

University of Cape Town

The Impact of new Women Infant Children  
(WIC) package on whole grain consumption of  
participating children in metro-Atlanta,  
Georgia

Study Protocol

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**Abbreviations:**

BMI	Body Mass Index
CDC	Centre for Disease Control and Prevention
CVD	Cardiovascular Disease
FMSN	Farmers Market Supplement Nutrition Programme
GEE	Generalised Estimating Equation
IRB	Institutional Review Board
MPH	Masters of Public Health
RSPH	Rollins School of Public Health
SES	Socio-Economic Status
UCT	University of Cape Town
U.S.	United States of America
USDA	United States Department of Agriculture
WGC	Whole Grain Council
WGF	Whole Grain Food
WIC	Women, Infants and Children
ZAR	South African Rand

## Abstract

**Purpose:** The purpose of this study is to investigate the impact of the revised Women Infant and Children (WIC) programme on whole grain consumption among WIC participating children. In addition, this study aims to investigate how knowledge on whole grain consumption and/or perceptions on cost of whole grain contribute to consumption.

**Background:** The WIC programme is a supplementary nutrition programme for women, infants and children which seeks to promote the health of women who are pregnant, postpartum and lactating and children up to the age of 5 years. The WIC programme is aimed at low-income women and children facing nutritional risk. This nutritional risk is classified by a number of factors that include anaemia, underweight, overweight, history of pregnancy complication or poor pregnancy outcomes. Women and children facing nutritional risk are provided with services that include supplementary foods, nutrition and education counselling, screening and referral to other health, welfare and social services.

**Methods:** This study is a secondary analysis of the Phase II Emory WIC study that investigated the impact of the new WIC programme on fruit and vegetable consumption among participating women. In addition to this, the primary study also investigated the consumption of whole grain foods. The study population consisted of 77 women and their children that attended routine visits in two Metro-Atlanta WIC clinics. In order to meet the aims of this secondary analysis, this study will firstly undertake a univariate analysis and thereafter simple bivariate analysis intended to determine any associations between exposure/risk factors (i.e. old and new WIC Emory Voucher package) and response variables. In addition to the above analysis, paired-tests will be conducted to determine if there is any statistical significant increase in whole grain consumption between; (a.) baseline and week 1 and (b.) baseline and 4 week. Finally, in order to account for possible confounding not taken into consideration by the aforementioned analysis, this study will use General Estimating Equation (GEE) approach to model the change in whole grain consumption over time (from baseline to 4 weeks). It is anticipated that the above methodology will help answer the objectives of this research.

**Conclusion:** It is hoped that the results of the study will highlight possible socio-economic factors that may lead to greater consumption of whole grain foods and provide recommendations on how to best improve the WIC programme with regard to Whole Grain Foods (WGFs) among participating children.

### **1.1.0: Background**

Setting an important precedent on whole grain consumption internationally, the United States of America (USA) continues to promote the inclusion of whole grain foods (WGF). An example of WGF promotion among its population was shown by holding the “Grains for the health of It” conference held in Minneapolis in 2001. [1] Despite this campaign and many others to promote increased consumption of WGF such as the 2005 and revised 2010 Dietary Guidelines for Healthy Americans, many Americans continue to consume WGF below recommended standards. [2,3] The commonly consumed grains in the USA include wheat, oats, rice, maize and rye which make up between 66-75percent of total whole grain consumption.[4] Current epidemiological evidence consistently shows that whole grain foods significantly reduce the risk of many disease including cardiovascular disease, diabetes, cancer and obesity.[5,6,7] It was for this reason the introduction of the Special Supplemental Nutrition Programme of Woman, Infant and Children (WIC) was highly welcomed as an intervention that would increase consumption of freshly, locally grown whole grain foods.[8]

#### **Women, Infant and Children (WIC) Programme**

According to the Department of Agriculture, the WIC programme is considered as a special supplementary nutrition programme for low-income women, infants and children which seeks to promote the health of women who are pregnant, postpartum and lactating and children up to the age of 5 years. [9] In addition the WIC programme is aimed at women and children facing “nutritional risk”. This risk in women may be as a result of a cascade of medical conditions such as anaemia, underweight, overweight, history of pregnancy complication or poor pregnancy outcomes. Women and children facing such risk are provided with services that include; supplementing diets, nutrition and education counselling, screening and referral to other health, welfare and social services. [10]

The WIC programme was first piloted in 1972 and later permanently adopted and administered by the Food and Nutrition Services of the U.S Department of Agriculture. [11] Since its inception, the WIC programme has grown to service all 50 states and other areas such as the 34 Indian Tribal Organisations and District of Columbia. [12] Women receive food vouchers that are accepted by numerous states and local organisations. A total of 46,000 merchants nationwide accept such vouchers. [13] Today, there has been the introduction of WIC Electronic Benefit Transfer (EBT) which is meant to replace the paper food checks or vouches currently being used in several states across the U.S. By October 2020, all WIC State agencies are required to implement the EBT with the view to examine a number of issues; the food choices

of WIC participants; how those choices are affected by the constraints imposed by the WIC State agency, and how they affect food costs by increasing the availability of WIC data (USDA, 2015).

In addition to the WIC program, the Farmer's Market Supplement Nutrition (FMSN) Programme was implemented in 1993 to increase the consumption of fresh, locally grown produce among low income women and children who were recipients of the Special Supplement Nutrition Programme for Women, Infants and Children. [14] Later in 2009, the national WIC programme was revised in order to be aligned with the 2005 Infants feeding practices guidelines of the American Academy of Paediatrics. With these revisions implemented in October 2005, WIC participants would experience an increase in consumption of essential foods including whole grain foods. [15] The new WIC programme and the Farmer's Market Supplement Nutrition Programme combined would ensure increased consumption of fresh and locally grown produce among low income women and their children. In December 2007, the USDA circulated new regulations for the WIC supplement feeding program. Whole grains for the first time became part of the food package subsidized by the U.S government. [16]

### **Whole Grain Consumption in U.S.A**

According to the Whole Grains Council, the overall WGF consumption in the U.S rose by 20 percent from 2005 to 2008 despite having remained steady from 1998 to 2005. The percentage of Americans consuming at least one whole grain product every fortnight increased from 35 percent in 2006 to 60 percent in 2009. [18]

Other U.S. data reviews that 20 percent of adults and 40 percent of children and teens in the U.S. had not had whole grain foods. In addition to this, a telephone survey conducted in 2001 found that only 40 percent of teens and children never ate whole grain foods. [19] Other data disaggregated by;

- Sex;
- races were affected by the level of income;
- Consumption patterns among different age groups;

shows that personal preference to the purchase of whole grain foods is affected by a number of reasons as elaborated by the socio-ecological model. The model suggests that despite people receiving the same amount of money for the vouchers, one's choice of food is affected at the interpersonal level (this is where one's taste preference, habits and nutritional knowledge). In addition, interpersonal level/social environment factors contribute to one's choice of food. These social environment factors include the cultural roles and social traditions, and expectations impacted by eating practices and patterns within

family settings and other social groupings. Beyond these factors is the physical environment such as food access and availability. [20]

According to the Whole Grain Council (WGC) of U.S, whole grains or foods consist of all essential parts and naturally-occurring nutrients of the entire grain seed. [21] Processed grain even after being cracked and crushed must still have approximately the same rich balance of nutrients that are found in the original seed. The American Association of Cereal Chemists define whole grain as “consisting of intact, ground, cracked or flaked caryopsis, whose principal anatomical components - the starchy endosperm, germ and bran - are present in the same relative proportions as they exist in the intact caryopsis”. [22]

Today the U.S. Guidelines recommends whole grain consumption specific to each age group and gender group, which implies a minimum amount of whole grains to be consumed. These guidelines recommend that children in the age group 2-3 years must eat at least 1 to 3 servings for girls and boys respectively. Within the age group 4-8, children must eat a minimum of 2-4 servings and 2.5-5 serving for girls and boys respectively. [23] Despite the existence of these recommendations in place, the majority of American children continue to consume less than the recommended servings. For example, the national dietary intake data (Continuing Survey of Food Intakes by Individuals 1994-1996) found that children only consumed an ounce which is a third of the recommended standard. Furthermore, the National Health and Nutrition Examination Survey (1999-2002) found that children and adolescents 6-19 years of age in the U.S consumed only 0.8-1.0 mean servings of whole grain products per day. From above, it can be noticed that whole grain consumption is not disaggregated to reflect the definition of children of 1-5 years.

In 2010, scores expressed as a percentage of the recommended dietary intake showed that there has been a considerable increase in whole grain consumption in the U.S. in children aged 2-17. During the observation periods of 2005-2006, 2007–2008, and 2009–2010, children consumed 52, 72 and 70 percent of recommended dietary whole grain intake. [24] This data corresponds with USDA, overall whole grain consumption results in general population show an increased from 2007-2008 averaged at 0.64 daily servings per person to 0.79 servings in 2009-2010 [25]. Despite this increase in whole grain consumption, overall consumption rate still falls below recommended daily consumption rates.

### **Health Benefits of Whole Grain foods**

As earlier mentioned, whole grain consumption has been shown through epidemiological evidence to have numerous health benefits to persons of all age groups. Today, in the U.S., the relationship between

health and whole grains has been publicized in three government documents that include; the Food Guide Pyramid, updated versions of the Dietary Guidelines for Healthy Americans and in the Healthy People 2020 which recommends for three serving of whole grain per day.

Whole grain consumption *inter alia* has been associated with the reduced risk of health conditions inducing cancer and coronary heart disease. [24] The U.S Department of Health and Human Services suggests that dietary factors are associated with 40% of leading causes of death which include coronary heart diseases, a selection of cancers, strokes and diabetes Type II. [25]

One of the major benefits of whole grain foods is that it contributes to protecting against obesity in children. The global burden of overweight children is high with 1 child in 10 being obese worldwide. Top among the list of countries with high prevalence of childhood obesity is the U.S. with an estimated 33.6% of children aged 2-19 years being overweight. In addition, obesity continues to be the second leading cause of preventable diseases and death in America second only to smoking among adults. [26] A sizable amount of these deaths are as a result of overweight children developing obesity related chronic diseases in later adolescence and early adulthood. [27] This is notwithstanding the fact that children that are overweight end up being more likely to be overweight during their adulthood when compared to slim children. [28] There is considerable evidence to suggest that the consumption of whole grains foods is inversely related to obesity. [29]

In addition, whole grain consumption has been associated with reduced risk of type II diabetes and coronary artery disease. One study in 2003 showed that habitual consumers of whole grain consistently had 20–40 percent reduction in the above mentioned conditions. [30] Diabetes in America has predominately been an adult problem as the number of Americans diagnosed with diabetes tripled from 1980 through 2010 (from 5.6 million to 20.9 million). [31] About 15 million adults also suffer from type II diabetes; this is notwithstanding the fact that there has been increase in the emerging numbers of children and adolescents developing type II diabetes. [32] This increased prevalence of diabetes among children in the U.S. increases the related burden of diabetes given its chronic nature. [33] This growing burden of diabetes in children is difficult to manage given the lack of accurate data on diabetes among children. For this reason, the scientific evidence that shows that whole grain reduces the risk of diabetes provides a worthy option in its reduction. [34] The use of whole grain is equally important from a curative stand point as it forms a significant part of medical nutrition used in the treatment of diabetes. [35]

## **1.1.1 Motivation and Rationale**

As shown within academic literature, the impact of whole grain foods on the health of children between the age of 1 and 5 years has not been extensively investigated despite showing that whole grain consumption generally reduces the risk to diseases such as diabetes type II, cardio vascular cancer and prevents obesity across all age groups. The goal of this study is to provide more information on the impact of the WIC programme on the consumption of whole grain among children in the U.S. The significance of this study is that it will add to the body of knowledge around the impact of WIC programme and that of nutrition generally in U.S. and beyond.

The rationale of this study is to increase knowledge around the impact of WIC programme as it relates to reduction of risk to various diseases and conditions; highlight possible socio-economic factors that may lead to greater consumption of whole grain foods and provide recommendations on how to best improve WIC programme with regards to WGFs consumption for participating children.

## **2.1.0 Research Aim & Objectives**

### **2.1.1: Research Aims**

The aim of this study is to determine whether the introduction of the New WIC package in Metro-Atlanta had an impact on the consumption of whole grain foods among participating children. This research works under the hypothesis that there is an increased level of consumption of whole grain foods after the introduction of the New WIC package. This hypothesis is based on a number of theories including the socio-ecological theory which suggests that consumption of whole grains foods is affected by factors such as socio-demographics of the participating women; family size, cultural nutrition practices and a host of other factors.

### **2.1.2: Specific Objectives**

1. Investigate the association between the new WIC package and increase in knowledge of whole grain consumption.
2. Assess the impact of the new WIC package on the perception one's cost and/or affordability of whole grain foods.
3. Investigate if the new WIC package increases consumption of whole grain foods among participating families.

The table 1 below provides a summary of the objectives in line with the questions that will be used in the survey to determine the required questions:

**Table 1: Questions that answer Study objectives**

Objective	Required information	Question in Survey
1. Investigate if the new WIC package increases knowledge in whole grain consumption	How do I measure knowledge?	B26 4W26 4W27 4W28
2. Assess the impact of the new WIC package on the perception of the cost and/or affordability of whole grain foods	Accessibility, affordability to purchase goods and	B30 B27 B27 4W24 4W25
3. Investigate the if the new WIC package increases consumption of whole grain foods		B18 B19 4W17 4W8

### 3.1.0: Methods

This section describes the methodology that will be used to answer the research objectives. In doing so, section 3.2.0 will begin by providing details of the research methods used in the primary study (Emory WIC New WIC Study) that looked at the Cost and Influence on Fruit and Vegetable Consumption Survey conducted in 2009. Thereafter, section 3.3.0 will provide details of the secondary analysis (this study) of the Emory University WIC database by also highlighting study population, sampling procedures and analysis methodology.

#### 3.1.1 Data Capturing, handing and Quality Control

The primary Emory WIC study conducted three separate interviews for data collection by trained interviewers. This process was conducted upon receipt of informed consent from respondents. The WIC Clinic waiting rooms were used for researcher questionnaire administered interviews with each mother at baseline. During the course of the interview, each participating mother was required to provide a

reliable phone number by which she could be contacted at a time of her convenience at one-week and four-week follow-up points. In the event that participants were unreachable by phone, email addresses were requested from participants.

In order to motivate participants, Kroger gift cards were handed out to the cost of \$5, \$10 and \$20 at baseline, one-week and four-week follow-up period respectively. In order to decrease lost to follow-up, research interviewers' left voicemail messages with a return phone numbers for those not successfully contacted. A participant was only considered lost to follow-up if they were not contacted after 3 attempts and had not responded to email. [36]

### **3.2.0 Primary Study Methodology**

#### **3.2.1 Study Population**

The population was all women participating in the WIC programme who had at least one child receiving WIC vouchers between the age one and less than five during the prior to the introduction of the revised WIC package in 2009. Furthermore, the population of women included all those that received the new WIC vouchers at Fulton Adamsville or Dekalb Kirkwood WIC clinics.

#### **3.2.2 Sample**

The Emory WIC study recruited 77 women during routine visits to metro Atlanta WIC clinics as they received new WIC voucher packages. Participants of the WIC study had to meet the following criteria in order to be suitable for selection into the WIC study; All participants were 18 years of age, English speaking, received WIC coupons/vouchers at the Fulton Adamsville or DeKalb Kirkwood WIC clinic, had at least one child receiving WIC vouchers between the age of one and less than five (in the case where the mother had more than one child receiving WIC, only the oldest child's consumption was measured). The selected women received new WIC vouchers on dates when the baseline interview was conducted. The sampling procedure used was a convenience sample.

#### **3.2.3 Study Measurements**

The WIC study collected data at three points in time: Participants were first introduced to the study by using a researcher administered questionnaire at baseline, at which point participants only received the original WIC vouchers. Thereafter, data was collected via telephone interviews at two points (1<sup>st</sup> week and 4<sup>th</sup> week) after introduction of the new WIC package.

With reference to the three survey interviews (Appendix C) described above, the baseline survey contained 48 questions regarding prior involvement in the WIC Farmers' Market Program, mother's and child's demographic information, mother's and child's consumption of specific foods and beverages, nutrition knowledge, access to fruits and vegetables, motivation for eating fruits and vegetables, and family incomes.

The one-week follow-up survey contained 29 questions including the similar food and beverage consumption questions as the baseline survey. Supplementary questions were asked concerning foods purchased with the new WIC vouchers, WIC education received on the last WIC visit, and knowledge of WIC services.

The four-week follow-up survey contained 30 questions again including the same food and beverage consumption questions as the baseline and one-week follow-up surveys and the same questions as the baseline survey regarding nutrition knowledge and access to fruits and vegetables. This question also included questions that asked children's whole grain consumption. Supplementary questions were asked in the four-week follow-up survey regarding the perceived benefits of WIC services. For the purpose of this analysis, only changes in whole grain intake will be taken into consideration.

### **3.3.0 This Study**

Data from this study is used for the secondary analysis of data collected during the Phase II Emory WIC Study conducted in 2009. Details of this secondary study are provided within section 3.3.7 below.

#### **3.3.1 Population and Sampling**

The population considered in this study that which was considered in the primary study in section 3.2.1 above. The population therefore includes all women that were attending WIC clinics at Fulton Adamsville or Dekalb clinics and a child aged between one, and less than five years over a period of 4 weeks.

#### **3.3.2 Methodology of This Study**

The sample of this secondary study includes all children recruited through the primary study as highlighted in section 3.2.2 above.

### **3.3.3 Exposure Variable**

The primary exposure variables for this study are the WIC Voucher package which is coded as a dichotomous variable (old or new WIC voucher package). The old WIC food voucher was provided at baseline and the new voucher packages were provided during the consequent 1 week and 4 weeks' survey

### **3.3.5 Outcome Variable**

The main outcome variable was the child's mean consumption of whole grain from baseline to 1 week and 4-week consumption of whole grain.

### **3.3.6 Variables**

All data used in this study is provided in the Table 2 appendix A. This table provides a list of all variables that have been used for this secondary study presenting the aspects of the data that is used.

### **3.3.7 Data Analysis**

The data analysis was started by conducting data cleaning which included data exploration. The data exploration was begun by firstly conducting a Univariate analysis which consisted of exploring the data for normality for continuous data and providing summary statistics for numerical categorical data. Graphical presentation of numerical continuous data was conducted by using histograms and box-plots. Tables were used to present summary statistics such as mean and standard deviation for normally distributed data and median and ranges for non-normally distributed data.

Finally, other pictorial graphs such as pie charts were used to demonstrate categorical variables.

Once the Univariate analysis was conducted, simple bivariate analysis was conducted in order to determine any associations between the exposure/risk factors (i.e. Old and New WIC Emory Voucher package) and response variables (i.e. whole grain consumption patterns). This analysis was followed by conducting a paired-test in order to determine if there is a statistically significant increase in whole grain consumption between:

- a. Baseline and 1 week
- b. Baseline and 4 week

The above paired-t testing was conducted without taking confounding into consideration. Given this limitation of not taking into account possible confounding, the secondary study used the General Estimating Equation (GEE) approach to model the change in whole grain consumption over time (from baseline to 4 week). The advantage of using this method was that the intervening variables between the

exposure and the response variable such as confounders were taken into account. Furthermore, this method also allowed us to take into account the dependency between the repeated measurements of the outcome in the same subject at different points in time (baseline, 1 week and 4 week points). Other advantages of using this method was that it provided a better statistical power compared separate analyse at each point in time considering that the sample size is relatively small. Given that the period under observation was count variable (i.e. number of weeks), the GEE model was conducted using a negative binomial distribution [37, 38]

Data was analysed using STATA version 12. [38] A dummy table is shown in appendix A.

## **Instruments**

Three questionnaires were used during the WIC study to measure the impact of the new WIC program. This consisted of a baseline questionnaire, another questionnaire was administered after 1 week and a final one was administered at 4 weeks' period.

### **4.1.0 Ethics and Communication**

The WIC Emory study gained approval from Institutional Review Board (IRB) to conduct gained ethical approval. This study is a re-analysis of data deriving from a larger study, therefore further ethical approval was obtained from University of Cape Town. I will not be reporting back to the participants who have previously received reports on the study. However, I will report back the final study findings to local health services by supplying the report to district health managers.

#### **4.1.1 Human Subjects recruitment and characteristics**

Being a secondary analysis of data, this study will not be recruiting any respondents other than the original 77 women used in the primary study (Emory WIC Study).

#### **4.1.2 Informed consent**

Participation was based on full informed consent. A consent form was signed by all survey respondents before any of the questions were posed, and after their rights had been explained to them in English. This study therefore is a secondary analysis of the IRB approved study.

#### **4.1.3 Privacy of Respondents**

Data was collected using the WIC participants name and a WIC ID name during the data collection and follow points. However, during data entry, only the WIC ID was used during aggregation and analysis of the WIC Emory Study in order to ensure that participants were not identifiable during results generation of the WIC Emory Study.

#### **4.1.4 Potential Risks and benefits to individuals**

Since this study forms a secondary analysis of data, there was no interaction with human subjects and therefore this study has reduced potential risks to individuals.

#### **4.1.5 Potential benefits of the proposed research of subjects and others**

It is anticipated that the study subjects will only benefit from this study indirectly through increased information about the WIC intervention. Furthermore, the information gathered from this study will contribute to knowledge of local staff of the WIC programme and inform fellow researchers as they conduct future studies.

#### **4.1.6 Importance of the knowledge to be gained**

Since there is almost no risk involved in participating in the study, the benefits to the individual participants, and the knowledge gained for the greater good far outweigh the potential risks.

In fulfilment of ethical obligation to make publicly available the results of scientific research, especially when human subjects are involved, through indirectly, the findings of this analysis will be made available to the Health Sciences Library of University of Cape Town and Emory University. Furthermore, the results of this analysis will be sent for publication in a peer-reviewed scientific journal in the field of Epidemiology and public health.

#### **4.1.7 Stakeholders**

Stakeholders include: participants, their families and communities of the study, policy-makers, RSPH, CDC, Whole grain farmers, U.S Department of Agriculture and other researchers in the field.

### **5.1.0 Logistics and Budget**

The following section provides the time frame for this study and budget considerations

#### **5.1.1 Time Frame**

The analyses of this study will be conducted during the month of November and December, 2012. Table below provides detailed activities by time.

Month	Activity
<b>January</b>	3 <sup>rd</sup> Week: Submit Draft Protocol to supervisor 4 <sup>th</sup> Week: Apply for UCT Ethical Approval
<b>February</b>	1 <sup>st</sup> Week: Commence drafting of Literature Review 3 <sup>rd</sup> Week: Commence data analysis
<b>March</b>	1 <sup>st</sup> Week: Continue data analysis 2 <sup>nd</sup> Week: Commence drafting of results and drafting of manuscript
<b>April</b>	1 <sup>st</sup> Week: Complete 1 <sup>st</sup> Draft mini-dissertation 2 <sup>nd</sup> Week Submit 1 <sup>st</sup> Draft of manuscript
<b>May</b>	1 <sup>st</sup> Week: Submit Final mini-dissertation

### 5.1.2 Budget

Given that this study is a secondary analysis, it is anticipated that there are minor costs limited to printing and the author's time commitment. The proposed budget is provided in table

**Table 2: Financial Budget for Study**

No.	Description/Item	Quantity	Unit Cost (ZAR)	Total (ZAR)
1.	Printing of Protocol	1	100	100
2.	Printing of Study Finding and Results	2	500	1000
<b>Total</b>				<b>1100</b>

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## Appendices

**Appendix A: Dummy Table for GEE**

GEE population-averaged model					Number of Obs =
Group and time vars					Number of groups =
Link:					Obs per group: .min =
Family					.avg =
Correlation:					.max=
Scale parameter:					Wald Chi2(5) =
					Prob > chi2 =
Score	Coef.	Std. Err.	z	p-values	[95% Confidence Intervals]

**Appendix B: Questionnaires**

University of Cape Town

# The Impact of new Women Infant Children (WIC) package on whole grain consumption of participating children in metro-Atlanta, Georgia

A Literature Review

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# Abbreviations

BMI	Body Mass Index
CDC	Center for Disease Control and Prevention
CHD	Coronary Heart Disease
CVD	Cardiovascular Disease
FDA	Food and Drug Administration
FMSNP	Farmers Market Supplement Nutrition Program
GEE	Generalised Estimation Equation
MPH	Masters of Public Health
NHANES	National Health and Nutrition Examination Survey
RSPH	Rollins School of Public Health
SES	Socio-Economic Status
UCT	University of Cape Town
USA	United States of America
USDA	United States Department of Agriculture
WGC	Whole Grain Council
WGF	Whole Grain Food
WIC	Supplemental Nutrition Programme for Women, Infants and Children

## **Introduction**

Data continue to accumulate that support daily consumption of whole grain foods for health promotion and reduction of chronic disease in adults and children (Delvin et al, 2013; O'Neil, 2010; Keast et al, 2011). Many families in the U.S. do not consume recommended amount of WG and therefore as a response to this nutritional risk, the federal government introduced the new Women Infant Children (WIC) program. The WIC is aimed at improving women's, infant's and children's health status in order to reduce infant mortality, premature births and low birth weight and assist in the general development of children (DHS, 2014).

This is a literature review on the impact of the new Women Infant Children (WIC) package on whole grain consumption of participating children in Metro-Atlanta, Georgia.

## **Objective of Literature Review**

The objective of this literature review is to provide evidence that shows the importance of the use of whole-grain foods among participating children in the WIC supplementary program. In addition, this literature review will attempt to provide a conceptual framework that may be used to predict consumption patterns among WIC families with a particular focus on participating children. Building off this conceptual framework, this literature review will provide information on the policy environment that may have influenced the consumption of whole-grain foods in the U.S. Given these policies, the literature review will also offer possible predictors that ultimately affect the consumption of whole-grain foods among children.

## **Methodology**

This literature review considered original research articles published in English between January, 1999 and September 2014. The following key words were used in the search of literature: Whole-grain food, WIC, health benefits and children.

PubMed, Medline, BioMed, JSTOR and Google Scholar were used to identify relevant papers. Reference lists of identified literature were searched to identify more articles. In addition to studies published in peer reviewed journals, this literature review includes working papers, USDA,

commentaries and dissertations/thesis from different geographic regions and population groups related to this study and mainly from the United States.

## **Scope and Limitations**

This literature review attempts to synthesis evidence on whole grain consumption and the benefits among children in the U.S. Firstly, the review aims at providing the benefits of whole-grain consumption through epidemiological evidence.

The limitations of the reviewed studies by nature of being studies on food consumption, results are usually self-reported by participants. This may therefore introduce a recall bias because people in most interviews are required to remember their consumption. Another limitation in this review is that most of the studies showing benefits of whole-grain consumption are mainly among adults and thus making it difficult to extrapolate the same impact on children (O'Neil, 2010).

## **Definition of Terms**

The American Association of Cereal Chemists define whole grain foods as “consisting of intact, ground crushed or flaked caryopsis, whole principle anatomical components- the starchy endosperm, germ and barn- are present in the same relative proportions as they exist in the caryosis. Whole grains are rich in phytonutrients containing vitamins and minerals, “unsaturated fatty acids, tocotrienols, tocopherols, insoluble fiber, phytosterols, stanols, sphingolipids, phytates, lignans, and antioxidants such as phenolic acids” (Jones et al, 2002). Despite this definition, there still continues to be challenges in defining whole grain as various studies have used different definitions (Thane et al, 2005). O'Neil (2010) explains that while several epidemiological studies have used the definition of whole-grain foods as those containing 25 percent or more whole grain or bran weight as recommended by Jacobs and colleagues; others have defined whole grain intake by determining the whole grain content according to dry weight grain ingredients in contrast to the latter where amount of whole grains may vary considerably (O'Neil et al, 2010). In spite of the numerous debates on the definition of whole grain used to predict health outcomes and content, Devlin and colleagues (2013) state that there are few

official government regulations which provide guidance on how much of whole grain must be in a product to be considered as a whole grain product.

In 2005, the Dietary Guidelines of America advised to consume three or more ounces-equivalent of whole grain products per day, with the rest of the recommended grains obtained from enriched or whole grain products (Reedy et al, 2010; O'Neil, 2010; US Dietary Guideline, 2011). In 2010, the Healthy Americans recommended that children 2 years and older must receive a daily intake of about 6 servings of which 3 must be whole grain servings (Harnack et al, 2003; Jones et al 2005; Keast et al 2011).

### **Women, Infant and Children (WIC) Program**

According to the Department of Agriculture, the WIC programme is considered as a special supplementary nutrition programme for women, infants and children which seeks to promote the health of women who are pregnant, postpartum and lactating and children up to the age of 5 years (U.S., 2010). In addition, the WIC programme is aimed at providing services to women and children at “nutritional risk”. This risk in women may be as a result of a cascade of medical conditions such as anaemia, underweight, overweight, history of pregnancy complication or poor pregnancy outcomes. Women and children with such risks are provided with services that include; supplementary diets, nutrition and educational counselling, screening and referral to other health, welfare and social services (Ibid, 2010).

The WIC programme was first piloted in 1972 and later permanently adopted and administered by the Food and Nutrition Services of the U.S Department of Agriculture. Since its inception, the WIC programme has grown to service all 50 States and other areas such as the 34 Indian Tribal Organisations and the District of Columbia. Today, women receive food vouchers that are accepted by numerous states and local organisations. There is a total of 46,000 merchants nationwide accept such vouchers (U.S., 2010).

Similar to the WIC program, is the Farmer’s Market Supplement Nutrition (FMSN) Programme which was implemented in 1993 to increase the consumption of fresh, locally grown produce among low income women and children who were recipients of the Special Supplement Nutrition

Programme for Women, Infants and Children (Ibid, 2010). In 2009, the national WIC programme was revised in order to be aligned with the 2005 Infants feeding practices guidelines of the American Academy of Paediatrics. With these revisions implemented in October 2009, WIC participants would experience an increase in consumption of essential foods including whole grain foods. The revised WIC programme and the Farmer's Market Supplement Nutrition Programme combined would ensure increased consumption of fresh and locally grown produce among low income women and their children. In December 2007, the USDA circulated fresh regulations for the WIC supplement feeding program. Whole grains for the first time became part of the food package subsidized by the U.S government (U.S, 2010).

Despite this inclusion of whole grains on the WIC program, there are specific foodstuffs that can be purchased with the WIC vouchers in accordance with state regulations. Nonetheless, federal rules specify which whole grains are eligible for consideration. The whole grain eligible for consideration include: 100 percent whole wheat breads that meet FDA standard; whole grain breads with whole grain as the first ingredient; breakfast cereal where the first ingredient is a whole grain and also meet requirements for iron and for limited sugar; brown rice, bulgur, oats and whole grain barley with no added fats or oils; and wheat or soft corn tortillas where first ingredient is whole wheat or corn (Whole Grain Council, 2013).

### **Whole grain consumption in the U.S**

Despite several policies that have been passed in the U.S. aimed at the promotion of whole grain consumption including the Health People Report 2010 drafted by the U.S. government in recognition of epidemiological evidence suggesting the protective effect of whole grains to chronic disease such as CHD, Cancer and type 2 Diabetes. (Julie M. Jone et al, 2002 ; Holman et al, 2011 ; Keast et al, 2011). Whole grain consumption in the U.S. continues to lag behind recommended levels of three daily servings of whole grain among adults and 2 to 3 servings or more among children as some studies show that 40 percent of Americans do not eat whole grains at all (Devlin et al, 2013; Kellie Chase, 1999; Whole Grain Council, 2013). A survey conducted by Cleveland and colleagues found that American adults consumed an average of 6.7 servings of grain products per day with only 1.0 serving was from whole grain (Cleveland et al, 2000). The

Dietary Guidelines for USA (2011) draws our attention to the fact that providing three servings in younger children to achieve recommended intake may be difficult to accomplish (Dietary Guidelines for USA, 2011). In proving this point, Devlin (2013) states that despite dietary recommendations, consumption of WG remains low in the U.S. at 11 g and 9.8g in children and teenagers respectively. Devlin et al, (2013) and Keast (2011) support this claim through analysis of the National Health and Examination Survey (NHANES) pointing out that approximately (less than or equal) 1% of children aged 9 to 18 years were consuming recommended amounts of whole grain foods (Keast et al, 2011). Therefore, a programme like the WIC programme are very important in increasing consumption of WG among women, infants and children in the US (Jone et al, 2005; Holman et al, 2011; Brownless et al, 2013).

### **Effect of the WIC revisions on Whole Grain purchases and consumption among WIC Participants**

The central theme of this section aims to assess the impact of the 2009 WIC revisions on participants' food purchases and consumption. Since 1972 when the first pilot of the WIC program was conducted, the 2009 revisions remain the most significant revisions to have ever existed addressing the WIC food package (U.S., 2010; Oliveria et al, 2015). Several studies have analysed the impact of the 2009 WIC revisions on food purchases and consumption including that of whole grain foods.

Historically, the 2009 WIC revisions came about after an evaluation of the WIC food package commissioned by the USDA in 2003. Recommendations from this evaluation were first released in 2005 and requested to be placed in effect by October, 2009 by all WIC state agencies. These recommendations resulted in the introduction a wider variety of foods to the WIC food package including whole grains (Ibid).

**Whole grain purchases:** In discussing the impact of the revised WIC program on whole grain food purchases, Andreyeva and Luedicke (2013) demonstrated it through a number of studies tracking grocery store purchases using a pre and post design after implementation of revised 2009 WIC

package. These studies conducted using scanned data from over 60 stores in Connecticut and Massachusetts found that the revised WIC package increased the amount of purchases for several WIC products including whole grains (bread and brown rice) (Andreyeva et al, 2013). Additionally, these studies showed that the WIC revisions lead to an increase in whole grain bread purchases from the previous white bread dominated purchases, and increases in brown rice purchases from white rice (Ibid, 2013). Ultimately, the 2009 revised WIC package lead to increases in whole grain foods.

**Whole grain consumption:** Several studies have been able to show the impact of the revised 2009 WIC programme on whole grain consumption. Among these studies was a secondary analysis of the WIC National Food and Nutrition Survey (NATFAN) which examined reported consumption of whole-grain foods and milk (Spaulding et al, 2014). Spaulding et el (2014) found that there was a lower intake of whole grain foods after the introduction of the revised WIC program (Ibid, 2014). Conversely, Whaley et al (2012) found a significant increase in whole grain consumption after the introduction of the 2009 revised WIC programme through pre and post telephone surveys of randomly sampled of WIC participants (Whaley et al, 2012). Similarly, Ishdorj et al (2013) stated that there was an observed an increase in consumption of whole grain bread and for white bread

In conclusion, the above literature suggests that the revised WIC package had a positive impact on both whole grain consumption and whole grain purchases since its adoption in 2009.

### **Health Benefits of whole grain nutrition**

This section aims at providing information on how the consumption of whole grain is associated with reduced risk of CVD, diabetes type II, obesity and certain cancers such as colorectal (Devlin et al, 2013; Holman et al, 2011; O'Neil et al, 2010; Lutsey, 2007; Ye, 2012). Several findings suggest that whole grain consumption as an intervention provides improvements in health or ultimately reducing disease onset (Brownlee et al, 2013).

However, despite the well documented benefits of whole grain Rampersaud and colleagues argue that the mechanisms of the beneficial effects of whole grain are not clear and suggest that

components of whole grains may work alone or synergistically to provide health benefits (Rampersaud et al, 2005).

In pointing out components of whole grain that maybe beneficial to health, Rampersaud states that whole grain is a good source of calcium. Its intake is critical for the nutrition of both children and adolescents because bone calcium accretion is the highest during adolescence. (O'Neil et al, 2010; Ibid, 2005). O'Neil and colleagues further outline that intake of whole grain consumption is associated with increased intake of macro and micronutrients such as fibrem magnesium, vitamin E and potassium (O'Neil et al, 2010). O'Neil (2010) further draws our attention to the theory that magnesium as a micronutritate found in whole grain is essential for the reduced risk to type 2 diabetes (O'Neil et al, 2010). He also states that one study conducted found that magnesium deficiency is associated with insulin resistance in obese children (O'Neil et al, 2010). Together these studies provide important insights into some benefits of consuming whole grain among children based on the nutritional components.

The literature below provides evidence of the benefits of whole grain consumption for specific conditions that include health diseases, diabetes type 2 and child obesity.

**Chronic Heart Disease:** Studies have shown that whole grain food protects from numerous disease including chronic diseases and other life style conditions like hypertension and diabetes. In the case of CHD, possible explanation of how whole grain protect against CHDs can be explained from the biological make up of grains. Once consumed, the no cholesterol, low fat and high levels of dietary levels of fibre, protein, vitamins and minerals account for protective factors that reduce the risk of CHD. (Rajasree et al, 2007; Jones et al, 2002; Chase et al, 1999).

Overall, there seems to be some evidence to indicate that there is an association between higher intake of whole grain foods and lower risk to cardiovascular diseases (Young et al, 2012; Keast et al, 2011; Devlin et al, 2013). Young and colleagues further demonstrate that whole grains contain various bioactive components, such as dietary fibre, phytoestrogens, minerals, antioxidants, vitamin E, and folate which may act synergistically to reduce risk of chronic disease.

Unfortunately to date there are still few studies that are focused on assessing reduced risk in children based on their increased consumption of whole grains. However, a plausible argument is that whole grain consumption reduces the risk of experiencing child obesity, a factor that may contribute to placing children at immediate and/or future risk of experiencing a heart attack (Young et al, 2010).

**Childhood Obesity:** In the 21<sup>st</sup> Century childhood obesity remains to be one of the most serious public health challenges (WHO, 2014). It is further suggested that children that are overweight are more likely to be obese in their adulthood (Ibid, 999). A number of studies have found that overweight children are likely to develop other chronic diseases such as diabetes and cardiovascular diseases at tender age also associated with greater chance of premature death and disability (Bradlee et al, 2009, Young et al, 2012, Gahagan et al, 2004).

What we know is that being overweight or obese can be defined as the "abnormal or excessive fat accumulation that may impair health" (WHO, 2014). The Centers for Disease Control and Prevention growth charts for United States define overweight "as at or above 95<sup>th</sup> percentile of body mass index". BMI is calculated as weight in kilograms divided by the square of height in meters for age (Ogden et al, 2002; De Onis et al, 2010). The World Health Organization defines overweight as a BMI equal to or more than 25, and obesity as a BMI equal to or more than 30 (De Onis et al, 2010).

In 2002, Ogden and colleagues estimated that prevalence of overweight (BMI for age  $\geq$  95<sup>th</sup> percentile) for children 2 to 5 years of age was 10 percent (Ogden et al, 2002). Ten years later, Wen and colleagues (2012) reported that there was a decrease in obesity among American children. For instance, in 2003-2004 obesity prevalence among children aged 2 to 5 years was 13.9 percent, 11.0% in 2005–2006, and 10.4% in 2007–2008 according to the NHANES data. This reviews that there has been an overall reduction in obesity among American children (Wen et al, 2012).

Despite several researches showing that the overweight is due to a mismatch stuck between dietary intake and energy expenditure, there still remains uncertainly as to what leads to this

imbalance (Reedy et al, 2010). Given the fact that it's difficult to measure this mismatch, most studies have forced on the relationship between foods including whole grain and obesity (Ogden et al, 2002; Young et al, 2012; Reedy et al, 2010; Rampersaud et al, 2012; Zanovec, 2010). Young (2012) showed that among adolescents there is an inverse relationship between whole grain intake and obesity. He explains that the consumption of fibre contained in whole grain may suppress appetite and ultimately reducing energy intake enhancing a state of sated (Young et al, 2012).

Several studies have revealed that obesity leads to major health problems that ultimately pose a risk of premature illness and mortality among children (Ebbeling et al, 2002). These premature illnesses include type 2 diabetes, CVD and several cancers (Diabetes Care, 2002; Dietary Guidelines for the USA, 2011; Ogden et al, 2002).

Children's social and physical environments tend to affect children's risk of obesity. These are also affected by children's choices, diet and physical activity. Wen and colleagues argues that obesity is more preventable among children as their behaviours are highly dependent or influenced by parents and family environments (Wen et al, 2012; Kranz, 2009).

**Diabetes:** There is a consensus among social scientists that the prevalence of type 2 diabetes among child, adolescents and adults has been on the increase in juxtaposition to the increasing prevalence of obesity (Murtaugh et al, 2003). While many risk factors for type 2 diabetes are non-modifiable such as genetic history, age and ethnicity, there are modifiable factors including obesity and a sedentary lifestyle. Therefore changes in these modifiable factors would result in reduced risk of type 2 diabetes (Ibid, 2003). For this reason there has been the promotion of whole grain in order to reduce the incidence of diabetes as it associated with lower fasting insulin concentration (Jones et al, 2002; Young et al, 2012). Data from several longitudinal and cross-sectional studies conducted in adults have shown that increased consumption of whole-grain is associated with reduced risk of diabetes incidence (Young et al, 2012; Murtaugh et al, 2003; American Diabetes Association, 2002).

Murtaugh et al. (2003) review of literature showed that the risk for incidence of type 2 diabetes was 21-27 percent lower for those that consumed high amounts whole grain in comparison to

those that consumed low amounts. Murtaugh has further provided a complete synthesis of the impact of whole grain consumption on incidence of diabetes by reviewing both prospective studies and clinical trials on the matter. Together the reviewed studies provide relatively consistent evidence of the protective effect of whole grain and/or cereal fibre (Murtaugh et al, 2003).

Surprisingly, a cross-sectional study measuring association between whole-grain intake and weight status and chronic disease found inconsistent relationship between risk factors; for type 2 diabetes which included fasting insulin and C-peptide levels in boys compared to their female counterparts (Young et al, 2012).

**Other diseases:** Other studies have shown that the consumption of whole grain is not only protective for conditions such as type II diabetes, cardiac heart disease and obesity which in itself are modifying factor. It may also prevent other conditions such as cancers (Holman et al; 2011, Brownlee, 2013)

### **Predictors for Whole Grain consumption**

In recognition of low consumption of whole grain among Americans, it would be important to understand what predictors affect one's consumption patterns. Understanding predictors to whole grain consumption provides an opportunity for meaningful intervention in a country such as the U.S. whereas demonstrated above WG consumption is low.

Evidence shows that there are several reasons that influence people's dietary behaviour which can be classified into their physical and social environment: individuals, interpersonal, community, and society levels (Holman et al, 2011). Therefore, improving dietary behaviour poses many challenges among children and adolescents as they are highly dependent physically and socially. Below is an attempt to highlight some reasons that may have affected low consumption of whole grain.

**Price:** Several studies suggest that consumption of whole grain is affected by costs of the product (Andreyeva et al, 2010; Chase et al, 1999). As earlier noticed there is lower consumption of whole grain among low-income families as it is influenced by high prices of whole grain. Chase et al

(1999) further argues that disparities in actual vs recommended consumption of productive foods such as whole grain are more evident in low-income and minority American compared to wealthier ones given the disparity in chronic diseases.

Therefore, price of whole-grain products is an important factor in predicting the amount consumed among vulnerable populations. In a study of 70 African American women aimed at determining factors that influenced whole grain consumption with particular focus on bread and cereals, it was found that most women viewed cost as a barrier to whole grain consumption as opposed to non-whole grain products. This is in the face of supermarket scanner data that showed that prices are higher for whole grain than non-whole grain products. (Chase et al, 1999). Therefore, the majority of low-income households in the U.S. are likely to purchase non-whole grain bread. This is because price changes have a direct impact on food demand. It is for this reason that public health initiatives that are attempting to increase people's intake of whole grain must target price-induced shifts aimed at influencing behaviour toward whole grain consumption. One good example of using changes in price in order to affect health behaviour is the relatively small scale, cost neutral approaches nutrition include the Special Supplementary Nutrition Programme for Women, Infants and Children (WIC) food package targeted at vulnerable populations (Andreyeva et al, 2010, Keast et al, 2011). However, it must be noted that these price changes are more important for low-income populations than the general populations.

**Availability:** Chase and colleagues (1999) further states that in addition to cost of whole grain, its unavailability tends to also be a key barrier to its consumption (Chase et al, 1999). Young and colleagues in 2012 analysed cross-sectional data from the National Health and Nutrition Examination Survey, 1999-2004 and discusses that whole grain options are less frequently provided for children even during school meals (Young et al, 2012).

In addition, several studies explain that a positive relationship exists between the availability of healthy options in a neighbourhood grocery store such as whole grain foods and the food that is found in the homes (Cheadles et al, 1991; Morland et al, 2002).

Limited availability of whole grain products is another factor that affects its consumption among vulnerable populations (Young, et al; 2012).

**Education:** In addition to the above structure issues is that of public education about the benefit of whole grain consumption. Price alteration solely does not impact the change in behaviour but there is also the need for the public to be educated about the benefits of whole grain consumption (Chase et al, 1999). Without education, consumers may lack the ability to purchase whole grain foods, understand the health benefits and prepare and integrate whole grain foods into their daily dietary patterns (Marquart et al, 2006). There is a large volume of published studies showing that knowledge on whole grain consumption is lower among low-income populations who in turn have lower consumption patterns compared to the general population (Keast et al, 2011; Nicklas, 2013).

**Acceptability:** A considerable amount of literature has been published on acceptability of whole grain foods especially among children. These studies show that acceptability is affected by various factors that include taste, texture, family preferences and ignorance of knowing what constitutes whole grain products (Chase et al, 2003; Jones et al 2002; O'Neil, 2010, Chu et al, 2011; Nicklas, 2013).

Among the above reasons taste alone has the ability to solely enhance the consumers' desirability of whole grain foods. This factor is more pronounced in the case of children who are greatly affected by the tastiness of food which also inevitably affects the amount they consume (O'Neil, 2010)

Children generally prefer to consume products that are sweet or taste in a particular way. For this reason, Keast and colleagues argue that "changing children's whole grain consumption patterns is gradual involving the substitution of whole-grain for refined ingredients of foods that are widely consumed by members of this age group" (Keast et al, 2011).

Accessibility of WGFs is also an important factor that contributes to its consumption. Often time accessibility of WGFs is affected by the preferences of children because of the actual tastes of

WGFs. Not many studies have investigated children's preference of WGFs in blends such as blend whole grain flour and whole grain flours.

## Conceptual Framework

In an attempt to determine the relationship between that factors that influence or predict the consumption of whole grain food to that of actual consumption patterns. This literature review draws from the socio-ecological framework to demonstrate the possible conceptual framework or mechanism that determines consumption of whole grain among children. This will in turn assist to identify variables that will be important for analysis and clarify relationships between these variables as they relate to the research problem.

The socio-ecological framework model provides broader perspective to understanding a public health problem given their complexity (Robinson et al, 2010). This framework assumes that health behaviour and health outcome are a sum of an interaction of multiple levels which include intra- and interpersonal factors, community and organizational factors (or institutional), and public policies (Ibid, 2010; Holman et al, 2011).

The goal of is conceptual framework would be to increase whole grain consumption among children in order to attain the aforementioned health benefits. Therefore, increasing whole grain consumption among children requires understanding factors that influence the demand for whole grain. This literature review outlines a four level social-ecological model which considers the interplay between societal factors, community, relationships and the individual and their role in influencing whole grain consumption (Robinson, 2010).

**Individual Level:** Robinson et al (2010) explains that interpersonal individual characteristics such as knowledge, attitudes, beliefs and personality affects one's demand for consumption of food.

**Relationships:** In addition, he further discusses that individuals are influenced by interpersonal processes which relate to interactions with family and friends that provide social identity, support and role definition. In the case of this study, mothers are the principle influencers of children's behaviour (Robinson et al, 2010; Burgess-Champoux et al, 2007). This level examines how relationships may increase the consumption of whole grain among children. Contrary to this

point, Jone et al (2005) argues that sometimes children may also influence household purchases of whole grain based on the fact they may deny certain foods based on taste. Therefore, children have a role to play in influencing household food purchases.

Some of the factors that influence the mothers and their influence on the child are age, education, income, and other history factors substance use, or history of abuse. Therefore, strategies that would affect whole grain consumption at this level can include promoting attitudes, and behaviour that ultimately can increase whole grain consumption (Robinson, 2010; Sweitzer, 2010).

**Community Level:** Another level within the conceptual framework is that of community level which investigates social relationships as they occur in places such as schools and neighbourhoods. This level addresses social networks and norms which may exist as formal or informal as they ultimately affect health behaviour and health outcomes (O’Neil et al, 2010; Keast et al; 2011, Bruening et al, 2012; Larson, 2010; Roth-Yousey, 2009).

**Societal level:** The other level that affects children's consumption of whole grain is that of broad societal factors which either can increase or reduce whole grain consumption. These are factors such as health policies, education, social policies including physical environments (factors that may affect food access and availability) (Robinson, 2010).

## Conclusion

Whole grain consumption remains very low among many American families despite evidence of the numerous health benefits. These health benefits include reduced risk to CVD, type 2 diabetes, obesity and onset of certain cancers in both adults and children. In the presence of strong policy environment that encourages whole grain consumption; low consumption continues to prevail on grounds of availability, accessibility and affordability of whole grain. Addressing this low consumption requires holistic public health and non-public health interventions that address the core reasons for low consumption. In the case of children, there is also the need to promote

health education among mothers and persons that take care of children. Nonetheless, health education alone is not enough to increase consumption of whole grain. This should be accompanied by policies that address accessibility issues such as price of whole grain.

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**Title:**

Impact of the new Women, Infants and Children package on whole grain consumption of participating children in metro-Atlanta, Georgia.

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## **Abstract**

**Objective:** To investigate the impact of the new Women Infant and Children (WIC) package on whole grain consumption among WIC participating children. In addition, this study aimed to investigate how knowledge on whole grain consumption and/or perceptions of cost of whole grain influences its consumption.

**Methods:** Secondary analysis using data from the Emory WIC study investigating the impact of the new WIC programme on fruit and vegetable, and whole grain consumption among participating women (n=77) in October 2009. The primary study collected data through face-to-face interviews at baseline (before receiving whole grain vouchers) followed by telephone interviews at week 1 and week 4 (after receiving whole grain vouchers). Whole grain consumption was measured using the number of servings per week. In addition, association among variables was analysed using linear regression adjusting for mother's education and type of childcare.

**Results:** Mothers with higher level of education, and with children attending day care, Head Start and/or pre-K/School, had children who were more likely to consume whole grain compared to their counterparts that were less educated and with children staying home with family. Overall, there was no difference between consumption at baseline and week 1, or between baseline and week 4. Week one appears to have a significantly higher rate of consumption than week 4.

**Conclusion:** Our findings suggest that the new WIC programme didn't significantly change whole grain consumption among participating children from baseline to week 1 or baseline to week 4. Nonetheless, this study shows that whole grain consumption among children was associated level of mother's education and type of childcare.

## Introduction

An increasing amount of literature shows significant association between whole grain consumption and the reduced risk of type II diabetes, obesity and other chronic diseases in children and adults (Devlin et al, 2013; Holman et al, 2011; O'Neil et al, 2010; Lutsey, 2007; Ye, 2012). In addition, significant evidence has shown that intake of fibre contained in whole grain is associated with lower risk of type II diabetes (O'Neil, 2010). Epidemiological evidence also shows that consuming whole grains is beneficial in the management of cardiovascular diseases, which are the leading cause of death and disability in the United States. (Chase et al, 1999; Rajasree et al, 2007). In adult populations, obesity has been associated with increased risk for a number of different types of cancer. Evidence shows that obesity in general population can be reduced through the consumption of whole grain (Keast et al, 2011; Young et al, 2012; Reedy et al, 2010). Evidence consistently supports an inverse relationship between whole grain consumption and childhood obesity. It has been reported that childhood obesity has drastically increased in the latter part of the 20th century with 18.2 percent of US children aged 6 to 19 years being obese in 2009-2010. However, several studies of predominately adult populations have reported an inverse association between whole grain consumption and body mass index (BMI) in both male and females (Mckeown et al, 2009; Ma et al, 2012)

Despite of the above mentioned benefits of whole grain consumption, related evidence also shows that the majority of the American population's whole grain consumption is not consistent with recommended daily intakes, leaving them unable to benefit from its nutritional value (Devlin et al, 2013; Kellie Chase, 1999; Whole Grain Council, 2013). This evidence of low whole grain consumption has given rise to numerous health promotion programmes or dietary health

campaigns including the WIC program, a supplementary nutrition programme for women, infants and children which seeks to promote the health of women who are pregnant, postpartum and lactating and children up to the age of 5 years (DHS, 2014).

Regardless of these numerous efforts to increase overall whole grain consumption in the US, consumption has remained considerably low. These low consumption rates in the US continue despite the enormous evidence that points out the health benefit(s) of whole grain in relation to risk of heart disease related mortality, obesity, diabetes and some cancers (Delvin et al, 2013; Keast et al, 2010).

Several reasons that have been offered to predict or explain what influences one's consumption of whole grain. Some evidence shows that WGC is affected by its price, availability, one's education and acceptability of whole grain foods (Chase et al, 1999; Marquart et al, 2006; Jones et al 2002; O'Neil, 2010,). This evidence shows that one's education plays a huge role in predicting income level which is also associated with one's ability to purchase whole grain foods. In addition, one's level of education may influence understanding of the health benefits of WGC (Keast et al, 2011; Nicklas, 2013). With regard to acceptability, studies have shown that whole grain acceptability is affected by numerous factors that include taste, texture, family preferences and unfamiliarity of knowing what constitutes whole grain products (Chase et al, 2003; Jones et al 2002; O'Neil, 2010, Chu et al, 2011; Nicklas, 2013).

Setting an important precedent for whole grain consumption internationally, the U.S. government continues to promote the inclusion of whole grain foods into diets. This has resulted in over three decades of encouragement aimed at increasing whole-grain consumption in the U.S. by various governmental bodies (e.g. the Department of Agriculture's introduction of the

Food Pyramid) (Jones et al, 2002; Slavin et al, 2001). Guidelines recommend that there should be at least six to eleven servings of whole grain foods, with one serving consisting of at least one of the following; a slice of bread, an ounce of ready-to-eat cereal and/or half a cup of cooked rice, pasta or cereal (DHS, 1992). Additionally, the Dietary Guidelines for Americans provided separate recommendations for at least three servings of whole grain foods on a daily basis (USDA, 2000). Other specific initiatives such as the Supplementary nutrition programme for Women, Infants and Children introduced aimed at increasing whole grain consumption among participating families.

In 2005, the sixth edition of the Dietary Guidelines for Americans from the Department of Agriculture Food and Nutrition Services proposed that the WIC programme be revised to ensure that the national WIC programme was aligned with the 2005 Infant feeding practices guidelines of the American Academy of Paediatrics. It was expected that all state agencies would adhere to these revised guidelines by October, 2009 (U.S. Dept. of Agriculture Food and Nutrition Service, 2010).

In December 2007, the USDA circulated fresh regulations for the WIC supplement feeding program. Whole grains for the first time became part of the food package subsidized by the USDA which would ensure that participating families would receive whole grain vouchers (Ibid, 2010).

Given the above, this study aims at investigating the impact of the new WIC package on whole grain consumption among WIC participating children. It further investigates how other social-economic factors such as level of education attained by mother and type of childcare received affects whole grain consumption.

## **Methods**

This study is a secondary analysis of the Phase II Emory WIC Study, which investigated the impact of the new WIC Food Package on the WIC participant's fruit and vegetable consumption in 2009.

### **Sample Population**

The population for this study was selected from two Metro-Atlanta clinics (Fulton Adamsville and Dekalb Kirkwood WIC Clinics) that had at least one child receiving WIC vouchers between the age one and less than five. From this population, 77 women were recruited during routine visits to the WIC clinics as they received standard new WIC voucher packages.

### **Data Collection**

Data during this study was collected through three separate interviews (at baseline, week one and week four). These interviews were conducted only after receipt of informed consent from respondents. The WIC Clinic waiting rooms were used for researcher questionnaire administered interviews with each mother at baseline. During the course of the interview, each participating mother was required to provide a reliable phone number by which she could be contacted at a time of her convenience for one-week and four-week follow-up interviews. In the event that participants were unreachable by phone, email addresses were requested from participants.

At baseline, the survey investigated mother's and child's demographic information, mother's and child's consumption of specific foods and beverages, nutrition knowledge, access to fruits and vegetables, motivation for eating fruits and vegetables. It was also during this visit to the WIC clinic that participates in the study received the new WIC vouchers which included whole grain foods. During this visit, participants were also provided with reinforced nutrition messages on the new food packages including that of whole grain foods (USDA, 2011).

At week one, the survey in addition to the questions asked at baseline, investigated foods purchased with the new WIC vouchers, WIC education received on the last WIC visit, and knowledge of WIC services. Lastly, at week four the questionnaire included questions that asked about children's whole grain consumption and perceived benefits of the WIC services. In order to decrease loss to follow-up, research interviewers' left voicemail messages with a return phone numbers for those not successfully contacted. A participant was only considered lost to follow-up if they were not contacted after three attempts and had not responded to email (Stalling et al, 2012).

### **Study Variables**

The primary exposure variables for this study were the WIC Voucher packages coded as a dichotomous variable (original/old or new WIC voucher package). The old WIC food voucher was received prior to WIC clinic visit at baseline. During this baseline survey, respondents received the new WIC vouchers that included whole grain. The main outcome variable was the child's mean consumption of whole grain from baseline to 1 week and 4-week consumption of whole grain. For example, respondents at each point of interview were asked: 'In the past week, how often did your oldest child who received WIC eat whole gains?' The response options included: number of times per day, per week and never.

### **Analysis**

The analysis began by calculating the mean and standard deviation for all continuous variables. Frequency distributions were examined for each categorical variable. The amount of whole grain consumption was categorized as amount of whole grain consumed per week instead of serving of whole grain received per day. Bivariate analysis was performed between consumption at week one with relevant categorical variables. Kruskal-wallis test was used to compare if there was a

difference between baseline median consumption and categorical indicated variables. A non-parametric test was used since baseline consumption was not normally distributed. To investigate for clusters and possible outliers, analysis included conducting and examining relevant descriptive graphs such as scatter plot and box plots of baseline consumption in relation to categorical variables (i.e. race, grade, childcare and childcare restructured).

The Wilcoxon signed rank test compared child's whole grain consumption at week one and week four with baseline. Furthermore, a Friedman test was conducted to compare all three weeks (baseline, week one and week four) simultaneously.

To accommodate for possible confounding not considered during the Wilcoxon sign rank test, a repeated General Estimation Equation (GEE) model using negative binomial distribution was used to concurrently compare the individual differences from baseline of child's whole grain consumption to week one and week four (Hardin, 2005). This test was used to determine if there was a change in whole grain consumption during the duration from baseline to week four. By using the GEE, each potential covariate was individually tested for association with the outcome variable (increased whole grain consumption) by including only the potential covariate and the main outcome variable in a multivariate paired t-test model. For this model all p values less than 0.05 were considered significant. Significant covariates were tested for correlation with each other. Non-correlated significant covariates were included in the final model.

All statistical analyses were performed using STATA 12 software (STATA, 2014).

## **Results**

The mean age of the children was 30.9 months (Standard Deviation {SD} = 11.3 months. Mother's mean age was 32.3 years (SD = 9.3 years), and almost the entire population identified themselves

as being black (Table 1). The results also show that the mean number of children receiving WIC services in each household was 1.5 children (SD = 0.7 children). The mean family size in the study population is 4.6 (SD = 1.3 people). At baseline 70.1% of mothers were concerned about having enough money to eat nutritious meals in the last 12 months. Seventy-six percent (59 of the 77) women at baseline were interviewed at week 1 and week 4. In addition, at baseline the majority (63.1%) of women had their children stay home with their family.

<b>Table 1: Descriptive Statistics of the social-demographic indicators for the WIC study</b>	
<b>Age of mother years, mean (SD), median</b>	30.8 (10.4), 27
<b>Concern about having enough money to eat nutritious meals in the last 12 months n (%)</b>	
<b>Yes</b>	54 (70.1)
<b>No</b>	23 (29.9)
<b>Race n (%)</b>	
<b>Black or African American</b>	76 (98.7)
<b>Other</b>	1 (1.3)
<b>Highest school grade n (%)</b>	
<b>Grades 9 through 11 (some high school)</b>	11 (14.3)
<b>Grade 12 or GED (high school graduate)</b>	35 (45.5)
<b>College 1 to 3 years</b>	27 (35.1)
<b>Master's</b>	4 (5.2)
<b>Childcare n (%)</b>	
<b>Stay at home with family</b>	49 (63.6)
<b>Stay at home of friend or community member</b>	2 (2.6)
<b>Attends daycare or head Start</b>	16 (20.8)
<b>Attends pre-K/school</b>	9 (11.7)
<b>Don't know</b>	1 (1.3)
<b>Child's whole grain consumption at baseline (servings per week) and childcare mean (SD), median*</b>	
<b>Stay at home with family</b>	7.6 (7.3)
<b>Stay at home or friend or community member</b>	7.0 (0.0)
<b>Attends daycare or head Start</b>	4.1 (4.0)
<b>Attends pre-K/school</b>	8.2 (4.7)
<b>Child's whole grain consumption at baseline (in weeks) and mother's level of education mean (SD)</b>	
<b>Grades 9 through 11 (some high school)</b>	2.9 (2.3)
<b>Grades 12 or GED (high school graduate)</b>	8.6 (7.8)
<b>College 1-3 years (some college or tech school)</b>	6.2 (5.1)
<b>Master's</b>	5.8 (5.1)

<b>Child's whole grain consumption at baseline (in weeks) and childcare mean (SD)</b>	
<b>Stay at home with family or friends or community member</b>	7.5 (7.2)
<b>Attends daycare or head Start</b>	4.1 (4.0)
<b>Attends pre-K/school</b>	8.2 (4.7)

Children's weekly mean whole grain consumption was 6.82 servings at baseline, 6.53 servings at one week and 5.68 servings at 4 weeks. These amounts all fall below the weekly whole grain consumption servings required for children of 14 servings according to the recommended 2015 Dietary Guidelines for Americans (Table 2).

**Table 2: Whole grain consumption of oldest child receiving WIC per week at baseline, week 1 and week 4**

<b>Whole grain consumption of oldest child in weeks, n (%)</b>	<b>Baseline (n=77) n (%)</b>	<b>Week 1 (n=59) n (%)</b>	<b>Week 4 (n=59) n (%)</b>
<b>0 servings</b>	8 (10.4)	3 (5.1)	4 (6.8)
<b>1-4 servings</b>	25 (32.5)	18 (30.5)	30 (50.8)
<b>5-8 servings</b>	27 (35.1)	26 (44.1)	17 (28.8)
<b>9-12 serving</b>	1 (1.3)	2 (3.4)	0 (0.0)
<b>13-14 serving</b>	11(14.3)	7 (11.9)	7 (11.9)
<b>&gt; 14 servings</b>	5 (6.5)	3 (5.1)	1 (1.7)
<b>Total</b>	77 (100)	59 (100)	59 (100)

The final model of the GEE using a negative binomial distribution considered the impact of education of mother and childcare on a child's whole grain consumption. Mother's race was not considered because there was no variability among respondents. In the final model (Table 3) that there was no significant change in children's whole grain consumption between baseline and Weeks 1 and baseline and Week 4 ( $p=0.787$  and  $p = 0.103$ , respectively). Children who attended day care or Head Start had significantly lower whole grain consumption than those who stayed

home (IRR= 0.61, p = 0.003) despite an expected higher intake in children attending day care. Nonetheless, children who attended pre-k/school had higher whole grain consumption than those who stayed home, although the difference was not significant (IRR = 1.06, p = 0.76). In addition, level of mother’s education had an influence on the level of child’s consumption of whole grain. In Table 3, it can be seen that mothers who had gone through Grades 9 to 11 had lower child whole grain consumption compared to Grades 12 or GED (IRR = 2.31, p = 0.00) and College 1 to 3 years (IRR = 2.13, p = 0.00).

**Table 3: Modelling for association between whole grain consumption, level of education and childcare (Final model)**

	IRR	P>z	Final Model 95% CI
<b>One Week vs. Baseline</b>	1.029	0.787	0.84, 1.27
<b>Four Weeks vs. Baseline</b>	0.851	0.103	0.70, 1.03
<b>Grade: 2 vs. 1</b>	2.313	0.000	1.61, 3.33
<b>Grade: 3 vs. 1</b>	2.128	0.000	1.48, 3.05
<b>Grade: 4 vs. 1</b>	1.988	0.037	1.04, 3.79
<b>Childcare: 3 vs. 1</b>	0.606	0.003	0.43, 0.84
<b>Childcare: 4 vs. 1</b>	1.059	0.757	0.74, 1.52
<b>Constant</b>	3.598	0.000	2.66, 4.87

CI – Confidence interval

Childcare 1: Stay at home with family

Childcare 2: Stay at the home of friend or community

Childcare 3: Attends daycare or Head start

Childcare 4: Attends pre-K/school

Grade 1: Grades 9 -11 (some high school)

Grade 2: Grades 12 or GED (high school graduate)

Grade 3: College 1-3 years (some college or tech school)

Grade 4: Master’s

## Discussion

This study found that the new WIC programme didn’t significantly change whole grain consumption among participating children from baseline to week 1 or baseline to week 4. Despite

these findings, Andrayeva et al (2015) and Odoms-Young (2014) argue that the new WIC programme lead to increased whole grain consumption due to modest reductions in food prices. One anticipated finding was that level of mother's education had an impact on the child's whole grain consumption. Several studies have highlighted the association between education and whole grain consumption (Turrell et al, 2006; De Vriendt et al, 2009; Keast et al, 2011). There are several possible explanations why education is important in ensuring increased whole grain consumption. One explanation is the women with higher education have better understanding of the nutritional benefit of whole grain consumption for their children. Another possible explanation is the higher education usually translates to higher income which ultimately influences whole grain consumption (Chase et al, 1999). In the case of the WIC programme where all women are low income, level of education (i.e. primary, secondary and tertiary education) is likely to influence knowledge on benefits of whole grain which may ultimately influence its consumption (Keast et al, 2011).

Furthermore, it can be observed from the study population that the average amount of whole grain consumption was lower than recommended servings (Devlin et al, 2013; Chase, 1999). Explanations for the low whole grain consumption include the fact that mother's education which has been shown to have an impact on whole grain consumption seems to be low in the study population. Related to education is the fact that one's ability to purchase goods is affected by education levels as it predicts one's income and ultimately ability to purchase whole grain foods (Chase et al, 1999; Keast et al, 2011)

Furthermore, this study has shown a strong association between children's whole grain consumption and type of childcare. This clearly demonstrates that children who attended day care or Head Start programme represent part of the pathway through which the health knowledge of caregiver or mother exerts its influence on whole grain consumption. This in the case of Head Start programme meets one of its aims of addressing children's health needs as they prepare for school entry (Barnett et al, 2004; Nelson et al, 2006).

Therefore, this study highlights that factors such level of education of mother and type of childcare provided are very important in influencing the amount of whole grain consumed by the child. These findings remain consistent with a majority of epidemiological evidence pointing to the association between social-economic factors such as education and whole grain consumption (Chase et al, 1999; Marquart et al, 2006; Keast et al, 2011; Nicklas, 2013).

Furthermore, the findings of this study remain highly relevant for developers of health promotion policy, as they show that participants whose children had attended childcare or Head Start programme were more likely to consumption higher amounts of whole grain. Therefore, this further shades light on the effectiveness of programmes such as Head Start on health outcomes of participating children (Barnett et al, 2004).

### **Study Limitations**

However, there are a number of limitations that need to be considered. For instance, this study has a small sample size (n=77) which makes it difficult to extrapolate the findings to the entire WIC programme participating children and/or influencing factors inherent of participating mothers. In addition to the small size being small (n =77), another limitation to this study maybe the small high attrition rate (n=77 to n=59) which may introduce a bias that affects the validity of

the inferences drawn from the study as well as reducing our ability to detect differences between timepoints. Another limitation of this study is that of the short follow up period (4 weeks) which may ultimately miss capturing overall change in dietary behaviour toward whole grain consumption in the study population. In addition to the above, is the possible recall bias that could have occurred as participants had to remember how much whole grain was consumed by their children. Lastly, lack of great variability in sample may affect the representativeness and the generalization of the results beyond the Metro-Atlanta population.

### **Recommendations**

Future studies on the current topic should ensure that they have a larger sample size. This increased sample size must also ensure that sample population has greater race variability to better understand its influence on whole grain consumption or possible influence on that of that of the participating child. Additional research should also include all children in the family rather than just the oldest child. This is because certain children based on age may change or exhibit differences in acceptance to whole grain foods based on various factors including taste (O'Neil, 2010). Furthermore, there is a need to ensure that all women that participate in the WIC programme have adequate information on the benefits of whole grain foods as this would in turn increase the amount consumed by their children.

### **Conclusion**

Whole grain consumption among children is well associated with social-economic differences among mothers or caregivers. Evidence gathered in this analysis shows that level of education of mother and type of childcare plays a significant role in influencing whole grain consumption despite all children receiving WIC services. Education alone has the ability to increase one's

dietary knowledge and/or ability to purchase healthy foods. However, this study shows that the new WIC programme did not have an influence on whole grain consumption among participating children.

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