previously described in Chapter 2: Project 1 Maternal Nutrition Knowledge, Attitudes, and Competencies and Fruit and Vegetable Intake of Mother and Child and will therefore not be repeated here.

c) Research on Characteristics of Participants Who Complete Questionnaires

Non-response of study participants and timing of response (i.e. early vs. late responders) can potentially lead to selection bias.[20,21] Selection biases can arise when there are systematic errors in study selection protocols or aspects affecting enrollment and participation that lead to distortions of the results such as an observed association when there truly is not one or no association when there truly is one.[21] Selection biases are concerning since they can threaten the internal validity and thus the extent of conclusions that can be made.[20] For example, when responders in a specific group (e.g. pregnant women) with the outcome of interest (e.g. high F&V intake) are primarily exposed (e.g. WIC recipient) and non-responders in a specific group with the outcome of interest are primarily non-exposed (e.g. non-WIC recipient) a selection bias can occur.[20,21] The implications of this potential selection bias are findings that are often not reflective of the results without this bias.

There are often demographic (e.g. sex, age, race, education, income, marital status), life-style (e.g. exercise, diet, parents/no children), and health condition (e.g. diabetes, obesity, cardiovascular diseases, cancer) variations among 1) people who complete study surveys or participate in research and those who do not return completed surveys or do not participate and 2) among study participants, those who respond earlier versus later.[20] Further, individuals who choose to complete lengthier dietary assessment surveys such as the dietary history questionnaires or food frequency questionnaires (FFQs) may have different dietary behaviors than those not completing lengthy dietary assessments. For example, one study found that respondents of food frequency questionnaires tended to use dietary supplements and follow a special diet compared to non-responders.[22]

Additionally, it is likely that individuals are more mindful of their nutrition and health during certain life situations such as pregnancy and postpartum, especially if breastfeeding. For example, one study found that WIC recipients were twice as concerned with eating healthy foods during pregnancy (41%) than compared to when not pregnant (20%).[23] To my knowledge, there are no studies that have examined which demographic characteristics differ between individuals completing versus not completing DHQs during pregnancy and postpartum.

3) Infant Feeding Practice Study II (IFPS II)

This section describes the IFPS II study design, sampling frame, study inclusion/exclusion criteria and sample size, and additional project 3 inclusion/exclusion criteria and sample size. The IFPS II data collection and questionnaires pertinent to Project 3 are also described.

a) Study Overview

A full description of the Infant Feeding Practices Study II (IFPS II) (2005-2007) has been previously described [24], however a brief description will be included here. Both the IFPS I (1992-93) and IFPS II evaluate current infant feeding practices and examine changes in infant feeding practices.[24,25] The Food and Drug Administration (FDA), Centers for Disease Control and Prevention (CDC), and a working group with representatives from numerous institutes, funding agencies, and bureaus conducted and contributed to the IFPS II with experts from these agencies providing input on nutrition, study design, and dietary assessment.[24]

i) Study Design

The IFPS II was a prospective study following women from late in their pregnancy through their infants' first birthday.[24] Data was collected by a series of mailed questionnaires gathering information on the infant's methods of feeding and the mother's health and diet. The questionnaires were mailed at the following times: prenatal (7-8 months pregnant), birth (right after birth), neonatal questionnaire (3-weeks after birth), and postnatal (every month from 2-12 months). Two Diet History Questionnaires (DHQs) were also mailed, the first collecting information on the prenatal diet and the second gathering data on the postpartum diet. These DHQs retrospectively collected diet data corresponding to the previous month's intake.

ii) Sampling Frame

The IFPS II participants were selected from over 500,000 households nationally that participated in commercial consumer opinion panels who had previously agreed to answer questionnaires for scientific research purposes.[24,26] The panel was managed by Synovate, a consumer opinion panel, who was responsible for mailing the questionnaires and entering all the data.[26] The consumer opinion panel company did not simultaneously have current pregnancy status information available on all households in the panel.[24] Every three months, one quarter of the panel households updated data their demographic characteristics and pregnancy status. The Synovate demographic questionnaire mailed to direct panel members asked if anyone in the household was expecting a baby and if so, the due date. Therefore, to obtain the desired sample size, questionnaires were mailed to all women believed to be in the third trimester of pregnancy over an eight month period. This data collection method and the Synovate company had been used in IFPS I and it was thought that households who participated in opinion panels would be likely to complete multiple, repeated questionnaires.

iii) Inclusion/exclusion criteria for IFPS II

Women initially included in the IFPS II were:

- Identified by the commercial consumer opinion panel as in their third trimester of pregnancy and
- 18 years of age or older

Women excluded in the IFPS II:

- Gave birth before the prenatal questionnaire could be mailed;

- Had or her infant had a serious, long-term medical condition affecting infant feeding (health concerns affecting infant feeding were evaluated by a physician, pediatrician, and a maternal and child health expert who came to a consensus for exclusion [24]);
- Had an infant that was born ≤ 35 weeks of gestation;
- Had an infant that weighed less than 5 pounds at birth;
- Had a non-singleton birth;
- Had an infant that had an intensive care stay > 3 days; or
- Had an unplanned exclusion criteria affecting prenatal through 4-month questionnaires occurred as the result of the 2005 hurricane season which caused the US Postal Service to stop delivering mail to certain ZIP codes in the Gulf Coast region

Analyses included participants until they were disqualified or excluded. Therefore, if a participant was excluded in the neonatal questionnaire, her data for the prenatal questionnaire remained in the dataset.

iv) Sample Size for IFPS II

A total of 15,147 households were identified in the consumer opinion panel that were thought to have a woman in the third trimester of pregnancy.[24] A prenatal questionnaire and an invitation to participate in the longitudinal study were mailed to these households and there were 4,902 participants who were eligible and completed/returned the prenatal questionnaire (Figure 1). A participant could have completed 14 questionnaires (demographic, prenatal, birth-screener, neonatal, and postnatal (months 2, 3, 4, 5, 6, 7, 8, 9, 10, and 12)). The participation rates were high, but declined with each subsequent questionnaire. For example, the response rates for the birth screener were 82.9%, for the three-month survey was 78.9%, and for the 12-month survey was 64.5%. When the number of completed surveys was considered among the IFPS II participants who completed the prenatal questionnaire, birth screener, and neonatal questionnaire, 38.7% of participants completed all postnatal questionnaires.

IFPS II participants were compared to a nationally representative sample of women enrolled in the National Survey of Family Growth (NSFG) cycle 6 (1998-2000) and compared to IFPS II participants, NSFG participants were younger in age, less educated, lower income, less likely to be employed, more likely to be a non-white race/ethnicity, and resided in the South region.[24] Further NSFG participants compared to IFPS II participants were more likely to have more children, to smoke during pregnancy, and to take more than six weeks of maternity leave. A comparison of IFPS II participants to the National Immunization Survey (NIS) indicated that more IFPS II participants were breastfeeding at six months and 12 months postpartum.

For the subsample of IFPS II participants who completed the prenatal and three-month postnatal questionnaires promptly, 1,749 prenatal (35.7% of those who completed and returned the prenatal questionnaire) and 1,785 postnatal (74.7% of those who completed and returned the three-month postnatal questionnaire) DHQs were mailed.[24] The term “promptly” means that the participants were early-responders to the prenatal and three-month questionnaires. These participants quickly completed the prenatal questionnaire with sufficient time to complete the prenatal DHQ before giving birth and completed the three-month postnatal questionnaire with sufficient time to complete the postnatal DHQ before the four-month postnatal survey was mailed. There were a total of 1,502 (85.9% response rate) prenatal DHQs and 1,483 (83.1%) postnatal DHQs completed and returned.

v) Potential Selection Bias in IFPS II

The Infant Feeding Practices Study II (IFPS II) included participants of an opinion panel who had previously agreed to answer questionnaires for scientific research purposes.[26] It was hypothesized that households who participated in opinion panels would be likely to complete multiple, repeated questionnaires.[24,26] A potential selection bias is of concern in the IFPS II, particularly with how IFPS II participants were selected to complete the prenatal and postnatal DHQs. The prenatal DHQ was mailed to the early-responding IFPS II participants who quickly completed the prenatal questionnaire (7-8 months pregnant).[24] Similarly, the postnatal DHQ was mailed to early-responding participants who promptly completed the postnatal 3-month questionnaire. These early responders were selected to reduce the survey and time burden for IFPS II participants and to ensure adequate time to complete the DHQ before birth or before the 4-month postnatal questionnaire was mailed. Thus, late responders to the prenatal and 3-month postnatal questionnaires were not eligible to complete the DHQs. It is uncertain if selection bias resulted due to this method of selecting participants to complete the DHQ based on early responding to the previous questionnaire.

vi) **Sample Size and Additional Exclusions for Project 3**

Two analytic samples including participants who completed the prenatal DHQ and/or postnatal DHQ were created with the following four exclusions. First, excessive fruit intake >16 servings/day and vegetable consumption >23 servings/day (Prenatal: n=28, Postnatal: n=6). I used the guidelines from the National Cancer Institute's "Diet Screener in the 2005 CHIS: Definition of Acceptable Dietary Values."[27] Second, participants either missing data on WIC participation and percent of PIR and/or reporting WIC participation but not financially eligible for WIC (>185% of poverty) (Prenatal: n=96, Postnatal: n=83) were excluded.

Third participants with a diagnosis of diabetes (Gestational, Type I, or Type II) were excluded since diabetic individuals may require different F&V intake than those without diabetes due to low-carbohydrate diet modifications (Prenatal n=104, Postnatal n=98). Diagnosis of diabetes was asked by two questions on the prenatal questionnaire. The first question asked, "Have you had gestational diabetes with this pregnancy?" and the second question asked, "As best you know, which of the following health conditions do you yourself have?: Juvenile onset diabetes (Type I), Adult onset diabetes (Type II)." Type I diabetes (previously called juvenile-onset), Type II diabetes (previously called adult-onset), and gestational diabetes or diabetes during pregnancy are diseases characterized by inadequate production or action of insulin resulting in elevated blood glucose levels.[28] It is estimated that 12.6 million or 10.8% of all women aged 20 years and older are diagnosed or undiagnosed diabetics.[28] Further, gestational diabetes is estimated to occur in approximately 2% to 10% of U.S. pregnancies.[28] Diabetes is often treated by methods of lowering blood glucose levels such as diet modifications, exercise, insulin, and medications.[28] Consumption of fruits and vegetables are encouraged among diabetics due to their vitamin, mineral, and fiber content.[29] However some fruits (e.g. bananas) and starchy vegetables (e.g. potatoes) are high carbohydrate foods that elevate blood glucose levels and should be considered in the nutrition plan.[29] Therefore, women with diabetes were excluded since a pregnant or lactating diabetic woman compared to a non-diabetic woman may require different fruit and vegetable intake regarding specific varieties of F&V (e.g. low vs. high carbohydrate) and total amount of F&V due to the low-carbohydrate diet modifications. Fourth, participants with missing data on demographic and health characteristics of interest including: age, race/ethnicity, marital status, education level, region of residence, prenatal smoking, gestational age at time of first prenatal care visit, parity, and breastfeeding status at 3-months postpartum (Prenatal questionnaire: n=123, Postnatal questionnaire: n=106) were excluded. Therefore, the two analytic samples included 1,085 prenatal participants and 1,015 postnatal participants.

b) IFPS II Data Collection

All questionnaires from the prenatal survey to the 12-month postpartum survey were mailed and managed by Synovate, a consumer opinion panel.[26] The demographic questionnaire collected the mother's race/ethnicity, marital status, annual income, education level, and street address. The prenatal questionnaire gathered data on the mother's age medical history, the mother's health and health care, employment, plans for and attitudes about infant feeding, and changes in diet due to pregnancy.[24] The birth-screener interview which collected data on singleton/multiple birth, the infant's date of birth, health status, and birth weight, was completed by telephone shortly after delivery or mailed with the neonatal questionnaire.[24] The neonatal questionnaire gathered information on the mother's childbirth experience, infant's jaundice, and breastfeeding practice, support, and attitudes. Participation in WIC was collected on the prenatal questionnaire and all of the 10 postnatal surveys.[24]

Similar topics were addressed in the multiple postnatal questionnaires for months two through twelve such as the infant diet (e.g. breast milk, formula, solid foods), use of mother's vitamin or herbal supplements, and infant health (e.g. illnesses and anthropometric measures).[24] Since the postnatal questionnaires were sent monthly, there was not sufficient time to re-mail questionnaires or allow for additional time to complete each questionnaire.

A subsample of IFPS II participants were mailed dietary history questionnaires (DHQs), prenatally when the mother was 8 to 9 months pregnant and postnatal when the infant was approximately 4 months old.[24] The DHQs were modified from the original DHQ developed by the National Cancer Institute and the changes included the addition of specific foods, such as fish and dietary supplements, and adjustment of the relevant intake time period from 1 year to 1 month.[24] Women were mailed each DHQ if they had completed the previous questionnaire promptly so that the DHQ and monthly questionnaires did not overlap and thus increase respondent response burden.[24] The prenatal DHQ was mailed if the prenatal questionnaire was returned in time to allow for DHQ completion before birth of the child and the postnatal DHQ was mailed to those women who completed and returned the three-month postpartum questionnaire promptly so that the postnatal DHQ and 4-month postpartum questionnaires did not overlap.

Respondents received a gift for the mother or the infant valued at less than $3.00 per questionnaire.[24] Respondents received a $10.00 cash incentive for completing each DHQ.

c) Overview of IFPS II Questionnaires and Specific Questions Pertinent to Project 3

The questionnaires and specific information of interest to this project are shown in Table 1 by questionnaire, timeframe, and data collected. The questionnaires of interest for this project are the demographic questionnaire, prenatal questionnaire, three-month postnatal questionnaire, and the prenatal and postnatal DHQs. The three-month postnatal questionnaire was included to collect WIC participation and breastfeeding status for the time period that corresponded with the postnatal DHQ. Specific questions or information pertinent to this research includes: participant demographics and other health practices, WIC participation, breastfeeding, and the mother's dietary intake of juice, fruits, and vegetables.

Table 1 Relevant Data Collected from Select IFPS II Questionnaires					
	Questionnaires				
Variable	**Demographic**	**Prenatal**	**Prenatal DHQ**	**Postnatal 3-Month**	**Postnatal DHQ**
Time Period		**7-8 Months Pregnant**	**8-9 Months Pregnant**	**3-Months Postnatal**	**3-4 Months Postnatal**
Demographics					
Age		X			
Race/Ethnicity	X				
Marital status	X				
Education	X				
Percent of poverty	X				
Region	X				
Health Practices					
Prenatal smoking		X			
First prenatal care visit		X			
Parity		X			
WIC participation		X		X	
F & V intake			X		X
Breastfeeding				X	

4) Study Questions

The following three study questions are addressed in this project:

1. Is there a difference in prenatal and postnatal fruit and vegetable median intake by WIC/poverty status?

2. Are fruit and vegetable intake associated with WIC/poverty status prenatal or postnatal?

3. How do IFPS II participants who completed dietary history questionnaires (DHQs) compare to participants who did not complete DHQs in terms of demographic characteristics and health practices?

5) Methods

This section describes the epidemiologic and biostatistical methods for the analyses among participants who completed at least one DHQ. The analyses are described separately for each question and variable categorizations are explained. Model building for the second research question is described here and in Appendix D section a. Sensitivity analysis of these results for participants who completed both DHQs is found in Appendix D section b.

1. Is there a difference in prenatal and postnatal fruit and vegetable median intake by WIC/poverty status?

This question was applied to those who completed the prenatal DHQ (n = 1,085) and/or postnatal DHQ (n = 1,015). The WIC/poverty variable was created by combining the WIC participation and percent of poverty variables. WIC participation was collected on the prenatal questionnaire and the three-month postnatal questionnaires.[24] Information on WIC participation was gathered on these questionnaires by asking, "In the past month, were you enrolled in the WIC program or did you get WIC food or vouchers for yourself or for any of your children? (WIC is a program that gives food to pregnant and nursing women, babies, and young children)." The three answer selections, in which all that applied were to be selected, were "Yes, I was enrolled or got WIC food for myself; Yes, my child was enrolled or got WIC food; No." Since I was only interested in the mother's F&V intake, I only examined the mother's WIC participation and did not consider the child's participation. Therefore, if the mother was recorded as being a WIC recipient at the prenatal or three-month postnatal questionnaires, then the IFPS II mother was considered a WIC participant at these respective time periods. If the response was "No," then the mother was considered to not be a WIC participant. Therefore, the WIC participation variable was dichotomized into Yes or No for both the prenatal and three-month postnatal time periods.

The percent of poverty variable was created by the annual income of all household members before taxes and including income from all sources (e.g. employment, pensions, social security) was collected income ranges from the demographic survey. The midpoint of these income ranges was used to estimate household income. The household size information came from the demographic questionnaire and one additional person was added to account for the new baby. Poverty status was determined by comparing household income and family size to the U.S. Census Bureau Federal Poverty thresholds to calculate the percent of poverty index ratio (PIR) for each women's household.[16] For example, a family of four with an annual family income less than or equal to $40,793 is considered at or below 185% of PIR and is financially eligible for WIC benefits using thresholds effective from July 1, 2009 to June 30, 2010.[30] The PIR was then categorized into ≤185% and >185% of PIR since financial eligibility for WIC benefits corresponds to a family living at or below 185% of PIR.[30] Annual household income data was not asked again on any survey, so the demographic income data was applicable throughout the study.

The three WIC/poverty status were: WIC recipient and living at ≤185% of PIR, non-recipient of WIC and ≤185% of PIR, and non-recipient of WIC and >185% of PIR. From here forward, the WIC/poverty status will be referred to as: WIC/≤185% of PIR, NonWIC/≤185% of PIR, and NonWIC/>185% of PIR.

Prenatal and postnatal fruit and vegetable intake were collected on the DHQs and included juices, whole fruits and vegetables, and foods that contain fruits and vegetables (e.g. marinara sauce, apple pie). Intake data was collected by frequency in terms of the number of times per month, week, or day and by amounts corresponding to small, medium, and large. The DHQ data was entered and analyzed by the National Cancer Institute using Diet*Calc software.[16] Using the frequency and amount data, this software estimated the total fruit and total vegetable servings per day.

The fruit and vegetable intake variables were not normally distributed as concluded by skewness, kurtosis, significant Shapiro-Wilk and Kolmogorov Smirnov tests, and histogram/boxplot results. Therefore, non-parametric tests were used and the median intakes of fruits and vegetables were compared among the three WIC/ poverty status (WIC Recipient ≤185% PIR, Non-WIC Recipient ≤185% PIR, and >185% of PIR) by Kruskal-Wallis tests. Kruskal-Wallis tests were used since I was comparing intake distributions of the three WIC/percent of poverty status and all distributions were similarly shaped.

The null hypothesis was that the F&V intake distributions were equal for the three WIC/poverty statuses. The alternative hypothesis was that not all of the distributions were equal. A significance level of 5% was used, alpha = 0.05. The degrees of freedom (df) for each Kruskal-Wallis test were k – 1 where k was the number of poverty status categorizations being compared and was therefore two df. Kruskal-Wallis tests were run in SAS using the NPAR1WAY procedure with the WILCOXON option.

2. Are fruit and vegetable intake associated with WIC/poverty status prenatal or postnatal?

This question applied to those who completed the prenatal DHQ (n = 1,085) and/or the postnatal DHQ (n = 1,015). There were a total of four models examining the relationship of WIC/poverty status and 1) prenatal fruit intake, 2) prenatal vegetable intake, 3) postnatal fruit intake, 4) postnatal vegetable intake.

Table 2 specifies the exposure, outcomes, and potential confounders, and potential interaction variables that were considered for inclusion in the models. The exposure of interest was the three WIC/poverty status (WIC/≤185% of PIR, NonWIC/≤185% of PIR, and NonWIC/>185% of PIR.). The exposure for the prenatal models used the prenatal WIC status and the exposure for the postnatal models used the postnatal WIC status. In all models, the exposure category "NonWIC/≤185% of PIR" was used as the reference because it was believed that these participants would have the lowest F&V intake due to their low-income level and lack of additional food assistance through the WIC program. Therefore, all model results reported two odds ratios: 1) WIC/≤185% of PIR vs. NonWIC/≤185% of PIR, and 2) NonWIC/>185% of PIR and NonWIC/≤185% of PIR. The four outcomes of interest were prenatal and postnatal fruit and vegetable intake. These outcomes were dichotomized into the previous 2010 health objectives of two or more fruit servings/day and three or more vegetable servings per day.[31] This categorization of F&V intake is similar to other studies of prenatal and postnatal F&V intake.[3,9]

The covariates considered to be potential confounders and a potential interaction term were those included in Table 2. The demographic characteristics and health practices variables were categorized as follows.

The <u>mother's age</u> was collected as age in years and it was the categorized into 18-24 years, 25-29, 30-34 years, and 35+ years.

<u>Race/ethnicity</u> information was collected by two questions. The first question asked about race with the following response options: White, Black, Asian/Pacific Islander, and Other. The second questions asked about Spanish/Hispanic Ethnicity with these response choices: No, Not Spanish/Hispanic; Mexican, Mexican American, Chicano; Puerto Rican; Cuban; Other Spanish/Hispanic. The responses to these questions were then

combined to create four race/ethnicity categories: Non-Hispanic White, Non-Hispanic Black, Hispanic, and Other. If race of the mother was unknown because the mother was sent but did not return the IFPS II Demographic questionnaire, then the race of the female household head from the consumer opinion panel demographic data was used as a proxy.

Marital Status data was gathered by one question with the following options: Married, Widowed, Divorced, Separated, Never Married, or Domestic Partnership. These responses were dichotomized into Married or cohabiting versus Other.

Education level information of the mother was collected by one question with the following response options: Some Grade School; Grade School; Some High School; High School Graduate; Some College; No Degree (1-3 yrs.); Associate Degree in College (2 yrs.); Bachelor's Degree (i.e. BA, AB, BS); Master's Degree (i.e. MA, MS, MBA); Doctorate (PhD); Professional Degree (i.e. MD, JD). These responses were categorized into three categories: High School or less, Some college, College graduate or more.

The mother's region of residence was gathered by using the state reported on the street/mailing address to form the four Census region categories of West, Midwest, South, and Northeast.[32]

Health practices of interest were prenatal smoking, start of prenatal care, and parity and all were collected on the prenatal questionnaire. The categorization of each health practice variable was as follows:

Prenatal smoking information was collected by the question, "On the average, how many cigarettes do you smoke a day now?" The responses were requested as the number of cigarettes per day with an answer of zero if the mother did not smoke. The prenatal smoking variable was the dichotomized into Yes (greater than zero/day) and No.

First prenatal care visit was asked by the question, "How many weeks pregnant were you when you went for your first prenatal visit?" The possible responses were: 4 weeks or less, 5 to 8 weeks, 9 to 12 weeks, 13 to 18 weeks, 19 to 24 weeks, and 25 weeks or more. These responses were then categorized into the following three categories: < 9 weeks, 9-12 weeks, and ≥ 13 weeks/never.

Parity data was gathered by the following question, "How many other babies have you had or adopted when younger than 12 months old? Do not include the baby you are expecting" with a blank for the number of babies had and a separate blank for the number of babies adopted. This project only examined the mother's other biological babies. The parity variable was dichotomized into none versus one or more biological babies.

Information about breastfeeding was asked in the three-month postnatal questionnaire by the question, "In the past 7 days, how often was your baby fed each food listed below?" and the first food listed was breast milk. If the frequency of feeding breast milk was greater than zero times per week, then the mother was considered to be breastfeeding; otherwise, the mother was not breastfeeding. Therefore, the breastfeeding variable corresponding to the three-month time period was dichotomized into Yes, breastfeeding versus No, not breastfeeding. The "Breastfeeding (3-month)" variable was first included as a possible interaction term in the postnatal models because it was hypothesized that mothers who were breastfeeding were more likely to be WIC recipients and thus in the WIC recipient exposure category.

Table 2 Variable Specification (Variable name, type, and categorization) for Logistic Models		
Variable	**Type[1]**	**Categorization**
WIC/poverty Groups	E	Categorical (WIC/≤185% PIR, NonWIC/≤185% PIR, and NonWIC/>185%)
Fruit and Vegetable Intake	D	Dichotomous (Meet recommendations[2], Don't meet recommendations)
Mother's Age	V	Categorical (18-24, 25-29, 30-34, 35+ yrs)
Race/Ethnicity	V	Categorical (White, Black, Hispanic, Other)
Marital Status	V	Dichotomous (Married or cohabiting, Other)
Education	V	Categorical (High school or less, Some college, College graduate)
Region	V	Categorical (West, Midwest, South, Northeast)
Prenatal Smoking	V	Dichotomous (Yes, No)
Start of Prenatal Care	V	Ordinal (< 9 weeks, 9-12 weeks, ≥13 weeks)
Parity	V	Dichotomous (0, 1+ child(ren))
Breastfeeding (3-month)	V, W	Dichotomous (Yes, No)

[1] E = Exposure, D = Dependent Variable (Outcome), V = Potential Confounder, W = Potential Interaction Term; [2] Fruit recommendation: ≥ 2 fruit servings/day, ≥ 3 vegetable servings/day

The prenatal and postnatal model building steps began with assessing collinearity using the collinearity macro and using condition indexes (CI) set at 20 and variance composition proportions (VDPs) > 0.5. The prenatal and postnatal models included age, race/ethnicity, region, and prenatal smoking as potential confounders which were identified as significantly associated with prenatal or postnatal F&V intake from previous research. The postnatal models also included breastfeeding as a potential confounder and the breastfeeding interaction term (WIC/poverty*breastfeeding). In the prenatal models, following assessment of collinearity, I examined confounding and precision by removing potential confounders one at a time and in groups and then comparing the odds ratios (ORs) to those of the gold standard model including all potential confounders. If the ORs were within 10% of the gold standard ORs, then precision was assessed by comparing the width of the 95% confidence interval to that of the gold standard model. In the postnatal models, following assessment of collinearity, I examined interaction using Likelihood Ratio tests and Wald tests. After assessing interaction, confounding and precision were assessed in the postnatal models as they were in the prenatal models. All models were hierarchically well-formulated and were run using the SAS PROC LOGISITIC procedure.

A more detailed account of the modeling methods and results of assessment of collinearity, interaction terms, confounding, and the final models are described in Appendix D section a) Approach 1.

Although I found no interaction by breastfeeding with WIC/poverty status, I did stratify postnatal F&V intake by breastfeeding status because previous literature has found significant differences in F&V intake by breastfeeding.[10] Since fruit and vegetable intake were not normally distributed when stratified by breastfeeding status, Mann-Whitney or Wilcoxon Rank Sum tests were used since the intake distributions were similarly shaped. Mann-Whitney tests were run in SAS using the NPAR1WAY procedure with the WILCOXON option and all z scores included a continuity correction of 0.5.

3. How do IFPS II participants who completed dietary history questionnaires (DHQs) compare to participants who did not complete DHQs in terms of demographic characteristics and health practices?

It is uncertain if selection bias resulted due to the method of selecting IFPS II participants who were early-responders to the questionnaires to be mailed the DHQs. Therefore, it was of interest to examine a possible selection bias by comparing demographic characteristics and health practices among those who completed DHQs versus those who did not complete DHQs. If no variation in demographic and health practices is found, I would be reasonably certain of no or little selection bias and be able to extrapolate the F&V consumption findings to the entire IFPS II study population instead of only the subset who completed the DHQs.

The following demographic characteristics and health practices were compared: mother's age, race/ethnicity, marital status, education level, region of residence, WIC/percent of poverty status

(WIC/≤185% of PIR, NonWIC/≤185% of PIR, and NonWIC/>185% of PIR), prenatal smoking, first prenatal care visit, parity, and breastfeeding at 3-months postpartum for those who completed DHQ versus did not complete DHQ. These comparisons were done for both the prenatal and postnatal DHQs. Chi-square tests were used for these comparisons since the characteristics and practices were all categorical variables. An alpha level of 0.05 was considered statistically significant.

6) Results

This section describes the overall demographic data and fruit and vegetable intake for the prenatal and postnatal samples and analyses results for each research question.

Demographic characteristics and health practices

The majority of IFPS II participants who completed at least one DHQ, either the prenatal or postnatal, were aged 25-34 years, white, married or cohabiting, college graduates, non-recipients of WIC and >185 of PIR, and from the Midwest and South regions (Table 3). Further, participants were non-smokers prenatally, began prenatal care less than nine weeks of gestation, had more than one biological child, and were breastfeeding at the three-month postnatal questionnaire.

Table 3 Demographic Characteristics and Health Practices of Infant Feeding Practice Study II Participants Who Completed at Least One Dietary History Questionnaire (DHQ)

	Prenatal DHQ		**Postnatal DHQ**	
	n=1,085	**%**	**n=1,015**	**%**
Mother's Age (years)				
18-24	223	20.55	173	17.04
25-29	343	31.61	332	32.71
30-34	334	30.78	334	32.91
35+	185	17.05	176	17.34
Race/Ethnicity				
White	932	85.90	872	85.91
Black	44	4.06	41	4.04
Hispanic	64	5.90	56	5.52
Other	45	4.15	46	4.53
Marital Status				
Married or cohabiting	875	80.65	852	83.94
Other	210	19.35	163	16.06
Education				
High School or less	222	20.46	173	17.04
Some college	421	38.80	382	37.64
College graduate	442	40.74	460	45.32
WIC/Poverty Group				
WIC recipients, ≤185% PIR	243	22.40	227	22.36
Non recipients of WIC, ≤185% PIR	216	19.91	184	18.13
Non recipients of WIC, >185% PIR	626	57.70	604	59.51
Region				
West	226	20.83	217	21.38
Midwest	341	31.43	324	31.92
South	343	31.61	293	28.87
Northeast	175	16.13	181	17.83
Prenatal Smoking				
Yes	97	8.94	76	7.49
No	988	91.06	939	92.51
Start of Prenatal Care				
<9 weeks	702	64.70	629	61.97
9-12 weeks	278	25.62	288	28.37
≥13 weeks/never	105	9.68	98	9.66
Parity				
0	296	27.28	270	26.60
1+	789	72.72	745	73.40
Breastfeeding at 3-month Questionnaire				
Yes	N/A		656	64.63
No			359	35.37

Overall prenatal and postnatal fruit and vegetable intake

Overall I found median daily prenatal intakes of 2.65 servings of fruit and 2.94 servings of vegetables with 65.62% consuming two or more fruits per day and 48.85% consuming three or more vegetables per day (Table 2). Overall median daily postnatal fruit intake was 1.61 servings (40.39% consuming ≥2 fruits/day) and vegetable intake was 3.05 servings (50.84% consuming ≥3 vegetables/day). Postnatal F&V consumption among breastfeeding women was significantly higher than that among non-breastfeeding women. Median numbers of servings/day were higher among breastfeeding women were 1.89 for fruit and 3.19 for vegetables whereas the corresponding estimates among non-breastfeeding women were 1.21 and 2.76, for fruits and vegetables, respectively (fruit: $p<0.0001$; vegetable: $p=0.006$).

Table 4 Overall Prenatal and Postnatal Fruit and Vegetable Intake Among Infant Feeding Practice Study II Participants who Completed at Least One Dietary History Questionnaire

	N	Fruit Intake			Vegetable Intake		
		Median (servings/day)	IQR (servings/day)	% Consuming ≥2 servings/day	Median (servings/day)	IQR (servings/day)	% Consuming ≥3 servings/day
Prenatal							
Overall Intake	1,085	2.65	1.56-4.42	65.62	2.94	2.00-4.35	48.85
Postnatal							
Overall Intake	1,015	1.61	0.82-2.76	40.39	3.05	2.00-4.46	50.84
Breastfeeding women	656	1.89 [a]	0.99-2.93	45.88	3.19 [b]	2.12-4.58	54.12
Non-breastfeeding women	359	1.21 [a]	0.55-2.37	30.36	2.76 [b]	1.82-4.22	44.85

Common superscripts indicate significant differences in fruit and vegetable intake between breastfeeding and non-breastfeeding postnatal women ([a] $p<0.0001$, [b] $p=0.006$)

1. Is there a difference in prenatal and postnatal fruit and vegetable median intake by WIC/poverty status?

Prenatal vegetable intakes significantly varied among WIC/poverty status with the highest median intake among WIC/≤185% of PIR ($p=0.04$) (Table 5). Prenatal fruit and postnatal fruit and vegetable consumption did not significantly vary among the WIC/poverty status. In general, median F&V intakes were the highest among WIC recipients followed by NonWIC/>185% of PIR and then lowest among Non-WIC recipients, ≤185% of PIR. For example, prenatal median fruit intake was 3.10 servings/day for WIC/≤185% of PIR, 2.51 for NonWIC/≤185% of PIR, and 2.67 for the NonWIC/>185% of PIR.

Table 5 Prenatal and Postnatal Fruit and Vegetable Intake (Servings/day) Among Infant Feeding Practice Study II Participants who Completed at Least One Dietary History Questionnaire by WIC/poverty Groups

WIC/poverty groups	N	Fruit Intake			Vegetable Intake		
		Median	IQR	p-value	Median	IQR	p-value
Prenatal							
WIC recipients, <185% PIR	243	3.10	1.55-5.10		3.37	2.09-4.75	
Non recipients of WIC, <185% PIR	216	2.51	1.36-3.88	0.10	3.01	2.04-4.26	0.04
Non recipients of WIC, ≥185% PIR	626	2.67	1.64-4.33		2.83	1.97-4.30	
Postnatal							
WIC recipients, <185% PIR	227	1.65	0.78-3.15		3.09	2.15-4.90	
Non recipients of WIC, <185% PIR	184	1.58	0.72-2.89	0.58	3.00	1.85-4.09	0.27
Non recipients of WIC, ≥185% PIR	604	1.62	0.87-2.59		3.06	2.00-4.43	

2. Are fruit and vegetable intake associated with WIC/poverty status prenatal or postnatal?

WIC recipients and those living >185% of PIR had somewhat higher prenatal and postnatal fruit and vegetable intakes compared to NonWIC/≤185% of PIR, however confidence intervals were wide and included 1.0 (Table 6). For example, when compared to WIC non-recipients living at ≤185% of PIR, WIC recipients had higher prenatal fruit intake, 67.08% consuming ≥2 fruit servings/day; however, in regression models the findings were not significant (adjusted odds ratio (OR)=1.29 (95% confidence interval (CI): 0.87–1.90) adjusting for race/ethnicity, region of residence, and prenatal smoking.

Table 6 Association of WIC/poverty Groups and Prenatal and Postnatal Fruit and Vegetable Intake, Adjusting for Confounders, Among IFPS II Participants who Completed at Least One DHQ

		≥2 Fruit Servings Daily			≥3 Vegetable Servings Daily		
Prenatal Intake							
WIC/poverty groups	N	%	OR and 95% CI		%	OR and 95% CI	
			Crude	Adjusted[1]		Crude	Adjusted[2]
WIC recipients, <185% PIR	243	67.08	1.30 (0.88-1.90)	1.29 (0.87-1.90)	55.56	1.23 (0.85-1.77)	1.20 (0.83-1.74)
Non recipients of WIC, <185% PIR	216	61.11	Reference (1.00)		50.46	Reference (1.00)	
Non recipients of WIC, ≥185% PIR	626	66.61	1.27 (0.92-1.75)	1.17 (0.84-1.62)	45.69	0.83 (0.61-1.13)	0.79 (0.58-1.08)
Postnatal Intake							
WIC/poverty groups	N	%	OR and 95% CI		%	OR and 95% CI	
			Crude	Adjusted[3]		Crude	Adjusted[4]
WIC recipients, <185% PIR	227	43.17	1.21 (0.81-1.80)	1.22 (0.82-1.82)	51.54	1.04 (0.71-1.54)	1.22 (0.82-1.83)
Non recipients of WIC, <185% PIR	184	38.59	Reference (1.00)		50.54	Reference (1.00)	
Non recipients of WIC, ≥185% PIR	604	39.90	1.06 (0.75-1.48)	1.03 (0.73-1.45)	50.66	1.01 (0.72-1.40)	0.98 (0.69-1.38)

[1] Adjusted for race/ethnicity, region, prenatal smoking; [2] Adjusted for race/ethnicity and region, [3] Adjusted for region, [4] Adjusted for region and prenatal smoking

3. How do IFPS II participants who completed dietary history questionnaires (DHQs) compare to participants who did not complete DHQs in terms of demographic characteristics and health practices?

Comparison of demographic characteristics and health practices among participants who completed versus did not complete DHQs, identified significant (p<0.05) differences for the prenatal DHQ characteristics of age, marital status, education, WIC/poverty status, and parity (Table 7). Compared to those who did not complete DHQs, participants who completed DHQs tended to be older ages, women that were married or cohabiting, those with a college degree, in the >185% of poverty WIC/poverty status group, residents of the Midwest region, and non-smokers. They were also more likely to be breastfeeding as reported in the three-month postnatal questionnaire.

Table 7 Comparison of Demographic Characteristics and Health Practices Among IFPS II Participants Who Did and Did Not Complete DHQs

	Prenatal (n=3,480)					Postnatal (n=1,839)				
	Completed DHQ		Did not complete DHQ		p-value	Completed DHQ		Did not complete DHQ		p-value
	n=1,085	%	n=2,395	%		n=1,015	%	n=824	%	
Mother's Age (years)										
18-24	223	20.55	573	23.92	0.003	173	17.04	154	18.69	0.1046
25-29	343	31.61	837	34.95		332	32.71	301	36.65	
30-34	334	30.78	638	26.64		334	32.91	233	28.28	
35+	185	17.05	347	14.49		176	17.34	135	16.38	
Race/Ethnicity										
White	932	85.9	1,982	82.76	0.0735	872	85.91	732	88.83	0.2962
Black	44	4.06	141	5.89		41	4.04	27	3.28	
Hispanic	64	5.9	153	6.39		56	5.52	38	4.61	
Other	45	4.15	119	4.97		46	4.53	27	3.28	
Marital Status										
Married or cohabiting	875	80.65	1,826	76.24	0.0039	852	83.94	677	82.16	0.3104
Other	210	19.35	569	23.76		163	16.06	147	17.84	
Education										
High School or less	222	20.46	577	24.09	0.0013	173	17.04	161	19.54	0.2999
Some college	421	38.8	990	41.34		382	37.64	313	37.99	
College graduate	442	40.74	828	34.57		460	45.32	350	42.48	
WIC/Poverty Group										
WIC recipients, ≤185% PIR	243	22.4	630	26.3	0.0014	227	22.36	205	24.88	0.148
Non recipients of WIC, ≤185% PIR	216	19.91	541	22.59		184	18.13	166	20.15	
Non recipients of WIC, >185% PIR	626	57.7	1,224	51.11		604	59.51	453	54.98	
Region										
West	226	20.83	492	20.54	0.1278	217	21.38	176	21.36	0.1694
Midwest	341	31.43	666	27.81		324	31.92	228	27.67	
South	343	31.61	823	34.36		293	28.87	270	32.77	
Northeast	175	16.13	414	17.29		181	17.83	150	18.2	
Prenatal Smoking										
Yes	97	8.94	259	10.81	0.091	76	7.49	65	7.89	0.7481
No	988	91.06	2,136	89.19		939	92.51	759	92.11	
Start of Prenatal Care										
<9 weeks	702	64.7	1,556	64.97	0.2102	629	61.97	512	62.14	0.4801
9-12 weeks	278	25.62	567	23.67		288	28.37	220	26.7	
≥13 weeks/never	105	9.68	272	11.36		98	9.66	92	11.17	
Parity										
0	296	27.28	732	30.56	0.0493	270	26.6	231	28.03	0.493
1+	789	72.72	1,663	69.44		745	73.4	593	71.97	
Breastfeeding at 3-month Questionnaire										
Yes	N/A					656	64.63	515	62.5	0.3448
No						359	35.37	309	37.5	

7) Discussion

This section provides a discussion for each research question.

IFPS II participants completing either the prenatal and/or postnatal DHQs had similar distributions of demographic characteristics and health practices. A comparison of IFPS II mothers of infants born in 2005 to a nationally representative sample of women enrolled in the National Survey of Family Growth (NSFG) cycle 6 (1998-2000) indicated that NSFG participants were younger in age, less educated, lower income, less likely to be employed, more likely to be a non-white race/ethnicity, and resided in the South region[24]. Further NSFG participants compared to IFPS II participants were more likely to have more children and to smoke during pregnancy. Comparison of this IFPS II sample to the National Immunization Survey (NIS) indicated that more IFPS II participants were breastfeeding at six months and 12 months postpartum.

My results indicate that overall prenatal and postnatal fruit and vegetable intakes were below the recommendations[19] as has been found in previous prenatal and postpartum research.[3,5,9,10] Additionally, compared to prenatal median fruit intake postnatal fruit intake decreased by over one serving per day. Another study found similar results of a reduction in mean fruit intake prenatal (3.4 servings/day) to 6-months postnatal (1.7 servings/day); however, this study retrospectively collected prenatal intake 1.5 months postpartum.[3] I hypothesize that fruit intake decreased prenatal to postnatal as a result of reduced fruit juice consumption. For example, the percentage of participants reporting never drinking 100% orange or grapefruit juice in the past month was 15.82% on the prenatal DHQ and 24.65% on the postnatal DHQ.

1. Is there a difference in prenatal and postnatal fruit and vegetable median intake by WIC/poverty status?

And

2. Are fruit and vegetable intake associated with WIC/poverty status prenatal or postnatal?

I found two interesting prenatal and postnatal F&V intake findings to highlight for the first two research questions. First, I confirmed my hypothesis that postnatal F&V intake would be higher among breastfeeding than non-breastfeeding women and my results are similar to previous studies that addressed the same issue.[3,8,10] For example, one study of women six months postpartum found a non-significantly higher percentage of lactating participants meeting the fruit and vegetable objectives (≥2 fruits servings/day, ≥3 vegetables servings/day) compared to their non-lactating counterparts.[3] For example, one study of women six months postpartum found a non-significantly higher percentage of lactating women meeting the fruit and vegetable objectives (≥2 fruits servings/day, ≥3 vegetables servings/day) than non-lactating women (Lactating: Fruit=41%, Vegetable=34%; Non-lactating: Fruit=32%, Vegetable=17%).[3]

Second, I confirmed my hypothesis of higher F&V intake among WIC recipients and women living at >185% of PIR compared to WIC non-recipients, ≤185% of PIR among IFPS II participants completing at least one DHQ. However, only differences in median prenatal vegetable intake significantly varied by WIC/poverty status. Among women living at ≤185% of PIR, I speculate that WIC recipients had higher intake than WIC non-recipients due to the former receiving additional food aid and nutrition education. Further, due to the greater financial means of participants living at >185% of PIR, they may have better access to F&V and may have consumed more fresh F&V of possibly higher quality and a greater variety, but they did not necessarily consume greater overall amounts of F&V.

My results were similar to the findings from a NHANES III (1988-94) study which reported that mean intake among pregnant women was lowest for WIC non-recipients, <185% of PIR compared to WIC recipients and WIC non-recipients, ≥185% of PIR.[7] However, contrary to my study that found highest median intakes among WIC recipients, the NHANES II study reported that mean intake was highest for WIC non-recipients, >185% of PIR. I believe these study differences in F&V intake by WIC/poverty status may be due to varied methods of dietary data collection, 24-hour recall for the NHANES III study and a DHQ in the current analyses.

3. How do IFPS II participants who completed dietary history questionnaires (DHQs) compare to participants who did not complete DHQs in terms of demographic characteristics and health practices?

Regarding the method of selecting participants to complete DHQs, my results suggest that substantial bias is unlikely, Even though some demographic characteristics and health practices significantly varied by DHQ status, they did not appear to be meaningfully different.

8) Strengths/Limitations

There are at least five strengths of Project 3. First, this was the first study to examine the IFPS II's fruit and vegetable intake data. Second, this research is the second study, to my knowledge. that has examined prenatal and postnatal fruit and vegetable intake for the same participant.[3] Most studies have considered either prenatal or postnatal intake, but not both studies have examined either prenatal [4-7] or postnatal[8-11] only. Third, this project advances my understanding of the relationship between WIC participation/percent of poverty and prenatal and postnatal fruit and vegetable intake. Fourth, my study used a 149-item DHQ which included many foods and I analyzed the fruit and vegetable intake data as whole F&V, juices, and foods that contain fruits and vegetables. This is similar to other prenatal and postnatal F&V research that has used 100+-item FFQs and thus allows for comparability of results. Fifth, the IFPS II was a large national survey whereas much of the previous research on prenatal and postnatal F&V intake has been on a relatively small regional scale.

Project 3 has at least three limitations. First, my overall classification of breastfeeding versus not breastfeeding at the three-month questionnaire might need to be divided into further categories by degree of breastfeeding (e.g. fully, half, some). Second, although also a strength, the inclusion of whole fruits and vegetables, juices, and all foods containing fruits and vegetables into one F&V intake measure might have limited the study. This one measure did not allow for examination of high juice intake, especially among WIC recipients receiving food vouchers for juice, or for low consumption of whole fruits and vegetables (e.g. fresh apples with no other food ingredients added). Future research should further consider the relationship between WIC/poverty status and 1) juice, 2) whole F&V, and 3) other foods containing F&V. Third, regarding the method of selecting participants to complete DHQs, my results suggest that substantial bias is unlikely and the demographic characteristics and health practices that significantly varied by DHQ status were not believed to be meaningfully different.

9) Study Implications

Project 3's results indicate that F&V intakes do not significantly vary by WIC/poverty group, except for prenatal vegetable consumption. Efforts to improve fruit and vegetable intakes are needed across all WIC/income groups studied, particularly women financially eligible for WIC who are not participating in the program since among those living at incomes ≤185% intakes were lower among non-recipients of WIC than WIC recipients. These findings could support increased efforts to inform women ≤185% of PIR that they financially qualify for WIC benefits and that they should pursue seeing if they meet the other eligibility requirements (e.g. at nutritional risk). Further, the IFPS II data was collected before the 2009 changes to the WIC food package, which now includes vouchers for fresh, canned, or frozen fruits and vegetables. Future research should re-examine the relationship of WIC/poverty status and F&V consumption with these changes to the WIC food package in mind.

10) Appendix: Chapter 4

a) Question 4 Model Building Methods and Results

i) Approach 1

The first approach of model building addresses confounding by first starting with a gold standard model that includes all potential confounders and second removing covariates to find the most precise model. All models were run in SAS using PROC LOGSTIC.

The following steps were taken for the prenatal F&V intake models: 1) multicollinearity, 2) confounding, and 3) precision. The starting gold standard model for prenatal fruit intake was:

Logit P(Prenatal Fruit Intake, **X**) = $\alpha + \beta 1$ (WIC/% of poverty group 1 $_i$) + $\beta 2$ (WIC/% of poverty group 3 $_i$) + $\beta 3$ (Age 1 $_i$) + $\beta 4$ (Age 2 $_i$) + $\beta 5$ (Age 3 $_i$) + $\beta 6$ (Race 1 $_i$) + $\beta 7$ (Race 2 $_i$) + $\beta 8$ (Race 3 $_i$) + $\beta 9$ (Region 1 $_i$) + $\beta 10$ (Region 2 $_i$) + $\beta 11$ (Region 3 $_i$) + $\beta 12$ (Prenatal Smoking $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

Multicollinearity was considered by using the collinearity macro. I set the condition index (CI) at 20 and the variance composition proportion (VDP) at < 0.5. The CI was <20 and the VDPs were <0.5. Therefore, there were no collinearity issues.

Next I considered confounding by removing the following variables: age, race, region, and prenatal smoking. I removed these four variables one at a time and then in every group combination. There were a total of 14 models compared as shown in Table D1. For assessment of confounding, all OR estimates were compared to within 10% of the gold standard estimate of OR 1 vs. 2 = 1.33 and OR 3 vs. 2 1= 1.12. If the estimate was not within 10% of the gold standard, this model did not adequately control for confounding and therefore these models were not considered further for precision. Among the ORs that were within 10% of the gold standard, the widths of the 95% confidence intervals were compared to the widths of the gold standard confidence interval. There were numerous models with more precise confidence intervals than the gold standard, but the most precise model (highlighted in gray) with the smallest confidence interval widths was the model that only included race, region, and prenatal smoking variables.

Table D1 Assessment of Confounding for Prenatal Fruit Model

	OR 1 vs 2	10% of GS OR	95% CI	Width of GS CI	OR 3 vs 2	10% of GS OR	95% CI	Width of GS CI
Crude	1.30		0.84-1.90		1.27		0.92-1.75	
Gold standard (GS) (adjusted for age, race, region, smoke)	1.33	1.20-1.46	0.90-1.98	1.08	1.12	1.01-1.23	0.80-1.57	0.77
Variables Included	**OR 1 vs 2**	**Within 10% of GS**	**95% CI**	**Width of CI**	**OR 3 vs 2**	**Within 10% of GS**	**95% CI**	**Width of CI**
Age, race, region	1.29	Yes	0.87-1.91	1.04	1.19	Yes	0.86-1.66	0.80
Age, race, smoke	1.36	Yes	0.92-2.01	1.09	1.15	Yes	0.82-1.60	0.78
Age, region, smoke	1.37	Yes	0.92-2.03	1.11	1.13	Yes	0.81-1.58	0.77
Race, region, smoke	1.29	Yes	0.87-1.90	1.03	1.17	Yes	0.84-1.62	0.78
Age, race	1.31	Yes	0.89-1.94	1.05	1.21	Yes	0.87-1.69	0.82
Age, region	1.33	Yes	0.90-1.96	1.06	1.20	Yes	0.86-1.67	0.81
Age, smoke	1.39	Yes	0.94-2.05	1.11	1.15	Yes	0.83-1.60	0.77
Race, region	1.24	Yes	0.84-1.83	0.99	1.24	No	0.90-1.71	
Race, smoke	1.30	Yes	0.88-1.92	1.04	1.20	Yes	0.86-1.66	0.80
Region, smoke	1.33	Yes	0.90-1.96	1.06	1.17	Yes	0.84-1.62	0.78
Age	1.34	Yes	0.91-1.98	1.07	1.22	Yes	0.88-1.70	0.82
Race	1.26	Yes	0.86-1.85	0.99	1.27	No	0.92-1.75	
Region	1.29	Yes	0.88-1.89	1.01	1.24	No	0.90-1.71	
Smoke	1.34	Yes	0.91-1.97	1.06	1.20	Yes	0.86-1.65	0.79

The starting gold standard model for prenatal vegetable intake was:

Logit P(Prenatal Vegetable Intake, $\mathbf{X}$) = $\alpha + \beta1$ (WIC/% of poverty group 1 $_i$) + $\beta2$ (WIC/% of poverty group 3 $_i$) + $\beta3$ (Age 1 $_i$) + $\beta4$ (Age 2 $_i$) + $\beta5$ (Age 3 $_i$) + $\beta6$ (Race 1 $_i$) + $\beta7$ (Race 2 $_i$) + $\beta8$ (Race 3 $_i$) + $\beta9$ (Region 1 $_i$) + $\beta10$ (Region 2 $_i$) + $\beta11$ (Region 3 $_i$) + $\beta12$ (Prenatal Smoking $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

Multicollinearity was considered by using the collinearity macro. I set the condition index (CI) at 20 and the variance composition proportion (VDP) at < 0.5. The CI was <20 and the VDPs were <0.5. Therefore, there were no collinearity issues.

Next I considered confounding by removing the following variables: age, race, region, and prenatal smoking. I removed these four variables one at a time and then in every group combination. There were a total of 14 models compared as shown in Table D2. For assessment of confounding, all OR estimates were compared to within 10% of the gold standard estimate of OR 1 vs. 2 = 1.24 and OR 3 vs. 2 1= 0.77. If the estimate was not within 10% of the gold standard, this model did not adequately control for confounding and therefore these models were not considered further for precision. Among the ORs that were within 10% of the gold standard, the widths of the 95% confidence intervals were compared to the widths of the gold standard confidence interval. There were numerous models with more precise confidence intervals than the gold standard, but the most precise model (highlighted in gray) with the smallest confidence interval widths was the model that only included race and region.

Table D2 Assessment of Confounding for Prenatal Vegetable Model								
	OR 1 vs 2	**10% of GS OR**	**95% CI**	**Width of GS CI**	**OR 3 vs 2**	**10% of GS OR**	**95% CI**	**Width of GS CI**
Crude	1.23		0.85-1.77		0.83		0.61-1.13	
Gold standard (GS) (adjusted for age, race, region, smoke)	1.24	1.12-1.36	0.85-1.82	0.97	0.77	0.69-0.85	0.55-1.06	0.51
Variables Included	**OR 1 vs 2**	**Within 10% of GS**	**95% CI**	**Width of CI**	**OR 3 vs 2**	**Within 10% of GS**	**95% CI**	**Width of CI**
Age, race, region	1.25	Yes	0.86-1.82	0.96	0.76	Yes	0.55-1.05	0.50
Age, race, smoke	1.27	Yes	0.87-1.85	0.98	0.78	Yes	0.57-1.08	0.51
Age, region, smoke	1.25	Yes	0.86-1.83	0.97	0.77	Yes	0.56-1.07	0.51
Race, region, smoke	1.20	Yes	0.82-1.73	0.91	0.80	Yes	0.58-1.09	0.51
Age, race	1.27	Yes	0.87-1.85	0.98	0.78	Yes	0.57-1.07	0.50
Age, region	1.26	Yes	0.86-1.83	0.97	0.77	Yes	0.56-1.06	0.50
Age, smoke	1.28	Yes	0.88-1.86	0.98	0.79	Yes	0.57-1.09	0.52
Race, region	1.20	Yes	0.83-1.74	0.91	0.79	Yes	0.58-1.08	0.50
Race, smoke	1.22	Yes	0.84-1.76	0.92	0.82	Yes	0.60-1.12	0.52
Region, smoke	1.20	Yes	0.83-1.74	0.91	0.80	Yes	0.59-1.10	0.51
Age	1.28	Yes	0.88-1.86	0.98	0.79	Yes	0.57-1.08	0.51
Race	1.22	Yes	0.84-1.76	0.92	0.82	Yes	0.60-1.12	0.52
Region	1.21	Yes	0.83-1.75	0.92	0.80	Yes	0.59-1.10	0.51
Smoke	1.22	Yes	0.85-1.77	0.92	0.83	Yes	0.61-1.13	0.52

The following steps were taken for the postnatal F&V intake models: 1) multicollinearity, 2) interaction, 3) confounding, and 4) precision. The starting gold standard model for postnatal fruit intake was:

Logit P(Postnatal Fruit Intake, **X**) = α + β1 (WIC/% of poverty group 1 $_i$) + β2 (WIC/% of poverty group 3 $_i$) + β3 (Age 1 $_i$) + β4 (Age 2 $_i$) + β5 (Age 3 $_i$) + β6 (Race 1 $_i$) + β7 (Race 2 $_i$) + β8 (Race 3 $_i$) + β9 (Region 1 $_i$) + β10 (Region 2 $_i$) + β11 (Region 3 $_i$) + β12 (Prenatal Smoking $_i$) + β13 (Breastfeeding $_i$) + β14 (WIC/% of poverty group 1*Breastfeeding $_i$) + β15 (WIC/% of poverty group 3*Breastfeeding $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

Multicollinearity was considered by using the collinearity macro. I set the condition index (CI) at 20 and the variance composition proportion (VDP) at < 0.5. The CI was <20 and the VDPs for prenatal smoking was >0.5. Therefore, I removed prenatal smoking and VDPs were <0.5 and thus there were no longer any collinearity issues.

Next, interaction was assessed by the Likelihood Ratio (LR) test and the Wald test (Table D3). For example, the LR test for the postnatal fruit intake was calculated by LR = -2 log L (reduced model without interaction term) – (-2 Log L (full model with interaction term)) = 1313.308 – 1311.301 = 2.01. This LR test result is equivalent to a chi-square test with two degrees of freedom since the exposure has two dummy variables for its three categories. This chi-square value of 2.01 was not significant (p = 0.37) at an alpha level of 0.05.

The Wald test for postnatal fruit intake was calculated by a z-statistic by dividing the coefficients of the interaction terms by their standard errors (SE). Therefore, I divided the β (WIC/percent of poverty 1*Breastfeeding) by the SE (WIC/percent of poverty 1*Breastfeeding) and β (WIC/percent of poverty 3*Breastfeeding) by the SE (WIC/percent of poverty 3*Breastfeeding). The Wald test for the former interaction term was = 0.0993 / 0.1134 = 0.876 and for the latter was = 0.0801 / 0.0983 = 0.815. Since 0.876 and 0.815 were less than 1.96, the Wald tests were not significant. Therefore, the breastfeeding interaction term was not significant by the LR or Wald tests in the postnatal fruit and postnatal vegetable intake models. Therefore, there was no interaction by breastfeeding status in the postnatal fruit intake model.

Table D3 Breastfeeding Interaction Term Assessment by Wald and LR Tests for Postnatal Logistic Models											
Interaction Term to be Considered for Removal		**Wald Test**				**LR Test**					
		B	**SE**	**z-statistic**	**p-value**	**- 2 log L (reduced)**	**- 2 log L (full)**	**LR**	**DF**	**p-value**
Fruit Intake										
WIC/poverty*Breastfeeding Status	WIC/poverty 1	0.0993	0.1134	0.876	0.38	1313.308	1311.301	2.01	2	0.37
	WIC/poverty 3	0.0801	0.0983	0.815	0.42					
Vegetable Intake										
WIC/poverty*Breastfeeding Status	WIC/poverty 1	0.1068	0.1138	0.938	0.35	1311.536	1308.988	2.55	2	0.28
	WIC/poverty 3	0.0968	0.0991	0.977	0.33					

Next I considered confounding by removing the following variables: age, race, region, and breastfeeding. I removed these four variables one at a time and then in every group combination. There were a total of 14 models compared as shown in Table D4. For assessment of confounding, all OR estimates were compared to within 10% of the gold standard estimate of OR 1 vs. 2 = 1.34 and OR 3 vs. 2 1= 1.02. If the estimate was not within 10% of the gold standard, this model did not adequately control for confounding and therefore these models were not considered further for precision. Among the ORs that were within 10% of the gold standard, the widths of the 95% confidence intervals were compared to the widths of the gold standard confidence interval. There were numerous models with more precise confidence intervals than the gold standard, but the most precise model (highlighted in gray) with the smallest confidence interval widths was the model that only included region.

Table D4 Assessment of Confounding for Postnatal Fruit Model								
	OR 1 vs 2	**10% of GS OR**	**95% CI**	**Width of GS CI**	**OR 3 vs 2**	**10% of GS OR**	**95% CI**	**Width of GS CI**
Crude	1.21		0.81-1.80		1.06		0.75-1.48	
Gold Standard (GS) (adjusted for age, race, region, breastfeed)	1.34	1.21-1.47	0.88-2.03	1.15	1.02	0.92-1.12	0.71-1.45	0.74
Variables Included	**OR 1 vs 2**	**Within 10% of GS**	**95% CI**	**Width of CI**	**OR 3 vs 2**	**Within 10% of GS**	**95% CI**	**Width of CI**
Age, race, region	1.20	No	0.80-1.80		1.02	Yes	0.72-1.45	0.73
Age, race, breastfeed	1.35	Yes	0.89-2.04	1.15	1.04	Yes	0.73-1.48	0.75
Age, region, breastfeed	1.39	Yes	0.92-2.10	1.18	1.02	Yes	0.71-1.45	0.74
Race, region, breastfeed	1.31	Yes	0.87-1.98	1.11	1.02	Yes	0.72-1.45	0.73
Age, race	1.19	No	0.79-1.78		1.04	Yes	0.73-1.47	0.74
Age, region	1.24	Yes	0.83-1.86	1.03	1.02	Yes	0.72-1.45	0.73
Age, breastfeed	1.40	Yes	0.93-2.11	1.18	1.04	Yes	0.73-1.47	0.74
Race, region	1.17	No	0.78-1.75		1.03	Yes	0.73-1.46	0.73
Race, breastfeed	1.32	Yes	0.87-1.99	1.12	1.05	Yes	0.74-1.48	0.74
Region, breastfeed	1.37	Yes	0.91-2.05	1.14	1.02	Yes	0.72-1.44	0.72
Age	1.24	Yes	0.83-1.85	1.02	1.04	Yes	0.73-1.47	0.74
Race	1.16	No	0.78-1.74		1.06	Yes	0.75-1.49	0.74
Region	1.22	Yes	0.82-1.82	1.00	1.03	Yes	0.73-1.45	0.72
Breastfeed	1.37	Yes	0.92-2.06	1.14	1.05	Yes	0.74-1.47	0.73

The starting gold standard model for postnatal vegetable intake was:

Logit P(Postnatal Vegetable Intake, **X**) = $\alpha + \beta 1$ (WIC/% of poverty group 1 $_i$) + $\beta 2$ (WIC/% of poverty group 3 $_i$) + $\beta 3$ (Age 1 $_i$) + $\beta 4$ (Age 2 $_i$) + $\beta 5$ (Age 3 $_i$) + $\beta 6$ (Race 1 $_i$) + $\beta 7$ (Race 2 $_i$) + $\beta 8$ (Race 3 $_i$) + $\beta 9$ (Region 1 $_i$) + $\beta 10$ (Region 2 $_i$) + $\beta 11$ (Region 3 $_i$) + $\beta 12$ (Prenatal Smoking $_i$) + $\beta 13$ (Breastfeeding $_i$) + $\beta 14$ (WIC/% of poverty group 1*Breastfeeding $_i$) + $\beta 15$ (WIC/% of poverty group 3*Breastfeeding $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

Multicollinearity was considered by using the collinearity macro. I set the condition index (CI) at 20 and the variance composition proportion (VDP) at < 0.5. The CI was <20 and the VDP was <0.5 and thus there were no collinearity issues.

Next, interaction was assessed by the Likelihood Ratio (LR) test and the Wald test (Table D3). For example, the LR test for the postnatal fruit intake was calculated by LR = -2 log L (reduced model without interaction term) – (-2 Log L (full model with interaction term)) = 1311.536 – 1308.988 = 2.55. This LR test result is equivalent to a chi-square test with two degrees of freedom since the exposure has two dummy variables for its three categories. This chi-square value of 2.55 was not significant (p = 0.28) at an alpha level of 0.05.

The Wald test for postnatal fruit intake was calculated by a z-statistic by dividing the coefficients of the interaction terms by their standard errors (SE). Therefore, I divided the β (WIC/percent of poverty 1*Breastfeeding) by the SE (WIC/percent of poverty 1*Breastfeeding) and β (WIC/percent of poverty 3*Breastfeeding) by the SE (WIC/percent of poverty 3*Breastfeeding). The Wald test for the former interaction term was = 0.1068 / 0.1138 = 0.938 and for the latter was = 0.0968 / 0.0991 = 0.977. Since 0.938 and 0.977 were less than 1.96, the Wald tests were not significant. Therefore, the breastfeeding interaction term was not significant by the LR or Wald tests in the postnatal fruit and postnatal vegetable intake models. Therefore, there was no interaction by breastfeeding status in the postnatal fruit intake model.

Next I considered confounding by removing the following variables: age, race, region, smoking, and breastfeeding. I removed these five variables one at a time and then in every group combination. There were a total of 28 models compared as shown in Table D5. For assessment of confounding, all OR estimates were compared to within 10% of the gold standard estimate of OR 1 vs. 2 = 1.33 and OR 3 vs. 2 1= 1.00. If the estimate was not within 10% of the gold standard, this model did not adequately control for confounding and therefore these models were not considered further for precision. Among the ORs that were within 10% of the gold standard, the widths of the 95% confidence intervals were compared to the widths of the gold standard confidence interval. There were numerous models with more precise confidence intervals than the gold standard, but the most precise model (highlighted in gray) with the smallest confidence interval widths was the model that only included region and smoking.

Table D5 Assessment of Confounding for Postnatal Vegetable Model								
	OR 1 vs 2	**10% of GS OR**	**95% CI**	**Width of GS CI**	**OR 3 vs 2**	**10% of GS OR**	**95% CI**	**Width of GS CI**
Crude	1.04		0.71-1.54		1.01		0.72-1.40	
Gold Standard (GS) (adjusted for age, race, region, presmok, breastfeed)	1.33	1.20-1.46	0.88-2.02	1.14	1.00	0.90-1.10	0.70-1.42	0.72
Variables Included	**OR 1 vs 2**	**Within 10% of GS**	**95% CI**	**Width of CI**	**OR 3 vs 2**	**Within 10% of GS**	**95% CI**	**Width of CI**
Age, race, region, presmok	1.20	Yes	0.79-1.80	1.01	0.98	Yes	0.69-1.40	0.71
Age, race, region, breastfeed	1.34	Yes	0.88-2.03	1.15	1.02	Yes	0.71-1.45	0.74
Age, race, presmok, breastfeed	1.34	Yes	0.89-2.03	1.14	1.01	Yes	0.71-1.45	0.74
Age, region, presmok, breastfeed	1.38	Yes	0.92-2.09	1.17	0.99	Yes	0.69-1.41	0.72
Race, region, presmok, breastfeed	1.31	Yes	0.87-1.98	1.11	0.99	Yes	0.70-1.41	0.71
Age, race, region	1.20	Yes	0.80-1.80	1.00	1.02	Yes	0.72-1.45	0.73
Age, race, presmok	1.19	No	0.79-1.79		0.99	Yes	0.70-1.41	0.71
Age, region, presmok	1.24	Yes	0.83-1.86	1.03	0.97	Yes	0.69-1.39	0.70
Age, race, breastfeed	1.35	Yes	0.89-2.04	1.15	1.04	Yes	0.73-1.48	0.75
Age, region, breastfeed	1.39	Yes	0.92-2.10	1.18	1.02	Yes	0.71-1.45	0.74
Race, region, presmok	1.18	No	0.79-1.77		0.98	Yes	0.69-1.40	0.71
Race, region, breastfeed	1.31	Yes	0.87-1.98	1.11	1.02	Yes	0.72-1.45	0.73
Region, presmok, breastfeed	1.36	Yes	0.91-2.05	1.14	0.99	Yes	0.70-1.40	0.70
Age, race	1.19	No	0.79-1.78		1.04	Yes	0.73-1.47	0.74
Age, region	1.24	Yes	0.83-1.86	1.03	1.02	Yes	0.72-1.45	0.73
Age, presmok	1.24	Yes	0.83-1.85	1.02	0.99	Yes	0.70-1.40	0.70
Age, breastfeed	1.40	Yes	0.93-2.11	1.18	1.04	Yes	0.73-1.47	0.74
Race, region	1.17	No	0.78-1.75		1.03	Yes	0.73-1.46	0.73
Race, presmok	1.17	No	0.78-1.75		1.00	Yes	0.71-1.42	0.71
Race, breastfeed	1.32	Yes	0.87-1.99	1.12	1.05	Yes	0.74-1.48	0.74
Region, presmok	1.22	Yes	0.82-1.83	1.01	0.98	Yes	0.69-1.38	0.69
Region, breastfeed	1.37	Yes	0.91-2.05	1.14	1.02	Yes	0.72-1.44	0.72
Presmok, breastfeed	1.37	Yes	0.91-2.05	1.14	1.01	Yes	0.72-1.43	0.71
Age	1.24	Yes	0.83-1.85	1.02	1.04	Yes	0.73-1.47	0.74
Race	1.16	No	0.78-1.74		1.06	Yes	0.75-1.49	0.74
Region	1.22	Yes	0.82-1.82	1.00	1.03	Yes	0.73-1.45	0.72
Presmok	1.21	Yes	0.82-1.81	0.99	1.00	Yes	0.71-1.41	0.70
Breastfeed	1.37	Yes	0.92-2.06	1.14	1.05	Yes	0.74-1.47	0.73

ii) Approach 2

The second approach of model building addresses confounding by only including covariates that were separately significantly associated with the exposure (WIC/PIR) and with the outcome (F&V intake). The methods and results of the prenatal model building are described first. Collinearity was examined by the collinearity macro and using (CIs) set at 20 and VDPs > 0.5. These postnatal models included potential confounders and the breastfeeding interaction term.

Included potential confounders were significantly associated with both the exposure (WIC/percent of poverty) AND the outcomes (prenatal F&V intake) also. Chi-square tests were used to examine these associations with an alpha of 0.05. Table D6 displays the results for the associations of the potential confounders with the prenatal exposure and outcomes (fruit and vegetable intake). All potential confounders were associated with the exposure with a p-value of <0.0001. With the prenatal fruit intake outcome, only region of residence (p = 0.025) and prenatal smoking (p = 0.005) were significantly associated and with the prenatal vegetable intake, only region of residence was significantly associated (p = 0.017).

Table D6 P-values for the Association of Potential Confounders with Exposure (WIC/poverty) and Outcomes (F & V Intake)

	Prenatal			**Postnatal**		
Potential Confounders	**Exposure (WIC/poverty)**	**Outcome 1 (Fruit Intake)**	**Outcome 2 (Vegetable Intake)**	**Exposure (WIC/poverty)**	**Outcome 3 (Fruit Intake)**	**Outcome 4 (Vegetable Intake)**
Mother's Age	<0.0001	0.660	0.134	<0.0001	0.072	0.118
Race/Ethnicity	<0.0001	0.090	0.491	0.0004	0.0002	0.053
Marital Status	<0.0001	0.056	0.056	<0.0001	0.309	0.240
Education	<0.0001	0.146	0.330	<0.0001	0.464	0.223
Region	<0.0001	0.025	0.017	<0.0001	0.115	0.651
Prenatal Smoking	<0.0001	0.005	0.441	<0.0001	0.009	0.069
Start of Prenatal Care	<0.0001	0.797	0.257	<0.0001	0.466	0.250
Parity	<0.0001	0.266	0.642	<0.0001	0.671	0.374
Breastfeeding at 3-month Questionnaire				<0.0001	<0.0001	0.005

So the starting logistic model for prenatal fruit intake was:

Logit P(Prenatal Fruit Intake, **X**) = $\alpha + \beta 1$ (WIC/% of poverty group 1_i) + $\beta 2$ (WIC/% of poverty group 3_i) + $\beta 3$ (Region 1_i) + $\beta 4$ (Region 2_i) + $\beta 5$ (Region 3_i) + $\beta 6$ (Prenatal Smoking $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

The starting model for prenatal vegetable intake was:

Logit P(Prenatal Vegetable Intake, **X**) == α + β1 (WIC/% of poverty group 1 $_i$) + β2 (WIC/% of poverty group 3 $_i$) + β3 (Region 1 $_i$) + β4 (Region 2 $_i$) + β5 (Region 3 $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

In the prenatal fruit intake model, the CI was 3.45 and the only VDPs >0.5 were the intercept and prenatal smoking (VDP = 0.85). Therefore, I considered removed prenatal smoking and re-ran the collinearity matrix. Now the model had a CI of 2.34 and the VDPs > 0.05 were the intercept and one of the region categories (Northeast VDP = 0.59). Therefore, there were no longer collinearity issues and the final prenatal fruit intake model only included region of residence as a confounder. In the prenatal vegetable intake model including region as a confounder, the CI was 2.28 and the only VDPs >0.5 were the intercept and one of the region categories (Northeast VDP = 0.52). Therefore, there were no longer collinearity issues and the final prenatal vegetable intake model only included region of residence as a confounder.

The final prenatal models are shown below:

Logit P(Prenatal Fruit Intake, **X**) = α + β1 (WIC/% of poverty group 1 $_i$) + β2 (WIC/% of poverty group 3 $_i$) + β3 (Region 1 $_i$) + β4 (Region 2 $_i$) + β5 (Region 3 $_i$)

Logit P(Prenatal Vegetable Intake, **X**) == $\alpha + \beta 1$ (WIC/% of poverty group 1 $_i$) + $\beta 2$ (WIC/% of poverty group 3 $_i$) + $\beta 3$ (Region 1 $_i$) + $\beta 4$ (Region 2 $_i$) + $\beta 5$ (Region 3 $_i$)

The methods and results of the two steps of the postnatal models building are described second. The first step involved examining collinearity by the collinearity macro and using (CIs) set at 20 and VDPs > 0.5. These postnatal models included potential confounders and the breastfeeding interaction term. Included potential confounders were significantly associated with both the exposure (WIC/percent of poverty) AND the outcomes (postnatal F&V intake) also. Chi-square tests were used to examine these associations with an alpha of 0.05. Table D1 displayed the results for the associations of the potential confounders with the prenatal exposure and outcomes (fruit and vegetable intake). All potential confounders were associated with the exposure. With the postnatal fruit intake outcome, race/ethnicity ($p = 0.001$), prenatal smoking ($p = 0.007$), and breastfeeding ($p < 0.0001$) were significantly associated and with the postnatal vegetable intake, only breastfeeding was significantly associated ($p = 0.005$).

So the starting logistic model for postnatal fruit intake was:

Logit P(Postnatal Fruit Intake, **X**) = $\alpha + \beta 1$ (WIC/% of poverty group 1 $_i$) + $\beta 2$ (WIC/% of poverty group 3 $_i$) + $\beta 3$ (Race/Ethnicity 1 $_i$) + $\beta 4$ (Race/Ethnicity 2 $_i$) + $\beta 5$ (Race/Ethnicity 3 $_i$) + $\beta 6$ (Prenatal Smoking $_i$) + $\beta 7$ (Breastfeeding $_i$) + $\beta 8$ (WIC/% of poverty group 1 $_i$*Breastfeeding $_i$) + $\beta 9$ (WIC/% of poverty group 3 $_i$*Breastfeeding $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

The starting model for postnatal vegetable intake was:

Logit P(Postnatal Vegetable Intake, **X**) = $\alpha + \beta 1$ (WIC/% of poverty group 1 $_i$) + $\beta 2$ (WIC/% of poverty group 3 $_i$) + $\beta 3$ (Breastfeeding $_i$) + $\beta 4$ (WIC/% of poverty group 1 $_i$*Breastfeeding $_i$) + $\beta 5$ (WIC/% of poverty group 3 $_i$*Breastfeeding $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

In the postnatal fruit intake model, the CI was 6.4 and the only VDPs >0.5 were the intercept and prenatal smoking (VDP = 0.52). Therefore, I removed prenatal smoking and re-ran the collinearity matrix. Now the model had a CI of 4.64 and the VDPs > 0.05 were the intercept and one of the race/ethnicity categories. Therefore, there were no longer collinearity issues. In the postnatal vegetable intake model, the CI was 2.38 and the only VDPs >0.5 were one of the exposure categories (WIC/% of poverty group 3 VDP = 0.52) and one of the interaction term categories (WIC/% of poverty group 3 *breastfeeding VDP = 0.52). Therefore, there were no longer collinearity issues and the final postnatal vegetable intake model.

The second step involved examining interaction by the breastfeeding variable (WIC/percent of poverty*breastfeeding). The models assessing interaction are shown below:

Full models including interaction term:

Logit P(Postnatal Fruit Intake, **X**) = $\alpha + \beta1$ (WIC/% of poverty group 1 $_i$) + $\beta2$ (WIC/% of poverty group 3 $_i$) + $\beta3$ (Race/Ethnicity 1 $_i$) + $\beta4$ (Race/Ethnicity 2 $_i$) + $\beta5$ (Race/Ethnicity 3 $_i$) + $\beta6$ (Breastfeeding $_i$) + $\beta7$ (WIC/% of poverty group 1 $_i$*Breastfeeding $_i$) + $\beta8$ (WIC/% of poverty group 3 $_i$*Breastfeeding $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

Logit P(Postnatal Vegetable Intake, **X**) == $\alpha + \beta1$ (WIC/% of poverty group 1 $_i$) + $\beta2$ (WIC/% of poverty group 3 $_i$) + $\beta3$ (Breastfeeding $_i$) + $\beta4$ (WIC/% of poverty group 1 $_i$*Breastfeeding $_i$) + $\beta5$ (WIC/% of poverty group 3 $_i$*Breastfeeding $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

Reduced models not including interaction term:

Logit P(Postnatal Fruit Intake, **X**) = $\alpha + \beta1$ (WIC/% of poverty group 1 $_i$) + $\beta2$ (WIC/% of poverty group 3 $_i$) + $\beta3$ (Race/Ethnicity 1 $_i$) + $\beta4$ (Race/Ethnicity 2 $_i$) + $\beta5$ (Race/Ethnicity 3 $_i$) + $\beta6$ (Breastfeeding $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

Logit P(Postnatal Vegetable Intake, **X**) == $\alpha + \beta 1$ (WIC/% of poverty group 1 $_i$) + $\beta 2$ (WIC/% of poverty group 3 $_i$) + $\beta 3$ (Breastfeeding $_i$)

Where: All variables are as described in Table 2 Variable Specification

α = intercept

β = parameter estimates for exposure and confounders

$_i$ = Study Participant

Interaction was assessed by the Likelihood Ratio (LR) test and the Wald test (Table D7). For example, the LR test for the postnatal fruit intake was calculated by LR = -2 log L (reduced model without interaction term) – (-2 Log L (full model with interaction term)) = 1323.700 – 1322.184 = 1.516. This LR test result is equivalent to a chi-square test with two degrees of freedom since the exposure has two dummy variables for its three categories. This chi-square value of 1.516 was not significant (p = 0.47) at an alpha level of 0.05.

The Wald test for postnatal fruit intake was calculated by a z-statistic by dividing the coefficients of the interaction terms by their standard errors (SE). Therefore, I divided the β (WIC/percent of poverty 1*Breastfeeding) by the SE (WIC/percent of poverty 1*Breastfeeding) and β (WIC/percent of poverty 3*Breastfeeding) by the SE (WIC/percent of poverty 3*Breastfeeding). The Wald test for the former interaction term was = 0.0909 / 0.1127 = 0.807 and for the latter was = 0.0635 / 0.0967 = 0.657. Since 0.807 and 0.657 were less than 1.96, the Wald tests were not significant. Therefore, the breastfeeding interaction term was not significant by the LR or Wald tests in the postnatal fruit and postnatal vegetable intake models. Therefore, there was no interaction by breastfeeding status in the postnatal models.

Table D7 Breastfeeding Interaction Term Assessment by Wald and LR Tests for Postnatal Logistic Models

Interaction Term to be Considered for Removal		Wald Test				LR Test				
		B	SE	z-statistic	p-value	- 2 log L (reduced)	- 2 log L (full)	LR	DF	p-value
Fruit Intake										
WIC/poverty*Breastfeeding Status	WIC/poverty 1	0.0909	0.1127	0.807	0.42	1323.700	1322.184	1.516	2	0.47
	WIC/poverty 3	0.0635	0.0967	0.657	0.51					
Vegetable Intake										
WIC/poverty*Breastfeeding Status	WIC/poverty 1	-0.0521	0.1075	-0.485	0.63	1398.314	1398.001	0.313	2	0.86
	WIC/poverty 3	-0.0113	0.091	-0.124	0.90					

The final postnatal models are shown below:

Logit P(Postnatal Fruit Intake, **X**) = $\alpha + \beta1$ (WIC/% of poverty group 1 $_i$) + $\beta2$ (WIC/% of poverty group 3 $_i$) + $\beta3$ (Race/Ethnicity 1 $_i$) + $\beta4$ (Race/Ethnicity 2 $_i$) + $\beta5$ (Race/Ethnicity 3 $_i$) + $\beta6$ (Breastfeeding $_i$)

Logit P(Postnatal Vegetable Intake, **X**) = $\alpha + \beta1$ (WIC/% of poverty group 1 $_i$) + $\beta2$ (WIC/% of poverty group 3 $_i$) + $\beta3$ (Breastfeeding $_i$)

Results to approach 2 are found in Table D8.

Table D8 Association of WIC/poverty Groups and Prenatal and Postnatal Fruit and Vegetable Intake, Adjusting for Confounders, Among IFPS II Participants who Completed at Least One DHQ							
			≥2 Fruit Servings Daily			≥3 Vegetable Servings Daily	
Prenatal Intake							
WIC/poverty groups	N	%	OR and 95% CI		%	OR and 95% CI	
			Crude	Adjusted[1]		Crude	Adjusted[1]
WIC recipients, <185% PIR	243	67.08	1.30 (0.88-1.90)	1.29 (0.88-1.90)	55.56	1.23 (0.85-1.77)	1.21 (0.83-1.75)
Non recipients of WIC, <185% PIR	216	61.11	Reference (1.00)		50.46	Reference (1.00)	
Non recipients of WIC, ≥185% PIR	626	66.61	1.27 (0.92-1.75)	1.24 (0.90-1.71)	45.69	0.83 (0.61-1.13)	0.80 (0.59-1.10)
Postnatal Intake							
WIC/poverty groups	N	%	OR and 95% CI		%	OR and 95% CI	
			Crude	Adjusted[2]		Crude	Adjusted[3]
WIC recipients, <185% PIR	227	43.17	1.21 (0.81-1.80)	1.32 (0.87-1.99)	51.54	1.04 (0.71-1.54)	1.11 (0.75-1.65)
Non recipients of WIC, <185% PIR	184	38.59	Reference (1.00)		50.54	Reference (1.00)	
Non recipients of WIC, ≥185% PIR	604	39.90	1.06 (0.75-1.48)	1.05 (0.74-1.48)	50.66	1.01 (0.72-1.40)	1.00 (0.72-1.39)

[1] Adjusted for region, [2] Adjusted for race/ethnicity and breastfeeding, [3] Adjusted for breastfeeding

b. Sensitivity Analysis for IFPS II participants who completed both DHQs

There were 567 IFPS II participants who completed both the prenatal and postnatal DHQs. Sensitivity analysis comparing participants who completed at least one DHQ to those who completed both DHQs was examined for: 1) prenatal and postnatal median F&V intakes, 2) the change in median intake from the prenatal to the postnatal DHQ, and 3) F&V intake stratified by three-month postpartum breastfeeding status. Methods were similar to those described previously in the methods section.

Overall, the results for participants completing both DHQs yielded similar conclusions when compared to participants completing at least one DHQ for the relations of F&V intake to WIC/poverty status and to breastfeeding status (Tables D8-D10). There are three interesting findings to highlight.

First, although none of the comparisons of median F&V intakes by WIC/poverty status were statistically significant, I did not find the same trend of higher intakes among WIC/≤185% of PIR and NonWIC/>185% of PIR than NonWIC/≤185% of PIR as was found among IFPS II participants who completed at least one DHQ (Table D9).

Table D9 Prenatal and Postnatal Fruit and Vegetable Intake (Servings/day) Among IFPS II Participants who Completed Both DHQs (n=567) by WIC/poverty status							
WIC/poverty groups	N	Fruit			Vegetable		
		Median	IQR	p-value	Median	IQR	p-value
Prenatal							
WIC recipients, <185% PIR	98	2.47	1.36-4.26	0.45	2.86	1.87-4.03	0.88
Non recipients of WIC, <185% PIR	87	2.55	1.71-3.67		2.77	1.86-3.93	
Non recipients of WIC, ≥185% PIR	382	2.73	1.66-4.22		2.80	1.89-4.15	
Postnatal							
WIC recipients, <185% PIR	98	1.22	0.48-2.42	0.13	2.84	2.14-4.43	0.97
Non recipients of WIC, <185% PIR	87	1.71	0.92-2.68		3.10	1.92-4.05	
Non recipients of WIC, ≥185% PIR	382	1.61	0.82-2.64		2.98	1.89-4.32	

Second, all fruit intake median differences were positive indicating that prenatal was greater than postnatal consumption (Table D9). On the other hand, all median vegetable intake differences were negative indicating that the postnatal was greater than prenatal vegetable consumption. For example, for WIC recipients, ≤185% PIR, their median intake differences for fruits were 0.87 servings/day and vegetables were -0.12 servings/day. There were no statistically significant differences in the median intake differences for fruits or vegetables by WIC/poverty status.

The methods applicable to Table D9's results are as follows. WIC participation was determined by considering WIC status for both DHQs and I only included those who had the same WIC status for both because these participants had similar food assistance (WIC or non-WIC) for each time period.

The changes in fruit and vegetable intakes between prenatal and the postnatal periods were calculated by prenatal intakes minus postnatal intakes. A positive change meant that the prenatal intake was higher than the postnatal intake and the opposite was true for a negative change. The changes in fruit and vegetable intake were not normally distributed as concluded by skewness, kurtosis, significant Shapiro-Wilk and Kolmogorov Smirnov tests, and histogram/boxplot results. Therefore, non-parametric tests were used and the distributions of intakes of fruits and vegetables were compared among the three WIC/poverty status (<185% of poverty and WIC Recipient, <185% of poverty and non-WIC Recipient, and ≥185% of poverty) by Kruskal-Wallis tests.

The null hypothesis was that the changes in F&V intake distributions were equal for the three WIC/percent of poverty status (Table D10). The alternative hypothesis was that not all of the distributions were equal. A significance level of 5% was used, alpha = 0.05. The degrees of freedom (df) for each Kruskal-Wallis test were k – 1 where k was the number of status being compared and was therefore two df. Kruskal-Wallis tests were run in SAS using the NPAR1WAY procedure with the WILCOXON option.

Table D10 Fruit and Vegetable Intake Median Differences (Prenatal - Postnatal) (Servings/day) by WIC/Poverty Status Among Only IFPS II Participants Who Completed Both DHQs (N = 567)

WIC/poverty Groups	N	Fruit Intake Median Difference	IQR	p-value	Vegetable Intake Median Difference	IQR	p-value
WIC recipients, ≤185% PIR	98	0.87	0.13-1.93		-0.12	-0.80-0.73	
Non recipients of WIC, ≤185% PIR	87	0.71	0.15-1.60	0.515	-0.12	-0.99-0.50	0.981
Non recipients of WIC, >185% PIR	382	0.92	0.19-2.09		-0.09	-0.84-0.62	

Third, among participants who completed both DHQs postnatal fruit intake significantly varied by three-month postpartum breastfeeding status as was found for participants who completed at least one DHQ (p<0.0001). Vegetable intake neared statistical significance (p=0.0575) (Table D11).

Table D11 Postnatal Fruit and Vegetable Intake (Servings/Day) Stratified by Three-Month Postpartum Breastfeeding Status Among IFPS II Participants Who Completed Both DHQs (n=567)							
	N	**Fruit Intake**			**Vegetable Intake**		
		Median	IQR	p-value	Median	IQR	p-value
Breastfeeding	397	1.89	1.01-2.78	<0.0001	3.14	2.01-4.40	0.0575
Non-Breastfeeding	185	1.07	0.44-2.11		2.73	1.78-4.32	

Further, I chose to compare demographic characteristics and health practices among three categories of prenatal and postnatal DHQ completion: early-responders who completed the DHQ, early-responders who did not complete the DHQ, and late-responders who did not complete the DHQ (Table D12). My results were similar to those when I compared two categories of DHQ completion: completed DHQ versus did not complete DHQ. I did find more significant differences for the postnatal DHQ for this comparison of three DHQ categories than for the previous comparison of two DHQ categories. However, regarding the method of selecting participants to complete DHQs, my results of three DHQ categories suggest that substantial bias is unlikely. Even though some demographic characteristics and health practices significantly varied by DHQ status, they did not appear to be meaningfully different.

Table D12 Comparison of Demographic Characteristics and Health Practices Among IFPS II Participants Who Did and Did Not Complete DHQs

	Prenatal (n=3,480)							Postnatal (n=1,839)						
	Early-Responder (mailed DHQ) & Completed DHQ		Early-Responder & Did Not Complete DHQ		Late-Responder (not mailed DHQ)		p-value	Early-Responder (mailed DHQ) & Completed DHQ		Early-Responder & Did Not Complete DHQ		Late-Responder (not mailed DHQ)		p-value
	n=1,085	%	n=132	%	n=2,263	%		n=1,015	%	n=101	%	n=723	%	
Mother's Age (years)														
18-24	223	20.55	40	30.30	533	23.55	0.004	173	17.04	27	26.73	127	17.57	0.0325
25-29	343	31.61	49	37.12	788	34.82		332	32.71	33	32.67	269	37.21	
30-34	334	30.78	28	21.21	610	26.96		334	32.91	21	20.79	212	29.32	
35+	185	17.05	15	11.36	332	14.67		176	17.34	20	19.80	115	15.91	
Race/Ethnicity														
White	932	85.90	94	71.21	1,888	83.43	0.001	872	85.91	89	88.12	643	88.93	0.69
Black	44	4.06	11	8.33	130	5.74		41	4.04	4	3.96	23	3.18	
Hispanic	64	5.90	18	13.64	135	5.97		56	5.52	5	4.95	33	4.56	
Other	45	4.15	9	6.82	110	4.86		46	4.53	3	2.97	24	3.32	
Marital Status														
Married or cohabiting	875	80.65	84	63.64	1,742	76.98	<0.0001	852	83.94	74	73.27	603	83.40	0.0232
Other	210	19.35	48	36.36	521	23.02		163	16.06	27	26.73	120	16.60	
Education														
High School or less	222	20.46	43	32.58	534	23.60	<0.0001	173	17.04	22	21.78	139	19.23	0.0104
Some college	421	38.80	62	46.97	928	41.01		382	37.64	51	50.50	262	36.24	
College graduate	442	40.74	27	20.45	801	35.40		460	45.32	28	27.72	322	44.54	
WIC/Percent of Poverty Group														
WIC recipients, ≤185% PIR	243	22.4	41	31.06	589	26.03	0.004	227	22.36	32	31.68	173	22.93	0.0816
Non recipients of WIC, ≤185%	216	19.91	32	24.24	509	22.49		184	18.13	23	22.77	143	19.78	
Non recipients of WIC, >185%	626	57.70	59	44.70	1,165	51.48		604	59.51	46	45.54	407	56.29	
Region														
West	226	20.83	19	14.39	473	20.90	0.158	217	21.38	26	25.74	150	20.75	0.3816
Midwest	341	31.43	38	28.79	628	27.75		324	31.92	27	26.73	201	27.80	
South	343	31.61	48	36.36	775	34.25		293	28.87	31	30.69	239	33.06	
Northeast	175	16.13	27	20.45	387	17.10		181	17.83	17	16.83	133	18.40	
Prenatal Smoking														
Yes	97	8.94	20	15.15	239	10.56	0.057	76	7.49	10	9.90	55	7.61	0.6833
No	988	91.06	112	84.85	2,024	89.44		939	92.51	91	90.10	668	92.39	
Start of Prenatal Care														
<9 weeks	702	64.70	88	66.67	1,468	64.87	0.508	629	61.97	66	65.35	446	61.69	0.6875
9-12 weeks	278	25.62	30	22.73	537	23.73		288	28.37	26	25.74	194	26.83	
≥13 weeks/never	105	9.68	14	10.61	258	11.40		98	9.66	9	8.91	83	11.48	
Parity														
0	296	27.28	42	31.82	690	30.49	0.137	270	26.60	26	25.74	205	28.35	0.678
1+	789	72.72	90	68.18	1,573	69.51		745	73.40	75	74.26	518	71.65	
Breastfeeding at 3-month Questionnaire														
Yes	N/A							656	64.63	59	58.42	456	63.07	0.4226
No								359	35.37	42	41.58	267	36.93	

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Chapter 5: Dissertation Summary

This chapter provides a summary of my dissertation research by 1) restating the main research questions and the corresponding analyses, 2) reviewing the major study results, and 3) describing my research findings in the broader context of fruit and vegetable consumption among low-income women.

1) Research Questions

Fruits and vegetables (F&V) provide essential nutrients for growth and development in children, adolescents, and adults.[1,2] Diets rich in F&V have been shown to prevent certain types of cancer and reduce risks for cardiovascular diseases, Type II diabetes, and obesity.[3-6] Overall F&V consumption is generally lower among low-income individuals and those of minority racial/ethnic groups.[7-11] The understanding of factors associated with F&V intake among those who tend to have lower intake, specifically recipients in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) was of specific interest in this dissertation. Therefore, my dissertation aimed to examine the following research questions:

1. Does the WIC Farmers' Market Nutrition Program (FMNP) increase F&V intake and/or nutrition knowledge and competencies about F&V among mothers and the oldest children receiving WIC benefits?
2. Is F&V intake of the mother and child associated with mother's nutrition knowledge of the F&V recommendations and/or F&V competencies learned from the FMNP?
3. What is the agreement between a woman's perceived and actual nutrition environment measures of availability, quality, and affordability/price of fresh and canned/frozen F&V?

4. How does F&V intake during pregnancy and postpartum vary by the following categories: WIC recipients, WIC non-recipients living at ≤185% of poverty index ratio (PIR), and women living at >185% of PIR.

2) Data Sources/Studies

This dissertation included two datasets: 1) Emory WIC FMNP Study (first and second projects), and 2) Infant Feeding Practice Study II (IFPS II) (third project). The Emory WIC FMNP Study was a prospective study that enrolled WIC recipients from two Atlanta WIC clinics from Fulton and DeKalb counties. There were three surveys: one at baseline completed in person at the WIC clinic and two follow-ups completed by phone one and four-weeks post enrollment. Study surveys assessed the mother's and child's fruit and vegetable consumption, nutrition knowledge, nutrition competencies learned from the FMNP, and perceptions about the nutrition environment of a reported food store.

For the <u>first and second research questions</u>, participants were divided into three groups: non-FMNP, overall FMNP, only FMNP participants who used all FMNP coupons. All groups received usual WIC food vouchers and nutrition education, but the FMNP groups also received $30-worth of FMNP coupons for fresh F&V from a local farmer. The FMNP varied by WIC clinic in that the Fulton county clinic required use of all FMNP coupons on day of issuance from farmer onsite; whereas the DeKalb clinic allowed coupons to be redeemed within two weeks of issuance from any approved farmers market.

Regarding the <u>third research question</u>, baseline data for a subsample of the Emory WIC FMNP study participants were included if their reported primary food store qualified for the project (i.e. open to the public, reported by >3 participants). Reported stores were dichotomized into large grocery stores/supermarkets versus mass-merchandisers. Perceived nutrition environment measures of availability, quality, and affordability of fresh and canned/frozen F&V corresponded to the primary food stores. The actual nutrition environment measures of availability, quality, and price of fresh, canned, and frozen F&V were assessed by the Nutrition Environment Measures Survey for Stores (NEMS-S) by trained surveyors in the reported food stores.

For the fourth research question, the IFPS II was a prospective study that followed women participating in consumer opinion panels from late pregnancy through their infants' first birthday and collected data by a series of mailed questionnaires. My study used data from five of the 12 questionnaires: demographic, prenatal, three-month postnatal, prenatal DHQ, and postnatal DHQ. Only a subsample of IFPS II participants who had promptly completed the previous survey was mailed DHQs that collected dietary data corresponding to the previous month's intake [12]. Intake data were gathered by frequency and amount and the National Cancer Institute's Diet*Calc software estimated total fruit and total vegetable servings per day[1]. Therefore, two analytic samples were created for analysis: prenatal DHQ and postnatal DHQ. Participants were divided into three WIC/poverty groups using WIC participation and PIR: WIC recipient and living at ≤185% of PIR, non-recipient of WIC and ≤185% of PIR, and non-recipient of WIC and >185% of PIR.

3) Analyses

The first research question used data from the Emory WIC FMNP study. I used McNemar chi-square tests to assess differences in nutrition knowledge and F&V consumption across survey time-points and when comparing intake between the FMNP groups. Second, the Friedman test was used to test differences in the repeated, correlated F&V intakes across all surveys. Third, the Cochran-Armitage Trend test was used to examine trends in the percentage consuming five or more daily F&V across all survey time-points for participants who used all of their FMNP coupons.

Data from the Emory WIC FMNP study was also used for the second research question. I examined whether learned nutrition competencies as a result of the FMNP (agree versus disagree that competencies were learned) influenced F&V intake (increase versus no change/decrease in intake from baseline to follow-up surveys for mother and child) by Fisher exact tests. Finally, logistic regression, adjusting for confounders, assessed the relationship between baseline nutrition knowledge and baseline F&V intake dichotomized into meeting or not meeting the recommendation.

Analyses for the third research question included kappa statistics and sensitivities and specificities to examine agreement between perceived and actual nutrition environment measures (assuming the actual nutrition environment as the "gold standard") using data from the Emory WIC FMNP study. All measures were accompanied by the corresponding 95% confidence intervals. Perceived measures were dichotomized into the highest rating ("excellent" for availability and quality; "very affordable" for affordability) versus other ratings ("<excellent" for availability and quality, "not very affordable" for affordability). Actual measures were dichotomized into highest quartile versus other quartiles for availability and quality and lowest quartile versus other quartiles for price.

The fourth research question used data from the Infant Feeding Practice Study II (IFPS II) and analyses included describing overall prenatal and postnatal F&V intakes; postnatal F&V intake was also assessed by breastfeeding status using Wilcoxon Rank Sum tests. Second, I compared median prenatal and postnatal F&V intakes for the three WIC/poverty groups using Kruskal-Wallis tests with two degrees of freedom. Lastly, I examined the relationship between prenatal and postnatal F&V intake and the WIC/poverty groups by logistic regression, adjusting for confounders.

4) Main Findings

The first research question's results were divided into: 1) influence of FMNP on nutrition knowledge/competencies, and 2) impact of FMNP on F&V intake. First, results indicated the FMNP influenced nutrition competencies, but had little impact on nutrition knowledge. For example, more than half of the FMNP participants agreed that they learned a new way to prepare or cook fresh F&V (56.5%) and learned a new way to store fresh F&V to prevent spoilage (58.7%) due to the WIC FMNP. However, the median reported numbers of total F&V that should be consumed daily for good health for the mother and child were less than five per day on both the baseline and four-week surveys and there were no significant differences in nutrition knowledge between FMNP groups or from baseline to four-week follow-up surveys.

Second, the influence of the FMNP on F&V intake was evident when results were stratified by WIC clinic and by FMNP groups. For example, the total fruit and vegetable intake for mother and child was below five or more F&V per day. However, when intake was stratified by WIC clinic site, four-week consumption was significantly higher for the FMNP group mothers at the Fulton county clinic (34.8%) than at the DeKalb county clinic (7.7%) ($p=0.019$) and the percent of women consuming five or more F&V daily increased over time at the Fulton county clinic (Baseline: 21.7%, One-week: 26.1%, Four-week: 34.8%) ($p=0.41$), but decreased at the DeKalb county clinic (Baseline: 23.1%, One-week: 19.2%, Four-week: 7.7%) ($p=0.20$). Further, the percentage of mother FMNP participants consuming five or more F&V daily who used all FMNP coupons showed a non-significant increasing prevalence in intake across survey time-points (Mother: Baseline: 18.4%, One-week: 21.0%, Four-week: 23.6%).

Findings from the second research question indicated that among FMNP mothers, there were significant increases in F&V consumption from baseline to one-week follow-up surveys for those who agreed with the competency statements compared to those who disagreed with these statements ($p=0.03$). Lastly, from the logistic regression results, mothers who knew that at least five F&V are recommended daily were non-significantly more likely to consume five or more F&V per day (crude OR: 1.7 (95% CI: 0.7–3.9)) as were their children (OR: 1.7 (0.8–3.6)) at baseline.

The third research question used a subsample of the Emory WIC FMNP Study data that included 84 participants and 13 NEMS-S stores. Among the 13 NEMS-S stores, approximately two thirds were grocery stores/supermarkets and one-third was comprised of one mass-merchandiser (Wal-Mart). The number of cash registers per store ranged from seven to 34 with a median of 13. Most participants perceived F&V availability and quality as “excellent” or “good” and reported that F&V were “very” or “somewhat” affordable. Actual store measures indicated that all canned fruit and vegetable items were available and nearly all fresh and frozen items were available (median percent available: fresh = 97%, frozen = 87%). The majority of fresh F&V items were considered to be of acceptable quality out of items available (median percent acceptable quality = 96%). The average price per ounce of each F&V category was highest for frozen items at $0.122 (SD 0.021) followed by fresh items at $0.082 (0.007) followed by canned items as the lowest at $0.061 (0.005). When the canned and frozen categories were combined for comparison with perceived affordability canned/frozen measures, the average price per ounce per item was $0.086. Further, in the analyses of agreement between perceived and actual measures, all kappa values were below 0.2. Agreement was highest for canned/frozen F&V affordability/price measures (kappa=0.17 95% CI: 0.01–0.33) and lowest for fresh F&V affordability/price measures (kappa=0.07 95% CI: -0.13–0.28).

The fourth research question used data from the IFPS II and participants who completed at least one DHQ, either the prenatal or postnatal, were aged 25-34 years, white, married or cohabiting, college graduates, non-recipients of WIC and >185 of PIR, and were breastfeeding at the three-month postnatal questionnaire. Overall I found median daily prenatal intakes of 2.65 servings of fruit and 2.94 servings of vegetables with 65.62% consuming two or more fruits per day and 48.85% consuming three or more vegetables per day. Overall median daily postnatal fruit intake was 1.61 servings (40.39% consuming ≥2 fruits/day) and vegetable intake was 3.05 servings (50.84% consuming ≥3 vegetables/day). Median numbers of servings/day were significantly higher among breastfeeding women at1.89 for fruit and 3.19 for vegetables whereas the corresponding estimates among non-breastfeeding women were 1.21 and 2.76, for fruits and vegetables, respectively (fruit: p<0.0001; vegetable: p=0.006). In general, median F&V intakes were the highest among WIC recipients followed by women living at >185% of the poverty index and then lowest among WIC non-recipients, living at ≤185% of PIR. For example, prenatal vegetable intakes significantly varied among WIC/poverty groups with the highest median intake among WIC/≤185% of PIR (p=0.04). Additionally, compared to WIC non-recipients living at ≤185% of PIR, WIC recipients had non-significantly higher prenatal fruit intake (adjusted odds ratio (OR)=1.29 (95% confidence interval (CI): 0.87–1.90) adjusting for race/ethnicity, region of residence, and prenatal smoking.

5) Discussion

Overall, my results from the Emory WIC FMNP study's first research question suggest that distribution of the WIC FMNP coupons in two metropolitan Atlanta WIC clinics had little influence on maternal and child F&V intake and nutrition knowledge, yet some impact on reported nutrition competencies about F&V preparation and storage. Further, it is interesting to note that there was an increase in the percentage of mothers consuming five or more F&V daily from baseline to the four-week survey among FMNP participants at the Fulton county WIC clinic, but a decrease at the DeKalb clinic. The requirement to use the coupons on the day they were issued seemed to ensure that the coupons were used and the results suggest continued increases in F&V intake across study time-points. Further, the second research question's results indicated that among FMNP participants who indicated learning nutrition competencies compared to those who did not, I found significant increases in F&V consumption from baseline to one-week follow-up surveys.

My third research question's findings of the majority of participants reporting "excellent" or "good" perceptions of availability and quality are likely due to all food stores being chain grocery stores/supermarkets or a mass-merchandiser. In general, my measures of the actual nutrition environment demonstrated high availability of F&V and "acceptable" quality of most fresh F&V. Further, it is interesting to note that when the average price per ounce of canned and frozen F&V were combined to correspond to the perceived affordability question for canned/frozen F&V, their price variations were masked and were similar to that for fresh F&V.
Lastly, when I considered the actual environment as the "gold standard," I found poor agreement between the actual and perceived nutrition environment measures of availability, quality, and price/affordability.

There are three interesting findings to highlight from research question four's results using the IFPS II data. First, my results indicate that overall prenatal and postnatal fruit and vegetable intakes were below the recommendations and compared to prenatal median fruit intake postnatal fruit intake decreased by over one serving per day. Second, I confirmed my hypothesis that postnatal F&V intake would be higher among breastfeeding than non-breastfeeding women and my results are similar to previous studies that addressed the same issue.[13-15] Third, I confirmed my hypothesis of higher F&V intake among WIC recipients and women living at >185% of PIR compared to WIC non-recipients, ≤185% of PIR among IFPS II participants. Among women living at ≤185% of PIR, I speculate that WIC recipients had higher intake than WIC non-recipients due to the former receiving additional food aid and nutrition education. Further, due to the greater financial means of participants living at >185% of PIR, they may have consumed more fresh F&V of possibly higher quality and a greater variety, but they did not necessarily consume greater overall amounts of F&V.

6) Implications of Dissertation

Taken together, these four dissertation research projects add to the existing literature on factors that influence F&V consumption among low-income women. Based on my dissertation findings, the requirement that WIC FMNP coupons be used on the day of issuance and packaging the selected F&V while families are in clinic may result in higher F&V intake. Also, my results could support WIC-led nutrition education programs to emphasize 1) the F&V storage and preparation competencies, and 2) the nutrition environment since working with consumers on aspects of availability, acceptable quality, and price per ounce may alter perceptions and possibly influence F&V purchases. My result of poor agreement between the perceived and actual environments is novel and my sensitivity findings were lower in magnitude than those found in a study not comprised of all low-income women that examined the availability of healthy foods by comparing the perceived and actual environments[16]. Future research enrolling a high proportion of low-income women should reexamine the agreement between the two nutrition environments since I found that questions about nutrition environment perceptions may not be appropriate for evaluations of the environment among low-income participants. I propose a future cross-sectional study that includes participants with varied income levels and surveys their perceptions of fruits and vegetables corresponding to three food stores near their residence: a convenience store, a small grocery store, and a large supermarket/mass-merchandiser. These three stores' actual fruit and vegetable environment would be assessed by NEMS-S. Then, the perceived and actual nutrition environments could be compared by kappa statistics and sensitivity/specificity by income level and by store type.

Lastly, the studies included in my dissertation, Emory WIC FMNP study data and IFPS II, collected data before the 2009 changes to the WIC food package, which now includes vouchers for fresh, canned, or frozen fruits and vegetables. Future research should consider these changes in package composition while evaluating the relation of 1) the perceived and actual nutrition environments, and 2) WIC/poverty status to F&V consumption. I suggest a cross-sectional study that includes households with various income levels and at least one-third being recipients of WIC benefits that examines F&V purchases and F&V consumption of each household member during the past week. F&V purchases would be stratified by 1) F&V bought via cash/credit/debit versus WIC F&V vouchers and 2) WIC/poverty status. F&V intake would be stratified by WIC/poverty status for each participant and an average for each household. All measures would separately examine fruits and vegetables and would specify fresh, canned, and frozen varieties.

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