ASSESSING THE REVISED SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS, AND CHILDREN (WIC) FOOD PACKAGES BY SURVEYING NATIVE AMERICAN WIC PARTICIPANTS AND ADMINISTERING A METABOLIC, DIETARY STUDY OF THE REVISED AND ORIGINAL WIC FOOD PACKAGES

A Dissertation

by

RACHEL CONDIE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2011

Major Subject: Nutrition

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ABSTRACT

Assessing the Revised Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) Food Packages by Surveying Native American WIC Participants and Administering a Metabolic, Dietary Study of the Revised and Original WIC Food Packages. (December 2011)

Rachel Condie, B.S., University of Texas at El Paso

Chair of Advisory Committee: Dr. Peter Stephen Murano

WIC food packages are undergoing major revisions to accommodate the unique requirements of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in the twenty-first century. This dissertation is an evaluation of the impact of the revised WIC food packages through national-level surveys obtaining data before and after food package changes. In addition, a community-level metabolic/dietary study of obese women consuming either the original or revised food packages was performed. Since WIC has never revamped its entire program before, this is an opportunity to learn more about the impact of the revisions on WIC participants across the country, including Native Americans from Indian Tribal Organizations (ITOs).

The National Food and Nutrition food frequency questionnaire (NATFAN) evaluates food and consumption practices of WIC participants, including Native Americans, for both the original and revised WIC food packages. The baseline surveys (NATFAN′) were administered before the 2009 rollout of the revised WIC food

packages (dates varied by state program). The post-rollout surveys (NATFAN´´) were administered spring through winter of 2010-2011, and at least six months after the implementation of the revised WIC food packages. Hierarchical linear modeling, with restricted maximum likelihood approximation, was used to evaluate 100% juice, fruit, and vegetable frequency of consumption based upon NATFAN´ and NATFAN´´, including samples from states, territories, and ITOs. This research is important because it was national in scope and analyzed nutritional behaviors of a Native American subpopulation of WIC that is seldom documented in national nutrition research.

For the metabolic/diet study, obese women 185% of the poverty level were given the original or revised WIC food packages (n=3). Three venous blood serum collections (0, 6, 12 weeks) were biomarker tested (cholesterol, glucose, C-reactive protein, etc.) in lipid and metabolic panels. Three, seventy-two hour dietary recalls were also assessed to determine fruit and vegetable consumption changes over the course of the study. This phase was important because it focused on the individual's actual consumption behaviors of specific WIC foods dispensed in the WIC food packages and assessed how such consumption affected the health of the individual.

DEDICATION

This dissertation is dedicated to my Grandpa, Arthur P. Ford and to my sister, Melissa K. Condie. Art Ford is probably the only person that I will ever give the advice, "Eat anything you want." He passed away in December of 2010 at the age of 90, one year before I graduated. Melissa Condie is the only person in my family who enjoys writing, and she graciously used her literary skills to proofread many of my drafts.

ACKNOWLEDGEMENTS

I would like to thank my committee, Drs. Murano, Lupton, McIntosh, and McKyer, for helping me through the graduate school process. I also appreciate the feedback and advice from the principal and co- investigators of my projects, staff at HEB and the Brazos Valley Community Action Agency (BVCAA), supervisors, family members, statisticians, classmates, friends, and coworkers. In particular, I would like to acknowledge Dr. Russell Warne who processed the Hierarchical Linear Modeling, Renee Smith who processed the Nutrition Data System for Research data, Richard White who allowed me to process the food orders at HEB, Chris Rasmussen who coordinated the blood tests with Quest Diagnostics, Julie Ribardo who facilitated the study at BVCAA, and Jenny Becker who helped organize and analyze data and dispense food packages.

I am also indebted to the programs that either provided funding for my dissertation projects or my assistantships. These entities in the order of when these organizations provided funding for me are: Texas A&M University Regents Fellowship, Texas A&M Nutrition Department, Texas Department of State Health Services, National Science Foundation GK-12 Fellowship, Institute for Obesity Research and Program Evaluation, HEB, and Texas A&M College of Agriculture and Life Sciences.

Lastly, I want to express my thankfulness to all the women, infants, and children who participated in NATFAN or the diet/metabolic study. If it were not for all these people, my research would have severely been limited.

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INTRODUCTION

Background for WIC Food Package Changes

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), managed by the United States Department of Agriculture **(**USDA), has been supplying nutrition assistance to lower waged, nutritionally susceptible women, infants, and children since the preliminary program was initiated in the early 1970s [(1)]. In contrast with the WIC program three or four decades ago, rates of underweight and anemic patients have decreased, and obesity rates in mothers and children have increased [(2)]. Interestingly, the childhood obesity issue does not affect all children at the same rates. In 2005, a study of four-year-olds showed obesity rates of 31% for Native Americans, 22% for Hispanics, 21% for Blacks, 16% for Whites, and 13% for Asians [(3)]. Native American adults also have some of the most elevated obesity rates [(4)]. Evidently, Native Americans are disproportionately affected by obesity.

The Food and Nutrition Service of the United States Department of Agriculture (FNS/USDA) decided to revamp the WIC food packages and sought help assessing the health and nutrition requirements of participants in the WIC Program administered in US states, US territories, and Indian tribes [(2)]. The Institute of Medicine (IOM), an organization within the National Academy of Sciences that evaluates and recommends changes in health programs, was assigned this task [(2)]. Specifically, the IOM was asked to evaluate the nutrient requirements of participants in order to recommend food package modifications while minimizing potential burden (both time and money) to WIC [(2)]. This

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This dissertation follows the style of *Public Health Nutrition*.

study was initiated in September of 2003, and the following recommendations for the WIC food packages were to:

- Decrease insufficient or unwarranted nutrients
- Increase alignment with *Dietary Guidelines for Americans*
- Increase alignment with recognized guidelines (e.g., American Academy of Pediatrics) for babies and toddlers, including encouragement of breastfeeding
- Increase accessibility of foods for participants with limited transportation, culinary skills, and space
- Increase attention to the cultural preferences of certain participants and give inducement for participation in the program, and
- Reflect on revisions that may alter food vendors and WIC agencies [(2)]

In 2006, the IOM's critical analysis of the current WIC food packages, recommendations for changes in the packages (removing or adding foods to meet the nutritional and cost consciousness of the committee), development of the revised food packages, and advisement for actually implementing changes was published in book form [(2)]. After receiving the recommendations, USDA proposed an interim rule for food package changes in December 2007 [(5)] . The interim packages were eventually mandated for implementation by October 2009 (one state had an extension through November 2009), the interim rule ended in February of 2010, and a final review is expected in 2011 [(5)]. Figure 1 details the major sequence of events of the WIC Program's evaluation steps.

The revised food packages now address excessive nutrient intake (e.g. total and saturated fat) in addition to promotion of nutrients and foods that may contribute to

reduction in disease risks (e.g. fiber, iron, fruits and vegetables) [2]. Nationally, only 36% of women consume fruit at least twice daily, and 31% consume vegetables at least three times daily [6]. Table 1 exhibits the seven revised WIC food packages currently offered.

Description of Research Projects

The response to the revised WIC food packages, in regards to fruit, vegetable, and 100% juice consumption, was evaluated in this dissertation at two different levels and separated into three different phases. The first level of research (with two phases) involved a national WIC survey, ahead of and following rollout of the revised WIC food packages. The second level of research involved a metabolic/dietary study of subjects consuming the original and revised WIC food packages. The National Food and Nutrition (NATFAN) food frequency questionnaire was designed to evaluate food and consumption practices of WIC participants, including Native Americans administered at both states/territories and Indian Tribal Organizations (ITOs), for both the original and revamped WIC food packages.

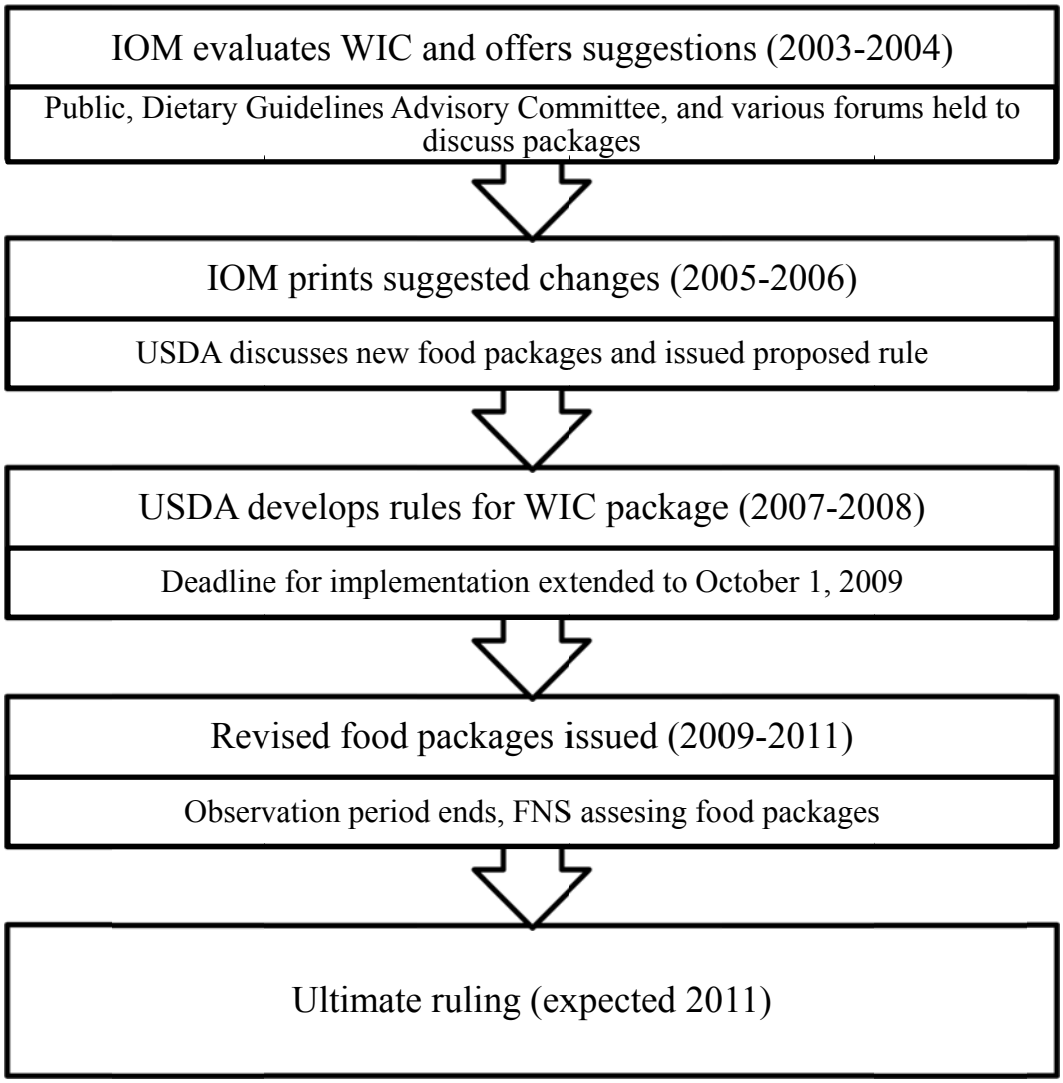

Fig. 1 Progression of the evaluation of the WIC food packages [2, 5, 7]

The baseline surveys from the first phase of (NATFAN´) were administered from 2008-2009 before food package changes. The post-rollout of the food package surveys (NATFAN´´) were sent to participating programs in 2010. For the third phase, research subjects in the metabolic/dietary study completed three-month test diets, with either the original or revised food packages, in the fall/winter of 2010. This dissertation is so

timely because WIC food packages are still undergoing review by USDA, as of September 2011, when this dissertation was completed. Figure 2 exhibits the three phases of the study.

Table 1 Revised WIC food packages for WIC participants and the new directions of the packages [2]

Food Packages	New participant category (old participant category)	New Focus as defined by the IOM
I	0-5 months (0-4 months)	Breast feeding/partial breastfeeding through 6 months
II	6-11 months (5-11 months), differs for breastfed, fully breastfed, and formula fed	Jar baby food to increase iron consumption for breastfed babies, fruits and vegetables to all, delayed cereal introduction
III	0-11 months with special needs	More flexibility in offering what the infant needs
IV	12-59 months	Less milk (2-5 year-olds only offered reduced fat milk or less), juice, and eggs; whole grains, fruits, and vegetables now offered
V	Pregnant or partially breastfeeding: 1-12 months	Less milk (reduced fat or less), juice, and eggs; whole grains, fruits, and vegetables now offered
VI	Fully formula feeding: through 6 months	Less milk (reduced fat or less), juice, and eggs; fruits, vegetable, and beans/peanut butter now offered
VII	Fully breastfeeding: through 1 year	Less milk (reduced fat or less), juice, and eggs; whole grains, fruits, and vegetables now offered

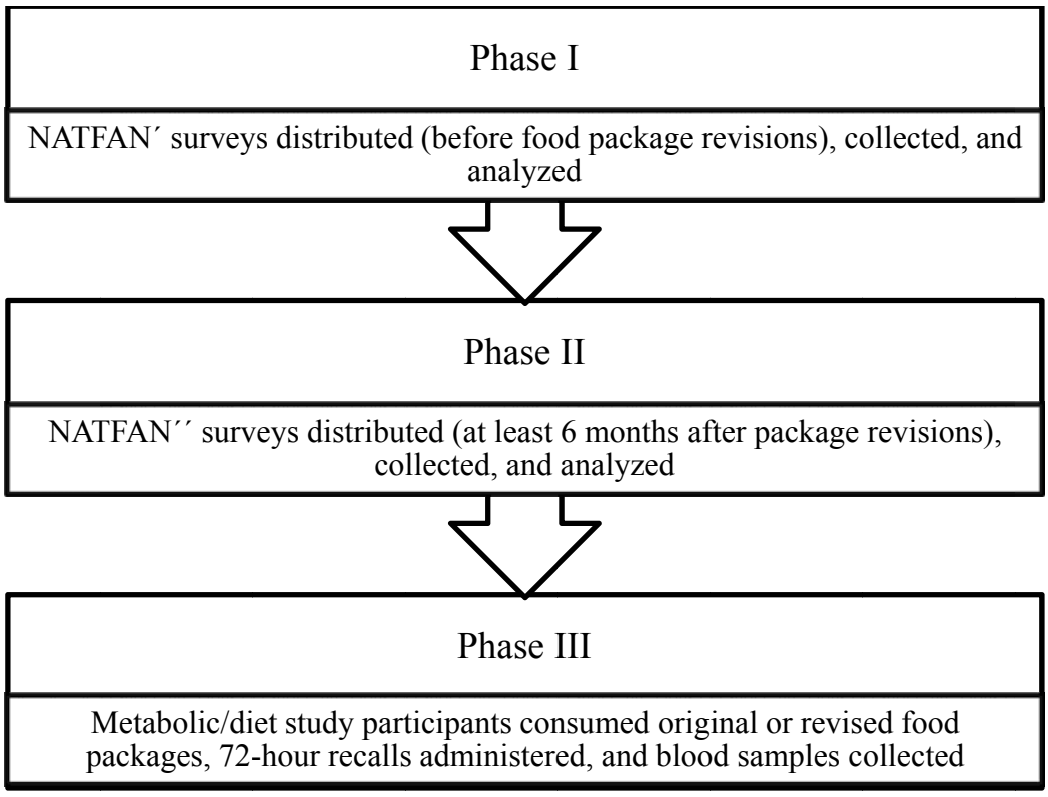

Fig. 2 Three phases of the dissertation research

Research Questions

The six research questions addressed in the dissertation include:

1. Are there fruit and vegetable frequency of consumption differences between NATFAN participants administered by states/territories and Indian Tribal Organizations (ITOs)?
2. Is the frequency of consumption of fruits and vegetables of Native American NATFAN participants different from non-Native Americans after the rollout of the updated WIC food packages?

3. What other characteristics affect 100% juice, fruit, and vegetable frequency of consumption in NATFAN participants?
4. Are there any detectable differences in weight or lipid blood profiles for obese women who consume WIC diets for three months?
5. What are the differences in blood profile changes or BMI between women who eat the original food package versus the revised food package?
6. Do participants actually consume the 100% juice, fruits, and vegetables offered in the food packages?

Research Hypotheses

I hypothesized that the Native Americans who participated in NATFAN were not meeting 2005 dietary recommendations for consumption of fruits or vegetables. Participants were considered Native American if they marked the survey response "Native American," regardless if they endorsed any other racial category. NATFAN participants were asked to respond to all races that apply. I further hypothesized that the NATFAN´´ would show only slight improvement in consumption of fruits and vegetables, but there would be a decrease in the frequency of 100% juice consumed due to less juice offered in the new WIC packages. As a frame of reference, the 2005 Dietary Guidelines for Americans suggested consuming approximately 2 cups of fruit and 2.5 cups of vegetables for a woman on a 2,000 calorie diet [(8)].

For the metabolic/diet phase, I hypothesized that participants on the revised diet would consume more fruits and vegetables than participants given the original diet because the revised food package offered fruits and vegetables. However, it was also

hypothesized that participants consuming either the original or revised WIC food packages would decrease their body mass index (BMI) and lower overall blood lipids (e.g. cholesterol, triglycerides) because of the increased awareness of nutrition and increased access to nutritious foods.

FRUIT, VEGETABLE, AND 100% JUICE CONSUMPTION IN WIC WOMEN FROM STATES, TERRITORIES, AND INDIAN TRIBAL ORGANIZATIONS: THE NATFAN STUDY

Introduction

Since 1972, the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) food benefits have supplied basic, healthy foods and beverages to provide key nutrients to lower-income mothers, infants, and young children [9]. To augment the wellbeing of WIC mothers and their young children, WIC food packages were nationally updated in 2009 to current nutritional standards in addition to expanding the food and beverage benefits to better represent the desires of the present-day WIC population [2, 7]. Tofu, canned beans, fruits and vegetables, whole grain products (bread, tortillas, and rice), and an increased number of whole grain ready-to-eat cereals are examples of some new options that address current needs of program participants [2]. Beneficial consequences of providing healthier food options to WIC participants are that the participants can explore a greater variety of healthy foods and learn to consume and prepare more nutritious meals for themselves and their families.

An obesity rate of 36% jeopardizes the health of millions of American women [10]. In addition, mothers often have worse diets than their non-parent counterparts, as evidenced by the consumption of more sugary beverages and saturated fat and less consumption of dark green vegetables [11]. Another study emphasized nutritional education and weight management for women obese in pregnancy because their habits contribute to unhealthy nutritional behaviors in their infants [12]. For WIC women

participants, the focus of this paper, a large portion—47%—are classified as too heavy for their height [13]. The food package updates were not solely tailored to overweight and obese mothers, but the increased prevalence of clients with overweight issues was a major consideration in the modified packages [2]. A major modification to the package which may help with weight management included redeemable vouchers for fruits and vegetables, foods that are not consumed at adequate levels [2, 14]. According to CDC data, Washington, DC, has the highest percentage of adults consuming produce five times a day, but adults from Washington still have daily consumption levels of fruits and vegetables less than a third of the daily recommendations [6].

Many fruit and vegetable studies with women WIC participants already exist [15-21]. The National Food and Nutrition questionnaire (NATFAN) data contributes to the WIC fruit and vegetable literature because it is the largest national study measuring WIC nutrition behaviors pre-/post-2009 WIC food package updates. NATFAN is a WIC participant food frequency questionnaire addressing food and beverage frequency and consumption by WIC women, infants, and children, which was administered nationally at WIC in 40 states, Washington DC, Northern Mariana Islands, and 17 Indian Tribal Organizations (ITOs) prior to and at least six months after the newly revised WIC food packages of 2009 (unpublished). This study administered surveys to many ITOs, which is also valuable because Native American WIC participants represent a sizable percentage of the WIC Program at a reported level over 11% [13]. Even though Native Americans are the third largest racial group in WIC, nutrition studies often do not represent Native Americans to the extent represented in WIC because the national

population of Native Americans is so small [6, 22, 23]. Incidentally, Native Americans exhibit some of the steepest rates of obesity in the nation [24].

Therefore, authors wanted to determine if the Native American populations in WIC, or the ITO WIC Programs that help reach Native Americans (in addition to any WIC-qualified individual within the WIC's service boundaries [25]) had fruit and vegetable behaviors different from other participants in the WIC Program. The authors' principle intention in writing this article is to describe women WIC participant demographic and nutritional variables that impact 100% juice, fruit, and vegetable consumption.

Materials and Methods

Women in WIC facilities (from the period 2008-2009 for the pre-food package change (NATFAN′) and/or 2010-2011 for the post-food package change (NATFAN′′)), across the US completed the women section of NATFAN (unpublished). NATFAN (NATFAN′ and NATFAN′′ have the same questions), developed by a collaboration of members of the Institute for Obesity Research and Program Evaluation and Texas WIC, has 31 items that include consumption questions about produce, grain products, milk, juice, and sweetened beverages in addition to basic demographic information. Questions and answers from the NATFAN utilized for this analysis and their coded values include:

How often do you do the following?

Drink 100% juice such as orange, apple, or tomato.

Eat fruit. This does not include juice.

Eat vegetables such as salad, carrots, or sweet potatoes. This does not include potatoes, French fries, or potato chips.

Answer options for the previous three questions were coded as: never or less than once per week =0; 1 to 3 times per week =1; 4 to 6 times per week =2; 1 time per day =3; 2 times per day =4; 3 times per day =5; and, 4 or more times per day =6.

During the past year, which fruits/vegetables did you eat? blank answer =0, responded =1 (fruit and vegetable response options are listed in Table 2)

Are you currently pregnant? no/I don't know =0, yes =1

Have you had a baby within the last 6 months? no =0, yes =1

Are you currently breastfeeding? no =0, yes =1

What is your race? Non-Native American =0, Native American =1

WIC Programs serviced by state/territory =0, ITO=1

NATFAN′ =0, NATFAN′′ =1

The coded NATFAN data files were analyzed with a proportional odds model and restricted maximum likelihood approximation utilizing hierarchical linear modeling (HLM) (version HLM 6.08; Lincolnwood, IL). The national administration of the NATFAN is a good candidate for HLM analysis because participants were clustered into state, territory, and ITO groups [26-28].

The first level of analysis made use of data from all NATFAN women participants (NWP) while the second level of data categorized NWP in state/territory or ITO clusters. Three unique HLM models were each created with one ordinal dependent variable (100% juice, fruit, or vegetable frequency of consumption). Each model started

as highly intricate with many independent variables at both the fixed and random effect levels. The formula $\tau_{00}/(\tau_{00}+\frac{\pi^2}{3})$ was used to calculate the intraclass correlation (ICC) [29]. After the creation of each model, a non-significant (P> 0.05) independent variable was removed from the model, starting with the random effects, and lastly by fixed effects; if there was a significant random effect, then the fixed effect was kept in the model even if it was non-significant [30]. The final model was economized to the least complex but statistically significant.

Independent variables used in all three initial HLM models were: pregnancy status, post-partum status within the past six months, breastfeeding status, survey (NATFAN´ or NATFAN´´), and Native American categorization. The fruit model used the fruit variety independent variable, and the vegetable model had the vegetable variety independent variable. This study was approved by the Texas A&M University Institutional Review Board # 2008-0528.

Table 2 Fruit and vegetable variety answer options on NATFAN

Fruit variety options		
apples	kiwis	prunes
apricots (fresh)	lemons or limes	raisins
apricots (dried)	mangos	rhubarb
bananas	nectarines	strawberries
berries (blueberries, blackberries, raspberries)	oranges	tangerines
melons (cantaloupe, honeydew)	papayas	watermelon
cherries	peaches	other
dates	pears	I do not eat fruit
figs grapefruit	pineapple	
grapes	plums	
Vegetable variety options		
asparagus	cucumbers	potatoes
avocados	eggplant	spinach
beets	greens (collard, mustard, turnip)	summer squash (yellow, zucchini
broccoli	green beans	sweet potatoes
Brussels sprouts	green peas	tomatoes
cabbage	lettuce (all varieties)	tomatillos
carrots	mushrooms	winter squash (acorn, pumpkin)
cauliflower	okra	other
chayote	onions	I do not eat vegetables
corn	peppers (bell yellow, green, orange, or red)	

Results

After all the independent variables were entered into HLM, the initial complex model was used to generate the ICC. The ICC for the 100% juice model was 0.015 with an effective sample size of 3677.491. The ICC for the fruit model was 0.010 with an effective sample size of 5156.954. The ICC for the vegetable model was 0.006 and the effective sample size was 7914.294. The final 100% juice model was created after five

more models, the fruit model after thirteen additional models, and the vegetable model after nine extra models to get to the most parsimonious model.

The following fruit and vegetable NATFAN data was produced for reports given to WIC Programs that participated in NATFAN [31, 32]. For NATFAN′, the fruits most commonly consumed in descending order were apples, bananas, grapes, oranges, strawberries, and watermelon. Strawberries and oranges exchanged places in NATFAN′′. For NATFAN′ and NATFAN′′, the least commonly consumed fruit options in ascending order were "I do not eat fruit," "other," dates, rhubarb, figs, and apricots (dried). During the NATFAN′, the vegetable options most normally consumed in descending order were corn, potatoes, lettuce, carrots, broccoli, and tomatoes. Carrots and broccoli switched positions for NATFAN′′. The least consumed vegetables for both the NATFAN′ and NATFAN′′ in ascending order were "I do not eat vegetables," "other," eggplant, beets, Brussels sprouts, and chayote.

NWP answered 16456 NATFAN′ with 100% juice responses, 16144 NATFAN′ with fruit responses, and 16389 NATFAN responses for vegetable frequency of consumption. The average for the responses is 16330 surveys from the approximately 27573 surveys that were mailed (59% response rate). NWP responded in 18692 NATFAN′′ for 100% juice, 18539 for fruit, and 18598 for vegetable frequency of consumption. The average of these responses is 18610 of the approximately 28670 NATFAN′′ returned (65% response rate). In addition to these responses, two programs administered their surveys with all three sections combined into one large survey (women, infants, and children sections) in either paper or internet format. The two of

these programs, averaged together for the dependent variables, returned 7637 NATFAN´ and 7271 NATFAN´´. The NATFAN surveys were grouped into 59 clusters (state/territory or ITO) with more clusters and more surveys from NATFAN´´, possibly because programs were interested in getting state-level data reports which could be compared to the national-level reports.

Table 3 shows the responses to both the NATFAN´ and NATFAN´´ frequency of consumption of 100% juice, fruits, and vegetables before and after the food package changes from NATFAN national reports [31, 32]. In NATFAN´´, more respondents reported that they consume 100% juice less than 1 time per day (NATFAN´-51%, NATFAN´´-54%). In NATFAN´´, a higher percentage of NWP reported they consume fruits one time a day or more (NATFAN´-57%, NATFAN´´-61%); more NWP from the NATFAN´´-phase also reported consuming vegetables at least one time a day (NATFAN´- 53%, NATFAN´´ 56%) [31, 32].

Table 3 NATFAN women participant frequency of consumption of 100% juice, fruits, and vegetables [31, 32]

Food or beverage	Surveys, *n*	Number of respondents for frequency of consumption						
		Never or less than 1 time per week, *n* (%)	1 to 3 times per week, *n* (%)	4 to 6 times per week, *n* (%)	1 time per day, *n* (%)	2 times per day, *n* (%)	3 times per day, *n* (%)	4 times per day, *n* (%)
100% juice*	NATFAN´ 24172	1907 (8)	6789 (28)	3659 (15)	3428 (14)	3960 (16)	2561 (11)	1868 (8)
	NATFAN´´ 26040	2429 (9)	7911 (30)	3829 (15)	3664 (14)	4039 (16)	2418 (9)	1750 (7)
Fruits±	NATFAN´ 23685	886 (4)	5300 (22)	4292 (18)	4182 (18)	4668 (20)	2540 (11)	1817 (8)
	NATFAN´´ 25694	752 (3)	4679 (18)	4671 (18)	4371 (17)	5604 (22)	3117 (12)	2500 (10)
Vegetables†	NATFAN´ 24042	1166 (5)	5622 (23)	4644 (19)	4820 (20)	4394 (18)	2049 (9)	1347 (6)
	NATFAN´´ 25909	1121 (4)	5600 (22)	4760 (18)	5158 (20)	5085 (20)	2418 (9)	1767 (7)

*such as orange, apple, or tomato, ± this does not include juice, †such as salad, carrots, or sweet potatoes but does not include potatoes, French fries, or potato chips

Table 4 shows that all independent variables used to model 100% juice consumption behaviors had significant fixed effects. In this sample, pregnant NWP less frequently consumed 100% juice than NWP who were not pregnant. Postpartum NWP were significantly less likely to consume 100% juice than non-postpartum NWP; but, postpartum NWP served at ITOs were 1.2 times more likely to consume 100% juice than their state/territory counterparts. Breastfeeding NWP significantly less frequently consumed 100% juice than their non-breastfeeding counterparts, and breastfeeding NWP at ITOs were 0.7 times as likely to consume 100% juice their state/territory peers. Native American NWP significantly less frequently consumed 100% juice than their non-Native American counterparts. Nationally, NWP were more 1.2 times more likely to consume 100% juice after the food package change. NWP served at ITOs had a significant increased likelihood of consuming 100% juice after package changes than NWP served at states/territories. Pregnancy status was the only variable that showed statistically significant variability amongst the clusters in the random effects.

Table 5 shows significant variables related to the fruit frequency of consumption. There were no significant fixed effect differences between NWP served by ITOs versus states/territories. Of the three analyses (100% juice, fruit, and vegetable), this model had the fewest statistically significant dependent variables although all 59 clusters analyzed as opposed to 58 cluster for 100% juice and 53 clusters for vegetable consumption. Pregnant and breastfeeding NWP significantly reported less frequently consuming fruit than their non-pregnant or non-breastfeeding peers. NWP who reported significantly consuming a greater variety of fruits less frequently consumed fruits. NWP answered in

NATFAN′′ showed that they significantly consumed fruit less frequently than NATFAN′. All four significant fixed effects had odds ratios less than 0.9. The only significant random effect among the clusters was fruit variety.

Table 4 Final women HLM model for 100% juice frequency of consumption

Fixed effects	Coefficient	SE	*P* value	Odds ratio [95% CI]
Intercept	-2.209	0.037	< 0.001	0.110 [0.102, 0.118]
ITO main effect	0.122	0.072	0.094	1.130 [0.979, 1.304]
Pregnant	-0.319	0.028	< 0.001	0.727 [0.687, 0.768]
Postpartum	-0.067	0.017	< 0.001	0.935 [0.905, 0.966]
ITO interaction	0.212	0.105	0.042	1.236 [1.007, 1.517]
Breastfeeding	-0.294	0.031	< 0.001	0.745 [0.701, 0.792]
ITO interaction	-0.345	0.132	0.009	0.708 [0.547, 0.918]
Survey administration	0.183	0.052	0.001	1.201 [1.086, 1.329]
ITO interaction	0.250	0.081	0.003	1.283 [1.094, 1.506]
Native American	-0.098	0.041	0.018	0.907 [0.837, 0.983]
Random effects		SD	*P* value	
Intercept		0.235	< 0.001	
Pregnant		0.086	0.009	

The entire sample was used to determine the fixed effects (*n*=50212) while 58 of the 59 clusters were used to determine the random effects.

Table 6 shows the final HLM model for vegetable frequency of consumption. Pregnant NWP significantly less frequently consumed vegetables than their non-pregnant counterparts. Breastfeeding NWP also significantly consumed vegetables less frequently than non-breastfeeding NWP. Breastfeeding NWP from ITOs were 0.8 times as likely to consume vegetables as NWP from states/territories. NWP from the NATFAN′′ significantly less frequently consumed vegetables than NATFAN′ NWP. Native American NWP were significantly less likely to consume vegetables than non-Native American NWP. Increased vegetable variety showed a decrease in likelihood to

consume vegetables. Random effects amongst the clusters include pregnancy, breastfeeding, and vegetable variety.

Table 5 Final women HLM model for fruit frequency of consumption

Fixed effects	Coefficient	SE	*P* value	Odds ratio [95% CI]
Intercept	-1.935	0.050	< 0.001	0.144 [0.131, 0.160]
Pregnant	-0.431	0.019	< 0.001	0.650 [0.626, 0.675]
Breastfeeding	-0.224	0.028	< 0.001	0.799 [0.757, 0.844]
Survey administration	-0.210	0.036	< 0.001	0.810 [0.755, 0.870]
Fruit variety	-0.109	0.003	< 0.001	0.897 [0.891, 0.902]
Random effects		SD	*P* value	
Intercept		0.234	< 0.001	
Fruit variety		0.012	0.004	

The entire data set was used for both the fixed and random effects (*n*=49379). There were no statistically significant interactions or main effects with ITOs.

Table 6 Final women HLM model for vegetable frequency of consumption

Fixed effects	Coefficient	SE	*P* value	Odds ratio [95% CI]
Intercept	-1.777	0.039	< 0.001	0.169 [0.156, 0.183]
ITO main effect	0.164	0.088	0.068	1.178 [0.987, 1.406]
Pregnant	-0.079	0.023	0.001	0.924 [0.884, 0.967]
Breastfeeding	-0.132	0.035	< 0.001	0.876 [0.818, 0.939]
ITO interaction	-0.246	0.076	0.002	0.782 [0.672, 0.911]
Survey administration	-0.133	0.017	< 0.001	0.875 [0.847, 0.904]
Native American	-0.102	0.037	0.006	0.903 [0.841, 0.970]
Vegetable variety	-0.106	0.003	< 0.001	0.900 [0.894, 0.905]
Random effects		SD	*P* value	
Intercept		0.234	< 0.001	
Pregnant		0.068	0.042	
Breastfeeding		0.134	0.017	
Vegetable variety		0.011	0.003	

The entire sample was used to determine the fixed effects (*n*=49951) while 53 of the 59 clusters were used to determine the random effects.

Discussion

As WIC Programs update and experiment with behavioral or learner-centered nutrition lessons to emphasize fruit and vegetable consumption in their participants' diets, WIC programs can use NATFAN data as a point of reference for nutritional behaviors [15, 33]. Current WIC food packages encourage nutritional behaviors like those recommended by the American Heart Association including increasing consumption of fruits and vegetables while decreasing consumption of juices, substituting fruits and vegetables for less healthy options, and consuming whole produce rather than juice [2, 14, 34-36] by now providing fruits and vegetables and a reduced amount of juice to WIC participants. Even with these efforts, NWP still did not consume adequate levels of produce after WIC food benefits were updated.

A benchmark of fruit consumption is two times a day and three times a day vegetable, is used by the Behavioral Risk Factor Surveillance System [6]. According to this standard, the majority of NWP were not consuming adequate levels of either fruits or vegetables. As shown by Table 3, the majority of NWP were consuming fruit less than two times per day and less than 20% were consuming vegetables at least three times a day for NATFAN´´.

It might appear from the raw data in Table 3 that juice consumption decreased and that fruit and vegetable consumption increased after food package change. Such assumptions are incorrect because a different batch of NWP was sampled in NATFAN´´. NWP were not tracked because many WIC Programs did not want to jeopardize their NWP' privacy; with that said, the NATFAN´ and NATFAN´´ demographic

characteristics including race, ethnicity, age, and education levels were very similar between NATFAN´ and NATFAN´´ (unpublished). Some participants completed the survey only six months after the package changes. If longer periods are necessary to incorporate these nutritional changes, this may explain why some nutritional behaviors were not in the initial direction intended by package changes. It is also probable that some NWP incorrectly identified 100% juice, fruit, or vegetables on NATFAN although these questions were written for a WIC audience and pilot tested in multiple WIC clinics [19, 37, 38].

The large number of programs from US states, territories, and ITOs allowed for cross level analysis between NWP served by states/territories and ITOs. NWP at state, territory, or ITO programs have some degree of similarity due to the nature of the WIC program including socioeconomic status (no more than 185% of the poverty level) or pregnant or post-partum mothers [13].

ITO WIC Programs are unique in that they are run independent of the state in which they are physically located, although they serve all WIC-eligible participants within their boundaries that are on or near tribal areas [25]. Even with ITO involvement where NWP might be more similar than programs covering a greater geographic boundary, the ICCs for these models were within range of other health and nutrition research studies [39-41]. The higher ICC, or NWP more similar within their clusters, was evidenced by a smaller effective sample size for the 100% juice model than the larger effective sample size for the vegetable model.

There were relatively few cross-level interactions between the states/territories and ITOs. Other than the breastfeeding interaction in the vegetable model, no other fruit or vegetable consumption behaviors were significantly different between the states/territories and ITOs implying that ITO fruit and vegetable behaviors parallel the state/territory programs. ITO juice behaviors varied slightly from the national population with no conclusive trend in behavior. Native Americans, independent of their connection to a state or ITO WIC Program, significantly consumed juice and vegetables less frequently than the rest of the NATFAN population. Native Americans did not exhibit any random effects in any of the models indicating that it might be beneficial to address their specific nutritional tendencies at both state and ITO settings. Other national, state, and tribal studies have also described low fruit and vegetable intake among Native American populations [21, 42, 43].

There were some major commonalities among all three HLM analyses. Although the effective sample size was smaller than the number of NWP sampled, many dependent variables were still significant. None of the fixed effects had an odds ratio over 1.3 for the neighboring effects of the first two answer options that were coded zero and one. Subsequent answer choices coded as two or three had an odds ratio of 1.7 and 2.2 (squared and cubed), etc. Although the initial odds ratio for the first two item choices did not show any huge differences in nutritional behaviors, the odds ratio increased as the answer options progressed to higher coded values, and there were still many significant behavior differences.

Pregnancy and breastfeeding status had significant coefficients in all models. Pregnant and breastfeeding NWP reported that they consumed less juice, fruits, and vegetables than the rest of the NATFAN population. This is troublesome because these foods contribute to vitamin, mineral, and fiber intake and such behaviors may negatively affect healthy food preferences of their infants and children [44, 45]. Although juice was reduced in the package partly due to the amount of sugar in the product, when NWP are not consuming adequate levels of fruits or vegetables, fruit or vegetable juice may be an acceptable alternative for nutritional and weight management [2, 46, 47]. Pregnancy did not have any statistically significant variance between NWP served by ITOs or states/territories implicating that pregnant NWP exhibited similar nutritional behaviors across all NATFAN programs.

NWP that usually consumed a greater variety of fruits were less likely to consume fruits. Vegetable variety and vegetable consumption followed the same trend. Some have suggested that the price of healthier foods is greater than less healthy alternatives, but recent analysis shows that the price of some fruits in the US were cheaper per gram than manufactured snacks or orange vegetables were sometimes cheaper than their starchy counterparts, but dark green vegetables cost more than high starch vegetables [48]. Another study specific to the WIC population suggested that the price of fruits and vegetables is a reason why an increased assortment of fruits and vegetables are not consumed as frequently [19]. This may be another explanation why cluster variability was the greatest within the vegetable model. Fruit consumption

showed little variability among clusters suggesting that all NATFAN programs should seek improvement for fruit consumption.

Conclusion

NATFAN can be useful to WIC agencies to gauge client progress towards greater acceptance of the healthier foods now found in the food packages. Analysis using the proportional odds model controlled for other confounding variables to help describe 100% juice, fruit, and vegetable characteristics of WIC women during the period of food package revisions. Pregnant and breastfeeding NWP fell short of current fruit and vegetable recommendations which should encourage WIC and nutrition educators to focus on new techniques to educate this population. NWP from ITOs did not show many fruit and vegetable consumption differences from state/territory programs, showing that ITOs face similar nutritional issues to that of the general NWP population, although Native Americans from across the US reported less frequent consumption of fruits and vegetables. As WIC participants embrace the new food packages, they will be able to improve nutritious consumption behaviors for themselves and their families.

WIC INFANT FEEDING VARIABLES ASSOCIATED WITH JUICE, FRUIT, AND VEGETABLE CONSUMPTION USING NATFAN DATA

Introduction

Inadequate parental nutritional behaviors are often broadcast to young children and may negatively influence the fruit and vegetable nutritional behaviors in children [6, 11, 49, 50]. Poor rates of produce consumption for adults, and also children, may warrant nutritionists to increase their efforts with infants and very young children [6, 51]. It has been shown that babies who are given a wide assortment of foods tend to be more willing to consume new foods [52]. A study where babies were given either baby food pears or other fruits at snack times showed an increase in pear consumption regardless of their assigned eight day treatment foods [53]. Additional Mennella, *et al.* data showed that when an array of green and orange vegetables were offered during and between meals, vegetable consumption also increased by the end of the eight day study [53]. These studies exhibit that infants can learn to improve consumption levels of fruits or vegetables over a fairly short period of time by increasing their exposure to either food category.

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), a major US government nutrition program that facilitates nutritional interests of nearly nine million mothers, infants, and children on a monthly basis, provides supplementary foods and beverages, lactation support, and aid in accessing other medical and social services [54]. WIC offers infants, aged zero through eleven months,

food packages that now provide: 1) an increased promotion of breastfeeding through enhanced packages for breastfeeding mothers, 2) a delay in providing food until the infant is six months, 3) the offering of prepared fruit, vegetable, and meat baby foods in addition to infant cereal, and 4) the removal of juice from the package until children are twelve months of age [14]. In 2009, WIC policies and packages all categories of participants were modified to promote Academy of Pediatrics (AAP) policies for infants and toddlers and *Dietary Guidelines for Americans* two and older [2]. For mothers capable of breastfeeding their infants, AAP suggests entirely breastfeeding for approximately six months; solid foods including those items provided in the WIC food packages can be introduced when deemed appropriate at approximately four to eight months of age [55].

This article uses data from the National Food and Nutrition questionnaire (NATFAN) which is a food frequency instrument utilized to measure nutritional behaviors addressed by WIC food package changes. NATFAN′ was distributed before the updated packages were implemented, and NATFAN′′ were dispensed after modified WIC packages were rolled (a minimum of six months after WIC package implementation). NATFAN is the largest known study of the WIC food package modifications that assesses both state and national-levels of WIC policy change at this critical period of nutritional transition [56]. NATFAN was administered to WIC Programs in 40 states, 2 territories, and 17 state-level Indian Tribal Organizations (ITOs). State-level ITOs are WIC Programs operated by Native American (Indian) tribes or partnerships that are governed independently of the US-state WIC Programs to help

meet the needs of WIC participants living on or near their reservations and their communities [25]. Native Americans are the third largest racial overall population in WIC and can be clients at any WIC Program [13]. A specific issue affecting Native American WIC infants who live in the vicinity of a reservation is that they are more likely to have WIC-categorized nutritional risks than other Native Americans [25]. Native American infants living away from a reservation (ITOs) were found to have slightly higher rates of excess weight than Native American infants living on a reservation, although all Native American infant weights were higher than the overall WIC population [25].

The purpose of this article is to depict independent variables that influenced fruit, vegetable, and 100% juice consumption in the infant (classified by WIC as newborn through eleven months) WIC population leading up to, and following, the recently modified WIC food packages. Analysis will show whether particular foods or beverages, Native American status, or participation at ITOs versus a state/territory WIC Programs, will increase or decrease consumption of fruits, vegetables, and 100% juice by infants.

Experimental Methods

Women, infant, and children versions of NATFAN were sent to WIC Programs across the US and were completed from 2008 to 2011, before and after WIC food package changes. NATFAN participant caregivers (NPC) answered five demographic questions about themselves in addition to 31 infant feeding and WIC questions on behalf of their infants (e.g. Do you have an infant younger than 12 months in your household who receives WIC food or formula?) Nutritional questions included breast milk and formula feeding behaviors (e.g. How often does your infant drink formula?), the age of

food and beverage introduction (e.g. Please choose the age at which the following foods (jarred or prepared) were first fed to your infant: Vegetables), and the current frequency of consumption of these foods (e.g. How often does your infant do the following? Eat fruits.).

In this analysis, the coding for frequency of consumption of fruits, vegetables, 100% juice, formula, milk (other than breast milk or formula), sweetened drinks (such as Kool-Aid®, sugar water, soda, cola, sports drinks, or sweet tea) were: never or less than once per week =0; one to three times per week =1; four to six times per week =2; one time per day =3; two times per day =4; three times per day =5; and, four or more times per day =6. NPC marked individual responses to the amount of jars/containers of baby food that were fed to their NATFAN infant participants (NIP) in an average week. Breastfed NIP were coded as 1, and non-breastfed NIP were coded as 0. Ages of NIP were coded as zero to two months =0; three to five months =1; six to eight months =3; and, nine to eleven months =4. Native American NPC were coded as 1 while all other NPC were coded as 0. Boy NIP were coded as =0 and girls =1. The NATFAN´ survey (baseline) was coded =0, and the NATFAN´´ survey =1. Finally, the clustered data was coded as state/territory WIC Programs =0 and ITO WIC Programs =1.

Restricted maximum likelihood approximations were used for hierarchical linear modeling (HLM) with the statistical software HLM 6.08 for Windows (Lincolnwood, IL, USA) to analyze the NATFAN infant data using a multi-level approach [57]. The three dependent variables (one for each model) were 100% juice (e.g. apple, orange, or tomato), fruit, or vegetable frequency of consumption. The initial, most complex model

with all predictors, cross-level interactions, and dependent variables contained the following independent variables: infant's current breastfeeding status, quantity of jars of prepared food offered in a week, frequency of milk consumption (non-breast milk or formula), frequency of sweetened beverage consumption (sugar or artificial sweeteners), sex, and age of NIP. The measurement category (NATFAN´ or NATFAN´´) and Native American status of the NPC were also independent variables. Additionally, the 100% juice model included frequency of fruit and vegetable consumption as independent variables. The fruit model included frequency of 100% juice and vegetable consumption as independent variables, and the vegetable model included frequency of fruit and 100% juice consumption as independent variables. All of the main effect variables in each model were also analyzed for the second-level analysis (states/territories and ITO).

The NIP data set was treated as interval rather than ordinal data because the HLM program had problems performing more than a few iterations before prematurely terminating the analysis. After the initial creation of each HLM model, one non-significant variable at a time was removed starting with random effects, followed by interactions, and lastly main effects. For significant random effects with interactions or main effects that were not significant, the interaction and/or main effect were left in the model [30]. The intraclass correlation (ICC) was determined using the following formula: $\tau_{00} / (\tau_{00} + \sigma^2)$, the value of which was also utilized to determine the effective sample size [26, 27, 29]. This research was approved through the Institutional Review Board #2008-0528.

Results

NPC provided 15975 NATFAN′ 100% juice responses, 15933 NATFAN′ fruit responses, and 15931 NATFAN responses for vegetable frequency of consumption. The mean for these item responses is 15946 surveys of the approximately 28792 surveys that were mailed (55% response rate). NPC responded in 17407 NATFAN′′ for 100% juice, 17426 for fruit, and 17369 for vegetable frequency of consumption. The mean of these survey responses is 17401 of the approximately 29969 NATFAN′′ that were mailed (58% response rate for the dependent variables used for this analysis). In addition to these responses, two programs administered their surveys with all three sections combined into one large survey (women, infants, and children sections) in either paper or internet format. These two programs, combined together and on average for the three dependent variables, returned 3575 NATFAN′ and 3073 NATFAN′′. NATFAN surveys were combined into 59 clusters (state/territory or ITO) with a higher number of clusters and surveys returned for NATFAN′′. This may be due to the incentive that WIC Programs received state-level and national-level data reports.

For all NATFAN surveys returned, 1174 NPC from NATFAN′ reported they were Native American and 1166 NPC from NATFAN′′ were classified as Native American. Approximately 19% (*n*=224) of the Native American NPC were from an ITO for NATFAN′ and 26% (*n*=302) for NATFAN′′. The majority of NIP were zero through five months of age (NATFAN′-52%, NATFAN′′-51%). NPC reported that they were mostly non-Hispanic (NATFAN′-and NATFAN′′-68%) and White (NATFAN′-and NATFAN′′-65%). Blacks were the second largest racial group (NATFAN′-17%,

NATFAN´´-19%) with Native Americans as the third largest category (NATFAN´-5%, NATFAN´´-4%). Table 7 shows the frequency of consumption of 100% juice, fruits, and vegetables that NPC marked in the NATFAN surveys [58, 59]. The majority of the NIP, during both phases of the survey, consumed juice less than one time per day (NATFAN´-82%, NATFAN´´-84%). A minority of NIP consumed fruits (NATFAN´-33%, NATFAN´´-37%) or vegetables (NATFAN´-34%, NATFAN´´-36%) on a daily basis [58, 59].

After formation of the original ICC model, the final, most significant model for 100% juice, with significant fixed and random effects, was created in sixteen models. The fruit model was also created in sixteen models, and the vegetable model was created in twenty-one models. The ICC for the juice frequency dependent variable was 0.013 with an effective sample size of 4137.614. The ICC in the fruit frequency model was 0.012 with an effective sample size of 4280.798. The ICC using the vegetable frequency dependent variable 0.011 with an effective sample size of 4763.708.

Table 7 NATFAN infant responses for 100% juice, fruit, and vegetable consumption for the infant sample [58, 59]

WIC food	Sample size per survey administration period, *n*	Number of responses for the frequency of consumption						
		Never or less than 1 time per week (%)	1 to 3 times per week (%)	4 to 6 times per week (%)	1 time per day (%)	2 times per day (%)	3 times per day (%)	4 times per day (%)
100% juice†	NATFAN´ 19568	11056 (57)	3541 (18)	1285 (7)	1780 (9)	1263 (7)	438 (2)	205 (1)
	NATFAN´´ 20499	12260 (60)	3681 (18)	1172 (6)	1633 (8)	1152 (6)	413 (2)	188 (1)
Fruits	NATFAN´ 19492	9141 (47)	2181 (11)	1691 (9)	2776 (14)	2539 (13)	825 (4)	339 (2)
	NATFAN´´ 20493	9250 (45)	2063 (10)	1620 (8)	2775 (14)	3127 (15)	1182 (6)	476 (2)
Vegetables	NATFAN´ 19503	9409 (48)	1982 (10)	1714 (9)	2871 (15)	2480 (13)	735 (4)	312 (2)
	NATFAN´´ 20430	9441 (46)	1927 (9)	1606 (8)	2843 (14)	3108 (15)	1055 (5)	450 (2)

†Such as apple, orange, or tomato

In the final 100% juice model (Table 8), breastfed NIP were significantly less likely to consume juice than their non-breastfeeding counterparts ($P<0.001$) as were NIP from NATFAN′′ compared to NIP from NATFAN′ ($P<0.001$). NIP were significantly more likely to consume juice if they were also consuming milk (not including formula or breast milk) ($P<0.001$), jars/containers of baby food ($P=0.008$), sweetened beverages (with sugar or artificial sweeteners) ($P<0.001$), fruit ($P<0.001$), or vegetables ($P<0.001$). As the age of the NIP increased, the likelihood of consumption of juice also significantly increased ($P<0.001$). The solitary cross-level interaction for the 100% juice model indicated that NIP from ITO who consumed jarred baby food were significantly less likely to consume juice than NIP from the states/territories ($P=0.031$). Jars of baby food ($P<0.001$) and age of the NIP ($P=0.023$), in addition to the frequency of milk ($P=0.001$), sweetened beverages ($P<0.001$), fruit ($P=0.001$), and vegetable consumption ($P<0.001$) were significant variables within ITO and state/territory clusters.

As shown in the final fruit model (Table 9), breastfed NIP were significantly less likely to consume fruit than non-breastfeeding NIP ($P=0.032$). NIP were more likely to consume fruit if they consumed: jars/containers of baby food ($P<0.001$), juice ($P<0.001$), sweetened beverages ($P=0.002$), vegetables ($P<0.001$), were older ($P<0.001$), or participated in NATFAN′′ ($P<0.001$). The milk frequency of consumption fixed effect ($P=0.740$) was left in the model even though it was not significant because the milk frequency random effect was significant. The only cross-level interaction for the fruit model was that older NIP from ITO were significantly less likely to consume fruit than their counterparts from states/territories ($P=0.005$). Jars of baby food

(*P*=0.007) and age of the NIP (*P*<0.001) as well as the frequency of consumption of milk (*P*=0.037), juice (*P*<0.001), sweetened beverages (*P*<0.001), and vegetables (*P*<0.001) were also significant random effects.

Table 8 Final infant HLM model of variables affecting 100% juice consumption

Fixed effects	Coefficient	SE	T-ratio	*P* value
Intercept	0.029	0.016	1.813	0.075
ITO interaction	-0.008	0.029	-0.289	0.774
Currently breastfed	-0.050	0.012	-4.218	< 0.001
Jars of baby food	0.004	0.001	2.775	0.008
ITO interaction	-0.011	0.005	-2.211	0.031
Milk frequency	0.077	0.006	13.162	< 0.001
Sweetened beverage frequency	0.354	0.023	15.100	< 0.001
Fruit frequency	0.206	0.014	14.573	< 0.001
Vegetable frequency	0.071	0.014	4.999	< 0.001
Age	0.279	0.012	23.464	< 0.001
Survey administration	-0.205	0.022	-9.518	< 0.001
Random effects		SD		*P* value
Intercept		0.052		>0.500
Jars of baby food		0.007		< 0.001
Milk frequency		0.028		0.001
Sweetened beverage frequency		0.126		< 0.001
Fruit frequency		0.067		0.001
Vegetable frequency		0.066		< 0.001
Age		0.048		0.023

The fixed effects were formulated from all data (*n*=40067) while the random effects were from 52 of the 59 clusters.

In the final vegetable model (Table 10), consumption of jars of baby food (*P*<0.001), milk (*P*=0.003), 100% fruit juice (*P*<0.001), fruit (*P*<0.001), age (*P*<0.001), and NATFAN´´ (*P*=0.024) were all individually significant predictor variables. The main effect for consumption of sweetened beverages (*P*=0.100) was kept in the model

because it had a significant random effect. Jars of baby food ($P<0.001$) besides 100% juice ($P<0.001$), sweetened beverages ($P<0.001$), and fruit frequency of consumption ($P<0.001$) were all significant random effects within NATFAN clusters. There were no cross-level interactions for the vegetable model.

Table 9 Final infant HLM model of variables affecting fruit consumption

Fixed effects	Coefficient	SE	T-ratio	*P* value
Intercept	0.027	0.008	3.176	0.003
ITO interaction	-0.024	0.020	-1.196	0.237
Currently breastfed	-0.025	0.012	-2.146	0.032
Jars of baby food	0.009	0.001	12.920	< 0.001
Milk frequency	-0.001	0.003	-0.333	0.740
Juice frequency	0.085	0.006	14.269	< 0.001
Sweetened beverage frequency	0.044	0.014	3.281	0.002
Vegetable frequency	0.791	0.008	103.304	< 0.001
Age	0.129	0.010	13.334	< 0.001
ITO interaction	-0.060	0.020	-2.993	0.005
Survey administration	0.037	0.009	4.033	< 0.001
Random effects		SD		*P* value
Intercept		0.022		>0.500
Jars baby food		0.003		0.007
Milk frequency		0.013		0.037
Juice frequency		0.028		< 0.001
Sweetened beverage frequency		0.066		< 0.001
Vegetable frequency		0.044		< 0.001
Age		0.048		< 0.001

The fixed effects were formulated from all data (n=39985) while the random effects were formed from 52 of the 59 clusters.

Table 10 Final infant HLM model of variables affecting vegetable consumption

Fixed effects	Coefficient	SE	T-ratio	*P* value
Intercept	-0.042	0.006	-6.561	< 0.001
Jars of baby food	0.010	0.001	13.434	< 0.001
Milk frequency	0.009	0.003	3.061	0.003
Juice frequency	0.031	0.006	4.728	< 0.001
Sweetened beverage frequency	-0.023	0.014	-1.669	0.100
Fruit frequency	0.793	0.007	112.216	< 0.001
Age	0.168	0.007	24.588	< 0.001
Survey administration	0.017	0.007	2.257	0.024
Random effects		SD		*P* value
Intercept		0.023		>0.500
Jars of baby food		0.004		< 0.001
Juice frequency		0.030		< 0.001
Sweetened beverage		0.069		< 0.001
Fruit frequency		0.035		< 0.001

The fixed effects were formulated from all data (*n*=39933) while the random effects were formed from 54 of the 59 clusters.

Discussion

An intention of the new WIC food packages is to increase healthful behaviors of mothers and their children [(2)]. This analysis shows that fruit and vegetable frequency of consumption was significantly higher, and the frequency of juice consumption was significantly lower after modifications to the WIC food packages. Likewise, the national Feeding Infants and Toddlers Study also saw a decrease in juice consumption for infants between their recent 2002 and 2008 surveys [(60)]. NATFAN had large sample-sizes for both NATFAN′ and NATFAN′′ and showed significant nutritional differences affected by the quantity of jars of baby food fed to infants, in all three models. Not surprisingly, NIP who were older and/or consuming jarred baby food were more likely to consume

juice, fruits, and vegetables. Although AAP recommends that parents supplement their infant's diet when their child is ready to eat solid foods, juice is not recommended to be fed in a bottle because it may replace consumption of milk/formula and contribute to dental problems [55, 61]. To note, there were many significant differences within state/territory and ITO clusters in this analysis as evidenced by six significant random effects for both the juice and fruit models, and four significant random effects in the vegetable model. Jars of baby food fed to NIP were common fixed effect differences for all three models. All this combined exhibits the complexity of developing policy for nutritional issues on a national-level when such variety is seen at the state level.

Increased sweetened beverage consumption increased the likelihood of consumption of juice and fruit. NIP sweetened beverage intake should be addressed during infancy because these beverages are likely to have sugar that contributes to dental caries [61]. Native Americans, in particular, have shown high rates of dental carries termed "baby bottle tooth decay" [62]. Contrasting with sweetened beverages, juice consumption increased the likelihood of vegetable consumption. Since vegetable consumption is so low in children and adults, infancy may be an opportune time to teach behaviors that will increase vegetable consumption habits; possible examples include increasingly offering vegetables and giving appropriate amounts of juice rather than sweetened beverages to enhance consumption vegetables [63]. It is important to establish fruit and vegetable consumption at an early age to meet nutritional recommendations, to contribute to healthy development. Additional encouragement for fruit and vegetable

consumption is from a study showed that infants who consumed fruits, vegetables, and homemade food had elevated verbal IQ levels at age four [64].

Mother can be fundamental in the acceptance of fruits and vegetables for her offspring. Maternal intake of carrot juice prenatally or during breastfeeding has been shown to increase the acceptance of carrot flavored cereal in their infants [44]. NIP who were breastfed at the time of the survey had an increased likelihood of consuming fruit and a decreased likelihood of consuming juice, following the positive trend of the general NATFAN population. Another study of interest showed that breastfed infants of mothers who consumed fruits accepted peaches better than their formula-fed peers [63]. Research has also shown that mothers who ate a more healthy diet including fruits and vegetables, had a higher likelihood that their infants consumed a more healthy diet [65]. In a study before six month recommendations for food introduction, consumption of prepared baby food at six months of age was not connected with an increased fruit and vegetable consumption in seven-year-old children, possibly because these children were in families that relied more heavily on convenience foods lower in vegetables rather than cooking and incorporating vegetables into family meals [60, 66]. Vegetable consumption efforts for infants should emphasize that mothers can influence certain food preferences of their offspring.

Unexpectedly, NIP of Native American NPC did not have any significant juice, fruit, or vegetable main or random-level effects. This was surprising because NATFAN data for adult women showed significant Native American nutritional behavior effects

for an increased likelihood of the consumption of juice and a decreased likelihood of vegetable consumption when compared to non-Native Americans.

For NIP, there were only two significant cross-level ITO interactions among the three final models. This limited number of cross-level interactions for the ITO show that the ITO NIP feeding patterns are not significantly different than NIP from states/territories. The two second-level differences were interesting though. One significant interaction showed that the increased consumption of jarred baby food decreased the likelihood of the consumption of juice, which is acceptable if the jarred baby food includes fruits and vegetables. The other cross-level difference showed that NIP were less likely to consume fruit as their age increased. Jarred baby foods may not have included many fruits, or as the NIP became older, they transitioned to foods consumed by their families, which according to adult NATFAN data and other national data, may be limited in fruits [6, 56]. Although there were no significant differences for NIP served at ITOs or NIP of Native American NPC (race of the infant was not requested), WIC staff need to focus on the transition from infancy to young children. If Native American NIP transition to the less healthy diets of their mothers, their fruit and vegetable consumption may decrease. This is worrisome because Native American four-year-olds were shown to be the most obese children of the major races in the US [3].

There were some limitations for this study. Food frequency questionnaires, like NATFAN, are limited as to what participants were able to identify as a fruit or vegetable and their ability to accurately report what they have consumed over an extended period of time, rather than the most recent season [67, 68]. Due to privacy issues, the individuals

were not tracked between the two administrations of NATFAN so individual changes in behavior were not studied. Plus, some of the NIP from NATFAN′ were no longer classified as NIP by the time NATFAN′′ was administered. Some of these limitations were alleviated by WIC participants of very similar demographics answering NATFAN′ and NATFAN′′ (unpublished data), frequently asked questions provided in each survey administration packet, and a large national sample.

Conclusion

Hierarchical linear modeling was a helpful tool for evaluating 100% juice, fruit, and vegetable consumption of NIP due to the clustered nature of the data. The analysis showed that NIP in Native American communities follow similar nutritional behaviors and encounter similar dietary issues as clients served at state/territory WIC Programs. Fruit and vegetable consumption was higher and 100% juice consumption was lower after implementation of the modified WIC food packages that now offer fruits and vegetables in all women, infants (six months and older), and children food packages. Although NIP nutritional behaviors are moving towards proper nutritional behaviors, nutrition and health educators should still focus on prevention of poor nutritional behaviors by teaching caregivers when to feed fruits and vegetables to infants in tandem with encouraging caregivers to also prepare and consume these foods. Educators should identify fruits and vegetables that are both acceptable to the infant and caregiver so that both improve and continue with healthful consumption patterns. Caregivers should also be taught that they can prenatally enhance the odds that their infants will consume fruits and vegetables.

DIET/METABOLIC STUDY WITH THE ORIGINAL AND REVISED WIC FOOD PACKAGES

Overview

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) instituted revised food packages in 2009 that now provide fruit, vegetables, whole grains, jarred baby food, and lower-fat dairy or dairy-replacement foods (tofu) [14]. Epidemiological studies show a wide range of health benefits of consuming foods and nutrients offered in the revised WIC food packages [69-72]. In addition to proactively addressing nutritional issues of the current WIC population, which has changed since the program was initiated by providing healthy foods (and nutrients) that are often under-consumed, the WIC Program has maintained price control of the packages [2]. The national average costs of the WIC packages leading up to revisions from 2006 through 2008 were $37.07- $43.41; the average costs actually decreased slightly following the national implementation of the revised food packages to $42.20 in 2009 and $41.42 in 2010 [73].

Table 11 Revised and original WIC food package for pregnant WIC women from Texas WIC

Foods	Revised monthly food package	Original monthly food package
Milk	4.5 gal and 1 quart	5.5 gal
Cheese	1 lb	2 lbs
Cereal	36 oz	36 oz
Juice	144 oz	288 oz
Eggs	1 dozen	2 dozen
Beans/peanut butter	1 lb and 18 oz	1 lb or 18 oz
Fruits/vegetables	$ 10.00	none
Whole grain bread	1 lb	none

Examples of the revised and original monthly food packages that have been used by Texas WIC for pregnant and mostly breastfeeding women are shown in Table 11. Differences between the revised and the original packages for women participants include:

1. Decreased milk-fat (now only reduced, low, or non-fat)
2. Decreased quantities of juice, milk, and eggs
3. Increased whole grain options for cereal benefits
4. Increased quantity of fish, beans, and peanut butter
5. Provisions for fruits, vegetables, and whole grains [2, 14, 35].

An intention of the WIC food packages has been to increase the nutritional outcomes of mothers and their children, but the items offered in the packages need to be consumed in order to receive the benefit. There are no known metabolic studies measuring if consumption of the original or revised WIC foods has different effects on the metabolic outcomes of participants consuming these diets. This metabolic/diet study attempted to mirror services offered at WIC clinics to women with a clinical issue and

socioeconomic profile that would be similar to WIC participation, but without competing against the real WIC Program that administers to pregnant and post-partum women. The overall goal of this pilot project was to determine if there were any quantifiable differences for obese women (not pregnant and more than six months post-partum) who participated in a nutrition lesson and were administered the original or revised WIC food packages.

Methods

The majority of the recruitment occurred at the health clinic of the Brazos Valley Community Action Agency Centers in Bryan, Texas. The health clinic serves the health needs of clients of the same socioeconomic profile as WIC participants. Recruitment also occurred at the Lincoln Recreation Center in College Station, Texas, the location of a satellite WIC clinic. Healthcare providers and recreation center staff posted and distributed fliers to potential study candidates in the summer of 2010.

Interested candidates contacted Institute members by email or phone for further information about the study. Participants qualified for the study because of their morbidly obese BMI classification. Criteria for the study included 18-50 years old women that were plus-sized or full-figured, not on medication for diabetes or heart disease, non-smokers, consumed of less than two servings of alcohol a day, not pregnant, and currently not a participant in the WIC Program. Potential candidates also answered that their income levels were 185% of the poverty level according to Texas WIC Income Guidelines [(74)].

Participants signed a five page consent form that detailed the study. Fundamental health questions, height, weight, and income questions were also asked of potential participants to verify that they could participate without significant risks to their health. Basic health histories were submitted to the study physician for approval to participate in the study. Upon enrollment in the study, participants were randomly assigned into the original food package or the revised food package groups. If a participant quit before the first blood collection, a replacement participant was sought.

The approximately three month study included three blood collections, one nutrition education lesson at the health clinic, and food packages available for pickup every two weeks from a grocery store near the health clinic. The nutrition education lesson was based on health and nutrition tips including how to incorporate fruit, vegetable, low-fat dairy, and whole grains into the diet. Three, twenty-four hour recalls (one weekend and two week days for a total of 72-hours) were relayed to Institute staff over the phone or in person the week leading up to or on the day of blood collection. Foods and beverages consumed over a 24-hour period was documented and analyzed in Nutrition Data System for Research (NDSR), a food analysis software from University of Minnesota (September 2009 NDSR with updates with Food Data-- Release Date: 5/24/2010, Version: 41, Detailed Version: 2010, Food/Nutrient Date: 5/24/2010; DSAM Data-- Release Data: 3/8/2010, Version: 2010 with NHANES 2005-2006 DSQ database (10/31/2008) and supplements added by NCC). Table 12 shows the timeline for major components of the study. The APPENDIX has supporting material for the diet/metabolic

study, including the advertisement, gift card receipt form, and an example of a food voucher.

For the blood collection, 30 mL blood draws from fasting participants were taken at the health clinic. Body mass was measured during the same visit to the health clinic as the three blood collections in the study. Participants were also given gas gift cards and vouchers redeemable for their food package pickup after their blood collections.

Blood samples were processed by Quest Diagnostics and tested for overall health and nutrition markers including:

1. Lipids— cholesterol (total, LDL, and HDL), triglycerides
2. Metabolic markers— glucose, urea nitrogen, creatinine, sodium, potassium, chloride, CO_2, calcium, total protein, albumin, globulin, total bilirubin, serum glutamate oxaloacetate transaminase (AST), serum glutamate pyruvate transaminase (ALT), alkaline phosphatase
3. Blood cells— white blood cell count, red blood cell count, mercury, hematocrit, mean corpuscle volume (MCV), mean corpuscle hemoglobin (MCH), mean corpuscle hemoglobin concentration (MCHC), red cell dimension width (RDW), platelet count, antibody (Ab) neutrophils, Ab lymphocytes, Ab monocytes, Ab eosinophils, Ab basophils, neutrophils, lymphocytes, monocytes, eosinophils, basophils
4. Inflammatory marker— C-reactive protein

Table 12 Sequence of metabolic/diet study events

Week of study	Redeemable voucher #	Food recalls	Blood draw date	Nutrition Lesson
Before study		X		
1	1		X (Day 1)	X (Day 1)
2				
3	2			
4				
5	3	X		
6			X	
7	4			
8				
9	5			
10				
11	6			
12		X	X (Last day)	

Results

Over the summer months, eight participants signed the consent form and provided health histories to participate in this study. Three of these participants did not provide baseline blood samples. One participant was excluded because she was a current smoker. One participant removed herself from the study before the first blood collection. Another participant left the study because the lab technicians were not able to

successfully collect blood from either of the participant's arms; this participant had a history of blood collection issues with these technicians.

Five participants successfully provided baseline blood collections. A participant removed herself from the study six weeks after the first blood collection; she reported that she had gained weight and was working out less frequently. It was suggested that the participant contact her physician for further guidance as this was a nutrition study and not directly a weight loss program. After the sixth and final food package was distributed to the last participant, contact was lost and she never showed for her final blood collection. Ultimately, three participants were able to complete the entire study.

Participants who received the revised food package were given a different combination of fruits and vegetables. The produce value was approximately five dollars per pickup or ten dollars a month, although the quantity of items varied greatly. Bi-monthly produce packages ranged from one mango, one cantaloupe, four bananas, one red bell pepper, one avocado, one zucchini, and one yellow onion, to another package that included one pomegranate, one head of green leaf lettuce, and one bunch of cilantro. All participants were given orange or pineapple orange juice in quantities corresponding to their food package. Both creamy and crunchy assortments of peanut butter were offered, frosted wheat squares were preferentially offered over corn flakes, and two percent milk was offered to everyone (at week six, one of the participants on the original package switched to 1%, and at week eight, another participant on the original package switched to 1%).

Table 13 Participant height, weight, and BMI at 0, 6, and 12 weeks

Participant	Package	Height*	Weight			BMI		
			0 weeks	6 weeks	12 weeks	0 weeks	6 weeks	12 weeks
A	Revised	63.6	270	272	270	46.9	47.3	46.9
B	Original	60.8	226	229	230	43.0	43.5	43.7
C	Original	63.0	364	356	361	64.5	63.1	63.9

* Average height of the measurements at the three time points

The three participants who completed the study are identified as Participants A, B, and C. Participant A was 27 years old and was administered the revised food packages. Participants B and C were 40 and 38 years old the start of the study and were administered the original food package. Table 13 shows the BMIs calculated over the duration of the study for each of the three days when blood was collected.

Table 14 shows the average fruit (including juice) and vegetable servings reported in 72-hour dietary recalls. An assortment of fruits and vegetables were consumed by all participants, and fruit juice was consumed by all participants during the second and third dietary recall collections.

Table 14 Participants' average reported consumption of fruits and vegetables at baseline, 5, and 12 weeks into the study

	Participant		
Servings of fruit	A	B	C
Baseline	2.0	0.5	0.0
5 weeks	2.8	1.2	0.8
12 weeks	2.7	0.8	1.7
Servings of vegetable			
Baseline	0.3	6.0	0.3
5 weeks	1.8	2.9	3.7
12 weeks	1.9	3.6	2.9

Table 15 exhibits the NDSR calculated calories, total fat, sugar, and fiber consumed on average during the three dietary recalls. Table 16 shows lipid, metabolic, blood cell, or inflammatory biomarkers where at least one of the participants was out of range of accepted values.

Table 15 Average calories, fat, sugar, and fiber consumption during the three 72-hour food recalls

	Participants								
	A			B			C		
Time points	Day 1	6 weeks	12 weeks	Day 1	6 weeks	12 weeks	Day 1	6 weeks	12 weeks
Calories(kcal)	1742	1577	1937	2200	1221	1320	2173	1514	1761
Total fat(g)	83.9	63.4	88.1	87.7	41.3	46.7	103.5	58.1	69.2
Sugars(g)	80.3	110.9	93.6	64.0	51.0	51.1	139.5	118.5	127.7
Fiber(g)	7.1	12.7	12.2	34.2	16.4	15.0	7.6	15.4	12.0

Table 16 Blood collection test results

Serum biomarker (acceptable range)	Revised food package group Participant A 0 weeks	Participant A 6 weeks	Participant A 12 weeks	Original food package group Participant B 0 weeks	Participant B 6 weeks	Participant B 12 weeks	Participant C 0 weeks	Participant C 6 weeks	Participant C 12 weeks
Total cholesterol (125-200mg/dL)	204	172	179	197	188	179	154	129	146
HDL (≥46mg/dL)	48	49	58	51	48	51	27	27	30
Triglycerides (<150mg/dL)	146	103	104	212	168	179	233	115	143
LDL (<130mg/dL)	127	102	100	104	106	92	80	79	87
Cholesterol to HDL ratio (≤5)	4.3	3.5	3.1	3.9	3.9	3.5	5.7	4.8	4.9
Glucose (65-99mg/dL)	85	95	81	82	90	77	84	100	78
Red cell width (11-15%)	14.7	14.9	15.4	13.9	13.7	13.3	15	14.1	14.8
Platelet count (x1000) (140,000-400,000/μL)	398	400	409	255	243	230	381	346	316
C-Reactive protein (<0.8mg/dL)	1.34	0.71	0.87	1.65	1.42	1.54	0.37	1.02	0.46

Discussion

If this metabolic/diet study only tested the dietary component, it would have appeared that participants had not improved their health or nutrition during participation in this study. Body mass index was stagnant for participants and values changed less than one point for all participants regardless of placement on the revised or original diet. Although participants were taught the benefits of fruits and vegetables, two out of the three participants did not consume adequate levels of either item. All participants increased their fruit group consumption by the end of the study, but there were mixed results for the vegetables. The participant on the revised diet consumed more fruits than both participants who received the original food packages (her baseline value was also higher) although she consumed fewer vegetables than both participants with the original diet. Fat consumption was unpredictable throughout the study for most participants as were sugar and fiber intakes. The overall calories did not appear excessive, but this could be attributed to under reporting or the inability to accurately determine portion sizes [(75)].

Conversely, the metabolic component uncovered some health benefits of this study with the lipid profiles showing improvement for all three participants. All three participants decreased their total cholesterol levels, decreased triglyceride levels, and decreased their cholesterol to HDL ratio. Fewer lipids circulating in the blood can lead to a decreased risk of heart disease; consumption of Vitamin C and fiber, nutrients found in fruits and vegetables, also contribute to decreased disease risk [(76, 77)]. The participant on the revised food package, who consumed the most fruit, decreased her C-reactive protein

the most although she was still was not within the acceptable range. A study in men showed that an increase in fruit consumption decreased C-reactive protein, an identifier of inflammation [78]. Another study in women showed that fruit and vegetable consumption helped decrease C-reactive protein [79]. Information from most of the biomarkers, like glucose or platelet counts, did not give conclusive data.

Due to the small number of participants completing this pilot, statistics were not used to analyze the data. Still, this study teaches many principles that can be applied for future research. Each revised package was supposed to utilize all five dollars of the produce voucher. Even with access to a calculator, we sometimes did not accurately measure the value of the produce. Scales used in the produce aisles may not have been calibrated to match the scales at the register, or the produce aisle scales were possibly not calibrated frequently enough to accurately weigh the produce. WIC documents were available in the produce area to help determine how much a certain measurement of fruit or vegetables would cost, but it was still helpful to have a calculator to determine costs.

In Texas, when WIC participants redeem their cash value of produce in excess of the value of the voucher, the entire product is removed from the transaction (e.g. all bananas or all grapes). Cashiers at this particular grocery store were trained to remove a single banana or tomato so that the entire transaction is not rejected. This is often not typical among stores that provide WIC foods. With such a potential hassle, items with a set price (e.g. $0.79 or 2 for $1.00) would be less of a bother when redeeming produce with the vouchers. Grocery stores should calibrate their scales more frequently so that

WIC participants will not have issues redeeming the entire value of their fruit and vegetable vouchers.

This pilot study encountered some limitations which could be corrected in future studies. The first weight measurement for Participant A was taken after a small breakfast snack was given rather than before the snack was offered. This problem could be ameliorated by better communication among researchers. There was also some discrepancy in measuring the height of participants which could be mediated by training all individuals the same methods for determining height and by investing in a more accurate measuring instrument. As shown by the sample size of this study, there were issues of participants prematurely exiting the study. A longer recruitment period could help generate a larger sample size. Packages were pre-made before the participant arrived at the grocery store which limited the participants' ability to choose their preferential foods. This may have also influenced the variety of foods consumed. In the future, researchers could have participants request the food for their packages. The nutrition lesson discussed low-fat dairy, whole grains, etc. which may have been too overwhelming to incorporate at one time although a recent WIC study in California showed benefits with lessons on these different components over a six-month period [80]. The duration of the study could be increased with subsequent nutrition lessons limited to one for two topics per education session.

Other limitations were that food packages offered in the study were not exactly identical to the food packages used by WIC participants because store brand foods were preferentially used over the name brands (due to sponsor guidelines). It was also not

feasible to provide the exact same food packages to participants who had different starting dates. There was variability in the quantity and category of fresh fruits and vegetables redeemable from week to week, and the weight or size of produce sometimes would be a hassle to match up. Car problems and other transportation issues contributed to difficulties for participants to arrive at the health clinic or grocery store in a timely fashion.

In conclusion, participation in this study showed detectable cholesterol and lipid improvements in all three participants even though weight and BMI exhibited minimal change. Other positive health impacts these participants included increased consumption of items in the fruit group. If an exercise component was added to future metabolic/diet studies, BMI might decrease more drastically which would have benefited these study participants.

CONCLUSIONS

WIC has made an impetus to create change for the health and nutrition of WIC participants all over the country by updating the WIC food packages. With so many WIC participants of varying ages, cultures, backgrounds, and education levels, this public health program has the opportunity to improve nutrition at multiple sectors of the population. WIC underwent an extensive process entailing the selection and approval of new food items, collaboration with vendors, and computer and redemption system updates. Remarkably, all national WIC Programs introduced the new WIC food packages by the end of the 2009. Even with the enhanced food package changes, the vast majority of the WIC budget is utilized for WIC food packages with average prices of food packages ($42.20 in 2009 and $41.42 in 2010) actually decreased post-implementation of the revamped food packages [81]. Like the WIC food packages, costs of administration, support, and education of the WIC program have been relatively contained from over 1.26 billion dollars for 2003 (28% of overall expenses), when evaluation by IOM began their evaluation, to 1.910 billion (29% of expenses) in 2010 [81, 82].

NATFAN

Although this dissertation focused on women and infant participants, it is important to mention some of the NATFAN children participants' (NCP) 100% juice, fruit, and vegetable consumption trends to more fully understand the implications of nutritional behaviors of NWP and NIP. In addition, childhood obesity rates are higher than twenty years ago, although data has also shown that WIC children were not more

likely to be in danger of obesity than non-WIC children [83]. NCP statistics for one-year-olds were run separately than the two up to five-year-olds because due to nutritional guidelines issued from the American government [84].

NCP two up to five-year-olds were significantly likely to consume 100% juice more frequently and consume fruits and vegetables less frequently following food package changes as reported in NATFAN´ and NATFAN´´. After package changes, one-year-old NCP were significantly more likely to consume 100% juice and fruits less frequently. There were no significant juice, fruit, or vegetable consumption differences between NCP aged one year or two up to five years of NPC versus children of non-Native American NPC.

For all women, infant, and children HLM models, there were only significant nutritional differenced for Native American NWP 100% juice and vegetable consumption. There were no fixed effect differences for NCP or NIP. When the significant 100% juice, fruit, and vegetable models were combined by age group, there were two ITO interaction differences for NIP (zero through eleven months), two ITO interactions for two up to five- year-old NCP, and one ITO interaction for the one-year-old NCP. NWP had four significant ITO interactions. It appears that NIP and NCP cared for by Native Americans and administered by ITO are following similar nutritional patterns to their non-Native American, state/territory counterparts. On the other hand, NWP are having some unique nutritional patterns from non-Native Americans and state/territory WIC programs. WIC staff at ITOs or those who administer to Native American participants need to be cognizant that their adult women population may

exhibit nutritional differences, especially with 100% juice consumption, from other NWP. WIC staff should specifically learn about the cultural practices of these Native American adult clients to help cultivate nutritional well-being of these women and their children.

As evidenced by the majority of NATFAN participants not meeting recommend levels of fruits and vegetables even after administration of the revised food packages, WIC Programs across the country are confronting great challenges. Since WIC participants are so diverse (culturally, academically, etc.), it is important for WIC staff to integrate the national WIC guidelines to meet the needs of participants in their community. Presentations about consuming a rainbow of colors, introduction of fruits and vegetables during taste tests or cooking demonstrations, recipe books, and guidelines for consuming healthy foods at popular restaurants are ideas that WIC staff can use to help increase fruit and vegetable consumption [80, 85]. Great flexibility is given to WIC to develop lessons or programs for their individual states and clinics, and WIC programs should use evaluation tools like NATFAN to monitor nutritional progress. WIC staff may also want to teach and collaborate with other medical professionals and medical organizations about maternal and early childhood nutrition so that WIC participants do not have to choose between two different sets of dietary advice [11].

Metabolic/Diet Study

There were also some interesting findings with the metabolic/diet data for obese women who were provided either the original or revised food packages. Since the BMI was minimally affected by participation in the program (nutrition lesson and

supplemental food packages), WIC may need to add more to the WIC Program to better meet the needs of its obese clients. There was no physical activity component of this project, nor is there any requisite exercise regimen for participants in the WIC program. I would recommend a more formal exercise approach added to the WIC program. Inexpensive and non-time consuming methods of incorporating exercise into the WIC program could include discussions during nutrition educations, formulating walking routes/walking groups near WIC clinics, or giving referrals to primary doctors to recommend exercise plans. These simple steps could help enhance the healthy lifestyle that WIC is encouraging with the new WIC food packages.

Some participants took part in the metabolic/diet project to deal with specific issues like weight or cholesterol. It may be helpful for WIC staff to ask why their clients are participating in the WIC Program so that individuals feel they truly are benefiting from the experience. Since so many participants in WIC are overweight, I would encourage WIC staff to teach that weight is not the only marker of health. Although many of the adult participants will be interested in losing weight after the delivery of their baby, WIC participants should understand that lifestyle modifications should focus on the long-term. Drinking less sugary beverages, walking and participating in other exercises, and continued incorporation of fruits and vegetables into their diet will help improve their overall health. It is important that participants know that some biomarkers, like cholesterol, cannot be determined by a person's weight but through tests like lipid panels.

Future Implications for WIC Food Package Evaluations

Although WIC staff mentioned increasing workloads and attrition of staff members, the national WIC Program was still growing in participant number and budget during the NATFAN study. There was a finite window of opportunity to administer NATFAN´ before food packages were rolled out, but the majority of WIC Programs were up to the challenge. Some WIC Programs implemented NATFAN´´ just six months after the rollout of the revised WIC food packages. Therefore, it would be optimal to offer another administration of NATFAN´´´ to determine further changes in nutritional behavior. The feasibility of large-scale WIC evaluations, like NATFAN, appears to be in jeopardy. Since NATFAN´´ was administered, the NATFAN project experienced sudden funding cuts before the contract was completed.

The economic situation affecting many aspects of the economy has now trickled down to the WIC Program. The WIC budget for 2011 was set at 6.7 billion dollars, down from the original 2010 budget of 7.3 billion [(54)]. A decreased budget directly relates to a decreased number of participants available to participate in the WIC Program. The mean WIC participation numbers for 2010 was approximately 9.2 million while the latest figures for 2011 show only 8.9 million participants [(86)]. With such a decrease in funding, subsequent large-scale NATFAN projects may not be probable, but should be available to state and individual programs to continue to monitor the dietary progression of their clients. Even without major evaluations, WIC staff should make concerted efforts to identify strategies to help improve fruit and vegetable consumption to help improve the health of their participants.

Research Questions with Answers

Specific research questions established in the introduction of this dissertation and detailed in the body sections of this dissertation are answered in the following segment.

Research question 1: Are there fruit and vegetable frequency of consumption differences between NATFAN participants administered by states/territories and ITOs?

Surprisingly, there was a decrease in the consumption of fruits and vegetables for overall NWP, with an increase in fruit and vegetable consumption for the overall NIP, post-rollout of the WIC food packages. Specific to differences between ITOs and states/territories, NWP from ITOs were significantly less likely to consume 100% juice or vegetables if they were breastfeeding as compared to breastfeeding NWP from states/territories. Postpartum NWP from ITOs were significantly more likely to consume 100% juice than their state/territory counterparts. ITO NWP were also significantly more likely to consume 100% juice after food package rollout than their state/territory peers.

NIP from ITOs who consumed greater quantities of jars of baby food were significantly less likely to consume 100% juice than NIP from states/territories. As age increased, NIP from ITOs were significantly less likely to consume fruit than their state/territory counterparts**.**

Research question 2: Is the frequency of consumption of fruits and vegetables of Native American NATFAN participants different from non-Native Americans after the rollout of the updated WIC food packages?

Native American NWP were less likely to consume 100% juice and vegetables than non-Native American NWP. There were no significant 100% juice, fruits, and

vegetables consumption differences for NIP with Native American versus non-Native American NPC. Racial status of the NIP was not requested in NATFAN.

Research question 3: What other characteristics affect 100% juice, fruit, and vegetable frequency of consumption in NATFAN participants?

Pregnant NWP were significantly less likely to consume 100% juice, fruit, and vegetables than their non-pregnant peers. Postpartum NWP were significantly less likely to consume 100% juice than non-postpartum NWP. Breastfeeding NWP were significantly less likely to consume 100% juice, fruit, and vegetable consumption than the rest of the NWP population. Pregnant, postpartum, and breastfeeding categories were not mutually exclusive categories, so some people may have answered for multiple categories, did not answer for any category, fed their infants formula, were new to the WIC program, or were not currently enrolled in WIC, although directions noted that the survey should be given to participants. NWP that consumed a greater variety of fruits were significantly less likely to consume fruit. NWP who consumed a greater variety of vegetables were significantly less likely to consume vegetables.

Currently breastfed NIP were significantly less likely to consume 100% juice or fruit than non-breastfed NIP. NIP who consumed jars of baby food were significantly more likely to consume 100% juice, fruits, and vegetables. NIP who consumed milk (other than breast milk or formula) or sweetened beverages were more likely to consume 100% juice than NIP who did not consume any of these items. NIP who had higher consumption rates of a variety of fruits or vegetables were significantly more likely to consume 100% juice. As NIP ages increased, they were significantly more likely to

consume 100% juice. Increased 100% juice, sweetened beverages, and vegetable frequency of consumption significantly increased the likelihood of consumption of fruit for NIP. Increased age also significantly increased the likelihood of fruit consumption in NIP. Milk, 100% juice, and fruit frequency of consumption significantly increased NIP likelihood of consumption of vegetables. Graduated age increased significantly increased NIP likelihood of vegetable consumption.

Research question 4: Are there any detectable differences in weight or lipid blood profiles for obese women who consume WIC diets for three months?

There were negligible weight and BMI differences between the baseline and completion phases of the study. Conversely, all participants showed decreases in total cholesterol, triglycerides, and total cholesterol to HDL ratios.

Research question 5: What are the differences in blood profile changes or BMI between women who eat the original food package versus the revised food package?

As stated earlier, there were minimal BMI changes. Since only three participants completed the study, clear trends cannot be established for many of the biomarkers that were measured. LDL, blood glucose levels, platelet counts, C-reactive protein, and red blood cell width were variable throughout the study. All participants showed improvements in their overall cholesterol and triglyceride levels.

Research question 6: Do participants actually consume the 100% juice, fruits, and vegetables offered in the food packages?

By the end of the study, all participants were consuming juice. On average, the participant given the revised diet consumed more items in the fruit group than the

participants given the original WIC food packages (at baseline, she also consumed the most fruits), although all participants increased consumption. There was no clear trend with vegetable consumption. Since the fruits and vegetables offered in the revised food package could have been eaten over a short period of time, it could not be determined through the dietary recalls if some or all of the fruits and vegetables provided in the revised were consumed.

Summary

At the time of this writing, the WIC Program and its food packages are undergoing critical evaluations to meet the unique needs of WIC participants in the twenty-first century. As part of the NATFAN study, WIC food packages were evaluated by obtaining baseline food frequency survey data before and after food package changes. Nationally, fruit and vegetable frequency of consumption decreased among NWP and increased among NIP between the two time points of the study. WIC should capitalize on the NIP success and work on improving the transition of the infant diet to the family diet; this means that fruit and vegetable lessons cannot center just on infant or child eating behaviors but should focus on improving the entire family's diet [66].

Native American NWP exhibited some nutritional differences including a decreased likelihood of 100% juice and vegetable consumption than non-Native American NWP while NIP of Native American caregivers did not show any 100% juice, fruit, or vegetable consumption differences from NIP of non-Native American NPC. There were minimal difference between ITOs and states/territories for NWP and NIP

showing that these ITO WIC communities are faced with similar nutritional issues encountered by the general NWP and NIP.

This dissertation research is important because it is national in scope and analyzes nutritional behaviors of populations from Native Americans and ITOs. Since WIC has never revamped its entire program to such a magnitude, this was an opportunity to learn more about the impacts of WIC in Native American nutritional practices. The metabolic/diet study is also important because it focused on the individual's actual consumption behaviors and assessed how the WIC diets affected the health of the individual by analyzing both dietary and metabolic profiles. WIC staff and medical professionals should encourage incorporation and consumption of the WIC foods because they contribute to an overall healthy diet and can help improve lipid profiles of participants.

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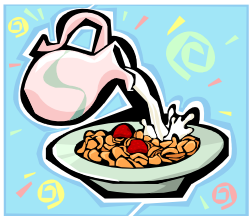
APPENDIX: DIET/METABOLIC STUDY DOCUMENTS


WANTED:

Plus-size Women to be in a Nutrition Study!

What you will get:

- To participate in a 3 month nutritional research study
- Free nutrition lesson on how to eat healthy
- Over $100 worth of food (including milk, cereal, juice, cheese)
- $50 worth of Gas cards

What you will be asked to do:

- Give three, small blood samples at the Brazos Valley Community Health Center
- Write three food diaries of what you eat

You will be able to participate, if you are

- A 18-50 years old women
- Plus-sized or full-figured
- Not on medication for diabetes or heart disease
- Non-smoker and drink less than 2 servings of alcohol a day
- Not pregnant or currently on WIC

Contact us today at **979-458-2679** or **orin@tamu.edu**

Gift Card Receipt Form

This form will need to be completed each time a gift card is distributed. If the participant is a state employee, the participant will have to waive the right to getting a gift card because it impacts payroll status.

Date _____

Name _____

Address_____

_____

Gift card amount _____

Gift card serial number _____

Please initial either option 1 or 2:

Option 1: I am NOT an employee of the State of Texas (eligible to receive gift card) _____

Option 2: I AM an employee of the State of Texas (*waiving right to compensation*). _____

Signature _____

FOOD VOUCHER #___

Please pick up your food package at the HEB Bryan store (725 East Villa Maria) from

_____Date to Date_____

Take this voucher to the HEB customer service desk to pick up your food package. You can use this voucher any time during the above dates.

If you have any questions, please contact Rachel at 979-458-2679.

VITA

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