Nutrition education and anaemia outcome in inner city black children

Arezoo Rojhani and Magdalena Niewiadomska-Bugaj

OPSOMMING

Agtergrond Genoegsame data dui aan / suggereer dat Afro-Amerikaanse kinders, veral dié wat deur arm sosio-ekonomiese omstandighede benadeel word, steeds 'n hoë voorkomssyfer van anemie ondervind.

Metode Hierdie studie het ondersoek ingestel na die effek van intensiewe voedingonderrig op die voorkomssyfer van anemie in 'n steekproef van 116 anemiese Afro-Amerikaanse kinders wat aan die "Special Supplementary Food Program for Women, Infants and Children" (WIC) deelneem. Die moeder/kind pare is ewekansig in 'n kontrole en 'n intervensie groep verdeel. Moeders in die kontrole groep het die gewone WIC voedinginstruksies ontvang, terwyl die moeders in die intervensie groep aan 'n spesiaal ontwikkelde meerfasettige voedingonderrig program blootgestel is. Die voorkoms van anemie, die voedingskennis van moeders rakende die ysterinhoud van voedsel, bloed hemoglobien (Hb) konsentrasies en dieettoereikendheid is aan die begin en die einde van die studie vir elke groep geassesseer.

Resultate Die gemiddelde verskille tussen die yster voedingkennis punte van die moeders en die bloed Hb konsentrasies van die kinders in die intervensiegroep voor- en na die proeftydperk was betekenisvol hoër as dié van die kontrole groep. Die omvang van die vermindering in anemie-voorkoms was ook hoër vir die kinders in die intervensiegroep.

Gevolgtrekking Daar is aangetoon dat die voorkoms van anemie in hierdie groep Afro-Amerikaanse kinders verlaag het deur gebruik te maak van meerfassettige- en teikengerigte voedingonderrig intervensies.

— **Dr Arezoo Rojhani**
Department of Family & Consumer Sciences
Western Michigan University
Kalamazoo MI 49008

— **Dr Magdalena Niewiadomska-Bugaj**
Department of Statistics
Western Michigan University
Kalamazoo MI 49008

Acknowledgment
The authors are indebted to Rosemary Barnum, B.S., WIC coordinator, Amy Erich, B.S., R.D., and the clerical and technical staff at Family Health Center WIC offices. This project was funded by a FRACASF grant from Western Michigan University.

INTRODUCTION

Iron deficiency anaemia (IDA) is an important public health issue for children as it is the most common nutritional disorder in early childhood (Bushnell, 1992; Adish *et al*, 1999). The requirement for iron is high during infancy and preschool years, when velocity of growth is rapid and metabolic demands are high (Chwang *et al*, 1988). The rapid rate of growth coincident with frequently inadequate intake of dietary iron places children aged <24 months, particularly those aged 9-18 months, at the highest risk of any age group for iron deficiency (Chwang *et al*, 1988; US Department of Health and Human Services, 1998:6). Important functional consequences of iron deficiency in children are reduced resistance to infection, growth faltering, and impaired intellectual development (FAO, 1988: 27).

By far the most significant outcomes of IDA among children are cognitive deficits as well as behavioural changes. IDA has been associated with lowered scores on tests of mental and motor development (Lozoff *et al*, 1991). There is evidence that the negative effects of IDA on mental and motor development are long lasting, and that these adverse consequences may not be fully reversible with treatment (Bushnell, 1992; Walter *et al*, 1989).

The prevalence of IDA in preschool children has been estimated as between 10 and 30% worldwide (Childs *et al*, 1997: 144; James & Laing, 1994). In the United States introduction of the federally funded Special Supplementary Food Program for Women, Infants, and Children (WIC) has resulted in a decreased incidence of iron deficiency and IDA (Miller *et al*, 1985, Vasquez-Seoane *et al*, 1985). Analysis of data collected from the third National Health and Nutrition Examination Survey (NHANES III) that took place from 1988-1994 in the United States indicates that for ages 1 to 2 years, the prevalence of iron deficiency was 9%, and IDA was found in 3%. For those aged 3 to 5 years prevalence of iron deficiency was 3%, and IDA was found in less than 1% (Looker *et al*, 1997). However, ample evidence suggests that low income black children, continue to have high rates of iron deficiency and IDA (Abilson, 2001).

AIM OF THE RESEARCH

This study examined the effect of intensive nutrition education over a 6-month period on anaemia outcome in a sample of low- income African American children 1-5 years of age at two inner city WIC program clinics. The anaemia status, maternal nutritional knowledge pertaining to iron content of foods, blood Hb concentrations, and diet quality was assessed at baseline and at the end of the study. To our knowledge this is the first report on the effect of intensive nutrition education on anaemia outcome among exclusively low- income anaemic African American children.

METHODS

Study Population

The study participants were African American mothers and their children who were enrolled at the WIC program offices in two inner city, independent, health centres. Both centres were located in primarily African American neighbourhoods, with high rates of socioeconomic deprivation. During the months of May and June one hundred thirty mothers of preschool children (ages 1-5 years) whose children were examined at routine WIC visits and found to be anaemic were identified by the staff at the participating WIC program offices. Approximately 1200 children aged 1-5 are seen at these WIC offices on a monthly basis. Of these roughly 15% are identified to be anaemic. Anaemia is defined as Hb <11,0 g /dl for age group 6 to 23 months and Hb <11,1 g /dl for age group 24 to 59 months in the WIC program offices in the state of Michigan. These age- specific cut off values are based on the data collected from the third National Health and Nutrition Examination Survey conducted in the United States of America from1988-1994 (US Department of Health and Human Services, 1998: 65). All mothers were appraised about the intent of the study.

In order to be selected into the study the children had to meet the following criteria: (1) no evidence of chronic disease, (2) no history of lead poisoning or exposure to lead, (3) no evidence of sickle cell-anaemia or Thalassemia trait, (4) no infections or hospitalizations i.e. ear infections, fractures etc during the month prior to enrolment, (5) no evidence of pre-maturity or low-birth weight, (6) not receiving iron therapy. After obtaining informed consent from the mothers, the mother-child pairs were randomized into control and intervention groups. Of the original one hundred thirty mother-child pairs, eleven were later excluded from the study based on a review of the child's WIC records. Of these two had evidence of elevated blood lead levels, three were born pre-maturely, and six had sickle cell anaemia. In addition three children, one from the control group, and two from the intervention group were later excluded from data analysis since they were not considered to be anaemic according to the Hb cut off values used by the WIC program. The Western Michigan University's Institutional Review Board granted approval for the study.

Design of the Intervention

The study was designed so that the mothers in the control group would experience the "business as usual ", in the WIC office when a child is identified to be anaemic. This usually consists of ten to fifteen minutes of nutrition education devoted to iron issues over a six-month period.

The nutrition education for the mothers in the intervention group was delivered through three different vehicles namely one on one education sessions conducted by trained dietetic students, direct mail, and cooking classes. All intervention components were designed under a unifying theme, entitled "Pump Some Iron into Your Child's Diet" in order to reinforce the purpose of the various interventions.

The nutrition education session was conducted during the months of May and June in the WIC program office at certification or re-certification time. During nutrition education session the mothers were presented with and talked through a colourful pamphlet that explained in simple words why it is important for young children to get enough iron, discussed symptoms of iron deficiency and provided examples of foods that are good sources of iron, and ways to improve absorption of iron from foods. Issues regarding problems with excess milk and juice consumption were also addressed since this can some times be a problem for toddlers. In addition the pamphlet provided a sample one- week menu with high iron and vitamin C meal and snack ideas. This pamphlet was created for the purposes of this study. A recipe handout was prepared and distributed as a supplement to the pamphlet to provide information on the preparation methods for some of the less familiar meal ideas. Most recipe ideas were taken from the *Betty Crocker's Kids Cook* (Crocker, 1999) and *Better Homes and Gardens New Junior Cookbook* (Dorland-Darling, 1997). Both of these cookbooks feature recipes that were created with input from children, and hence tend to be more popular with children. Portion sizes were stated in simple, straightforward amounts (eg ½ cup of milk, two slices of whole wheat bread, etc). Food models and measuring utensils were used during nutrition education sessions as an additional aid to help mothers understand portion sizes for different foods.

The cooking class was conducted in July and again in August to ensure that most intervention group subjects would have a chance to participate. Several strategies were utilized to maximize attendance: (1) personal invitations were mailed to the mothers two weeks in advance of the scheduled cooking class along with free bus passes for families with no means of personal transportation, (2) attempts were made to remind the participants by phone two days prior to each cooking class, and (3) all those who attended the class received a ten -dollar gift certificate that could be redeemed at a large supermarket chain in the city. The session started with a short quiz to stimulate interest and provide additional feed back for the researcher regarding retention of nutrition information from the one on one education session. After a short discussion of the quiz, three simple, quick and fun recipes rich in iron that mothers and children could prepare together were demonstrated. Each participant was provided a hand out that outlined preparation methods for the recipes. After the demonstration the participants and their children were encouraged to taste the prepared foods.

Since we had limited opportunities for personal contact with the WIC clients, we also used direct mail as an intervention tool. The direct mail messages were organized into short one- page newsletters that reinforced information presented during the one on one nutrition education session and cooking class. All newsletters contained a "cooking tips and helpful hints" section where strategies for dealing with picky eaters and ideas for overcoming barriers to incorporating iron into the child's diet were discussed. In addition, a game was included with each newsletter encouraging parents and children to work together to unscramble the foods rich in iron and vitamin C.

Survey Instruments

A structured, coded, self-administered questionnaire consisting of 58 items was presented to each participant once at the time of enrolment in the study, and again shortly after the end of the six months study period. The purpose of the instrument was to collect data on demographic and family/child characteristics, assess adequacy of consumption of foods from the different food groups of the Food Guide Pyramid (US Department of Agriculture, 2000), as well as specific foods rich in iron and vitamin C, and evaluate mother's knowledge about iron content of foods. Fourteen items on the instrument dealt with demographics and family/child characteristics, thirty with frequency of consumption of different foods, and fourteen with knowledge of iron content of foods. Some of the questions were open-ended and were included on the instrument for clarification purposes.

Demographic characteristics collected included maternal age, marital status, mother's educational attainment, family size, child's sex, and child's age. The following data on family/child characteristics were also obtained from participating mothers: access to food assistance other than WIC, whether mothers had previously received any education about foods that are good sources of iron, individual responsible for grocery shopping at home, person primarily responsible for cooking at home, and use of iron therapy. Information on breast-feeding practices was abstracted from WIC records.

A food frequency questionnaire was utilized to assess diet quality. Mothers were questioned about frequency of consumption of foods from the different food groups on a daily or weekly basis, for example, 3 servings per day, 1-2 servings per day, 3-5 servings per week, or less than 3 servings per week. The emphasis was on determining regularity of consumption of foods rich in heme iron such as meats, fish, poultry, and those containing primarily non-heme iron, such as dried beans, fortified cereals, and green leafy vegetables (Hallberg, 1994). Data was also collected on the frequency of consumption of specific foodstuffs rich in vitamin C, such as fresh fruits, fruit juices, and fresh vegetables as an adjunct to iron absorption (Hallberg, 1994). Selection of food items for the questionnaire was done in consultation with two WIC dieticians with ample knowledge about modern day African American food habits. The questionnaire listed standard foods supplied by WIC such as fortified cereals, bread, dairy products, and other protein foods, as well as foods that are common staples of African American cuisine such as watermelon, tomatoes, collard greens, etc (Kittler and Sucher, 2001: 183). Participating mothers were also asked about frequency of consumption of fast foods by their pre-schoolers.

The nutrition knowledge questions were designed to examine the mother's ability to identify commonly used foods that are considered to be significant and insignificant sources of dietary iron. The survey was not intended to be extremely difficult, but to measure fundamental nutrition knowledge about iron sources. Food items chosen for the survey represented all five food groups of the Food Guide Pyramid (FGP) (US Department of Agriculture, 2000): 1) bread, cereal, rice, and pasta group; 2) Vegetables; 3) fruits; 4) milk, yogurt, and cheese; and 5) meat, fish, poultry, and meat alternates. Of the fourteen food items chosen six were poor sources of iron (<1,0 mg/serving), and eight were good sources of iron (>1,5 mg/serving).

The foods that contained significant amounts of iron were whole grain breads, green peas, broccoli, ground beef, raisins, baked beans, fortified cereals, and chicken. These foods were chosen from a nutrition education handout regarding iron-rich foods given out by WIC dieticians to mothers of anaemic children at certification or recertification time. Foods that were considered to be poor sources of iron were apple, milk, hot dog, cheese, peanut butter, and pudding (Whitney & Rolfes, 2002: 436). The mothers were asked to answer each question by marking the box corresponding to yes, no or don't know. If the mother's response was wrong or they marked the "don't know" box on the questionnaire, they received a score of 0 for that question. Individual scores for each respondent were then calculated by tracking the number of questions answered correctly (eg 1 point = 1 question right).

The survey instrument was developed after reviewing instruments used in public nutrition surveys and was based on current knowledge regarding risk factors for childhood iron deficiency anaemia. Content validity was established by a review committee consisting of five WIC dieticians with extensive experience in this population. We pre-tested the survey instrument using the cognitive interview technique, a think-aloud interview in which the client is asked to read each question aloud and then think aloud when answering the question (Willis, 1994: 1; Jobe & Mingay, 1989). This method allows the interviewer to identify questions that are misinterpreted or not easily understood. Cognitive testing of the questionnaire was carried out two different times and appropriate changes were made to the survey.

Data Collection and haematological assessments

WIC records for the one hundred and sixteen study participants were reviewed to obtain Hb values at the start of the study and again at the end of the six-months study period. All Hb values were obtained by capillary venous sample and processed by an office-based screening instrument (Hemocue b-haemoglobin photometer, Angelholm, Sweden).

Information from WIC records

Additional pieces of information that were abstracted from the WIC records were: exact age of the child, breast-feeding practices, and child's length and weight at baseline and at the end of the study.

Data processing and statistical analysis

All questionnaires were checked for completeness and accuracy of responses following completion by participants. Initially, frequencies and descriptive statistics were calculated on all demographic and family/child characteristics, iron nutritional knowledge score, and blood Hb data. Baseline differences between control and intervention groups were compared using Pearson's chi-square test in the case of categorical data such as demographic and family child characteristics. Test for two proportions was used to analyze other categorical data including post-trial differences between control and intervention groups for prevalence of anaemia as well as comparison of pre- and post-trial adequacy of food consumption.

For numerical measurements (eg, haemoglobin level, iron nutritional knowledge score), a two-sample t-test was used; where significance of expected trends (i.e. increase in blood haemoglobin levels or decrease in anaemia rates) was tested using a one-sided two-sample t-test, while comparison of baseline data between control and intervention groups was done with a two-sided two sample t-test. Correlation between changes in iron nutritional knowledge score and the corresponding change in blood haemoglobin concentrations was assessed with Pearson's correlation coefficient.

Due to missing data with respect to some variables, in interpreting the results of statistical analysis, p-value <0,05 was considered highly significant, while p-values in the range of 0,05 – 0,1 were considered significant. All statistical tests were run on MINITAB statistical software (Minitab Inc., 2000).

RESULTS

Characteristics of the study population are presented in Table 1. The control and intervention groups were similar with respect to all demographic and family / child characteristics. Majority of mothers in both control and intervention groups were between 18 to 30 years of age. Very few of the mothers in either group had graduated from college or vocational school. Most of the mothers in both groups either had completed some high school or had graduated from high school. More than 70 percent of mothers in both groups were single. Majority of the mothers had no more than 3 children.

More than half of the families in both groups were receiving other forms of food assistance in addition to WIC. Of those receiving additional food assistance 32 percent of the families in the control group and 38 percent of the intervention group participants were receiving welfare benefits, the remainder were making regular use of Loaves and Fishes (a local food bank). More than 80 percent of the mothers in both groups were primarily responsible for doing the grocery shopping and cooking.

Most of the children in both control and intervention groups were in the age groups of 12 to 18 months, and 25 to 36 months (Table 1). Few of the children in either group were breast-fed. The only child variable found to be significantly different between control and intervention groups was age of introduction of meat into the child's diet. The mean (± standard error of the mean) age for the control and intervention groups was 11,7 ± 0,46 and 10,2 ± 0,32 months respectively, p=0,007 (data not shown in table). It is interesting to note that 77 percent of the mothers in the control group and 82 percent of the mothers in the intervention group stated that they had previously received nutrition education on iron.

Baseline iron nutritional knowledge score of the mothers and blood haemoglobin concentration of the children in the control and intervention groups were not significantly different (p-values 0,234 and 0,157 respectively – Table 2A). To examine the effect of the intervention we assessed significance of the differences between pre-and post trial maternal iron nutritional knowledge score and children's blood haemoglobin level. Pre- and post-trial differences for both variables were significantly larger in the intervention group than in the control group (p-values for iron nutritional knowledge score and blood Hb level are 0,000 and 0,022 respectively – Table 2B).

The influence of previous iron education on the pre-trial iron nutritional knowledge score of the mothers is presented in Table 3. The mean pre-trial iron nutritional knowledge score of the mothers who had previously received nutrition education on iron was significantly higher than those who did not have previous iron education (P=0,016). We also examined the correlation between the change in mothers' iron nutritional knowledge score and the corresponding change in their children's blood Hb level. A strong correlation among these variables was observed for both control (r=0,41) and intervention (r=0,55) groups (Table 4).

Table 5 illustrates prevalence of anaemia among target children at the end of the 6-months study period. At the conclusion of the study, there were more than twice as many anaemic children in the control group as compared to the intervention group. The prevalence rate dropped to the level of 28,6% in the intervention group versus 62,5 % in the control group. This difference was highly significant (p=0,000).

Adequacy of children's diet was assessed at baseline and again at the end of the intervention by comparing mother's reported frequency of consumption of different foods by their children with guidelines used by the WIC (Michigan Department of Community Health, 2001)(Table 6). From the Food Guide Pyramid food groups (US Department of Agriculture, 2000), post-trial adequacy of fruit juice consumption significantly increased (p=0,076) for the children in the intervention group as illustrated by an increase in the percentage of children that consumed no more than 12 ounces of fruit juice per day. At the end of the intervention, both control and intervention groups showed a significant increase in percentage of children that were consuming adequate number of servings from iron-rich foods, red meat, chicken, fish and fortified cereals as well as some of the vitamin C-rich foods, mainly the leafy greens and broccoli. There was also a significant increase in percentage of children in the intervention group who reportedly consumed adequate number of servings of tomato or tomato juice (p=0,000). A similar increase in consumption of "other vitamin C fortified juices" and kiwi was reported for the children in the control group.

At the end of the study, for both control and intervention groups, there was a decrease in per-

TABLE 1: COMPARISON OF CHARACTERISTICS OF STUDY POPULATION

VARIABLE	CONTROL GROUP (N =59)		INTERVENTION GROUP (N = 57)		P-VALUE [a]
	N	%	N	%	
Maternal age (yrs)					0,410
<18	1	1,69	3	5,26	
18-24	23	38,99	29	50,88	
25-30	23	38,99	16	28,07	
31-40	9	15,25	8	14,04	
>40	3	5,08	1	1,75	
Marital status					0,985
Single / divorced	43	72,88	42	73,68	
Single w/live-in companion	10	16,95	9	15,79	
Married	6	10,17	6	10,53	
Mother's education					0,316
Some high school	16	27,12	22	38,60	
Graduated from high school	29	49,15	19	33,33	
Some college or vocational training	9	15,25	12	21,05	
Graduated from college or completed vocational training	5	8,47	4	7,02	
Family size					0,357
3 or less children	42	71,19	36	63,16	
4 or more children	17	29,81	21	36,84	
Child sex					0,573
Female	29	49,15	31	54,39	
Male	30	50,85	26	45,61	
Child age (mo)					0,709
12 - 18	21	35,59	19	33,33	
19 - 24	11	18,65	14	24,56	
25 - 36	21	35,59	16	28,07	
> 36	6	10,17	8	14,04	
Food assistance					0,679
WIC [b]	25	42,37	22	38,60	
Other	34	57,63	35	61,40	
Breast feeding [c]					0,300
Breast-fed	11	21,15	7	13,46	
Non breast-fed	41	78,85	45	86,54	
Person doing most of the cooking					0,672
Mother	48	81,36	46	80,70	
Father or companion	5	8,47	3	5,26	
Grandmother or Grandfather	6	10,17	8	14,04	
Person doing most of the grocery shopping					0,868
Mother	50	84,75	48	84,21	
Father or companion	3	5,08	2	3,51	
Grandmother or Grandfather	6	10,17	7	12,28	
Received iron education previously					0,544
Yes	46	77,97	47	82,46	
No	13	22,03	10	17,54	

[a] All P-values were obtained by Pearson chi-square test
[b] Women, infants and children
[c] Not all WIC records reviewed documented breast-feeding practices

TABLE 2A: PRE-TRIAL COMPARISON OF MOTHERS' IRON NUTRITIONAL KNOWLEDGE SCORE AND BLOOD HEMOGLOBIN CONCENTRATION OF THEIR CHILDREN IN CONTROL AND INTERVENTION GROUPS

VARIABLE	CONTROL GROUP (N = 59)	INTERVENTION GROUP (N = 57)	P-VALUE [d]
	Mean ± SE [a, b]	Mean ± SE	
Iron nutritional knowledge score [c]	8,00 ± 0,25	8,44 ± 0,22	0,234
Blood haemoglobin concentration (g/dl)	9,97 ± 0,09	10,15 ± 0,09	0,157

[a] SE = standard error of the mean
[b] All values are mean ± SE
[c] Score was based on mother's response to 14 questions, with each correct response attributing 1 point to the total iron nutritional knowledge score
[d] Comparisons were made using a two sided two sample t-test

TABLE 2B: DIFFERENCES BETWEEN PRE- AND POST-TRIAL IRON NUTRITIONAL KNOWLEDGE SCORE OF MOTHERS AND BLOOD HEMOGLOBIN CONCENTRATION OF CHILDREN

VARIABLE	CONTROL GROUP (N =48)	INTERVENTION GROUP (N = 49)	P-VALUE [c]
	Mean ± SE [a, b]	Mean ± SE	
Iron nutritional knowledge score change	0,52 ± 0,41	3,35 ± 0,36	0,000
Blood haemoglobin concentration change(g/dl)	0,12 ± 0,19	1,15 ± 0,12	0,022

[a] SE = standard error of the mean
[b] All values are mean difference ± SE
[c] Comparisons were made using a one sided two sample t-test

TABLE 3: CORRESPONDANCE OF PRIOR IRON EDUCATION AND PRE-TRIAL IRON NUTRITIONAL KNOWLEDGE SCORE OF MOTHERS

VARIABLE	NO PRIOR IRON EDUCATION (N =23)	PRIOR IRON EDUCATION (N =93)	P-VALUE [d]
	Mean ± SE [a, b]	Mean ± SE	
Nutritional knowledge score	7,52 ± 0,33	8,39 ± 0,21	0,016

[A] SE = standard error of the mean
[B] All values are mean ± SE .
[C] Score was based on mother's response to 14 questions, with each correct response attributing 1 point to the total NK score.
[D] Comparisons were made using a one sided two sample t-test.

TABLE 4: CORRELATION BETWEEN MOTHERS' PRE-AND POST TRIAL DIFFERENCE IN IRON NUTRITIONAL KNOWLEDGE SCORE AND CORRESPONDING DIFFERENCE IN BLOOD HEMOGLOBIN CONCENTRATION OF CHILDREN

VARIABLE	CONTROL GROUP (N =48)	INTERVENTION GROUP (N = 49)
Correlation [a]	0,412	0,551
P-value [b]	0,000	0,004

[a] *Comparisons were made using Pearson's correlation.*
[b] P-values result from statistical test of the hypothesis that correlation in the population equals 0

TABLE 5: POST-TRIAL PREVALENCE OF ANAEMIA IN THE STUDY CHILDREN [a]

WIC CUTOFF VALUES [b]	NOT ANAEMIC	ANAEMIC	% ANAEMIC	P-VALUE [c]
Control (N =48)	18	30	62,50	0,000
Intervention (N = 49)	35	14	28,57	

[a] Data are counts in groups unless otherwise indicated
[b] The hemoglobin (Hb) cutoff values used by WIC to define anaemia are Hb < 11,0 g/dl for children aged 6 to 23 months, and Hb < 11,1 g/dl for children aged 24 to 59 months
[c] Comparisons of percentage of children identified to be anaemic were made by a one sided test for two proportions

centage of children who consumed adequate number of servings for several of the vitamin C-rich foods, including honeydew melon, cantaloupe, and watermelon. In addition, children in the control group were reported to eat more meals away from home at restaurants or fast food places at the conclusion of the study. The opposite was true for the intervention group children (p=0,015).

DISCUSSION

Despite the overall success of WIC in suppression and control of iron deficiency and IDA in the United States, evidence continues to point to the fact that inner city black children have a high prevalence of iron deficiency and IDA (Bogen *et al*, 2001; US Department of Health and Human Services, 1998:6). Our results are in agreement with those of previous investigators in that participation in the WIC program appears to reduce anaemia prevalence among children at nutritional risk (Vasquez-Seoane *et al*, 1985; Looker *et al*, 1997; Rastrelli, 1994:32). This downward decline in anaemia rates appears to be at least in part due to the nutrition education component, as in the present study there was a strong correlation between the change in mother's iron nutritional knowledge score and the corresponding change in their children's blood Hb levels for both the control and intervention groups.

Parents/guardians of pre-school age children who participate in the WIC program receive free food vouchers that can be redeemed at local grocery stores to purchase fortified cereals, milk, cheese, eggs, dried beans, peanut butter, and vitamin C fortified juices. It is possible that the supplemental foods offered through the WIC program also contribute to the reported decrease in the incidence of anaemia noted here and previously reported by other investigators (Vasquez-Seoane *et al*, 1985; Looker *et al*, 1997; Rastrelli, 1994:18). In this study, we observed an increase in adequacy of consumption for milk, cheese, and yogurt, protein foods, fortified cereals, and vitamin C fortified juices for children in the control group indicating an improvement in the diet quality.

Johnson reported that of the parents enrolled in a Minnesota WIC program only 50% recalled receiving nutrition education regarding iron. Since all parents that participate in WIC must receive nutrition education on a routine basis, this low response rate indicates that parents are not retaining this information and therefore require more reinforcement and education (Johnson, 1996: 51).

In the present study, the mothers in both groups responded correctly to on average eight of the 14 questions. This could be indicative of inadequate knowledge regarding dietary iron content of foods by participating mothers. This overall low level of iron nutritional knowledge at baseline documented in this study is supported by findings of two recent studies reporting low maternal nutrition knowledge and high prevalence of anaemia among children of adolescent mothers enrolled at an urban WIC program office (Venkateswaran *et al*, 1998; Gupta *et al*, 1999). Similar results have been reported from UK in a large sample of primarily Asian immigrants (Childs *et al*, 1997).

Our results clearly demonstrate that more targeted and multifaceted nutrition education interventions than what is currently offered through the WIC program offices are effective means of improving iron nutritional knowledge and reducing anaemia rates in high- risk populations such as African American children**.** These results are contradictory to those from an earlier study (James *et al*, 1989) reporting success in significantly raising dietary awareness with conventional nutrition education methods similar to what is offered through most WIC offices. It may be that in order to maximize benefits achieved by children from groups at high nutritional risk

TABLE 6: PERCENTAGE OF CHILDREN CONSUMING ADEQUATE SERVINGS FROM THE DIFFERENT FOOD GROUPS OF THE FOOD GUIDE PYRAMID, FOODS RICH IN IRON AND VITAMIN C, AND FAST FOODS

Variable	CONTROL GROUP		P-Value [a]	INTERVENTION GROUP		P-Value [a]
	Pre-trial	Post-trial		Pre-trial	Post-trial	
Food guide pyramid groups						
Bread, cereal, pasta [b]	15,2	25,0	0,106	43,9	35,3	0,819
Milk, cheese, cottage cheese, yogurt [c]	1,7	8,3	0,063	1,8	0,0	0,843
Vegetables [d]	33,9	37,5	0,350	52,6	41,2	0,885
Fruits [e]	98,3	100,0	0,157	94,7	98,0	0,175
Fruit juice [f] (oz /day)	37,3	31,3	0,744	24,6	37,2	0,076
Protein foods (meat, eggs, chicken, fish, dried beans or peas, peanut butter, tofu)[g]	62,7	84,5	0,003	91,2	88,2	0,695
Sweets (soft drinks, kool-aid, fruit drinks, candy, cake, pie, donuts, cookies, pastries), and fried foods (chips, french fries) [h]	40,7	37,5	0,631	52,6	46,0	0,754
Iron-rich foods						
Red meat, chicken, or fish [i]	71,2	87,2	0,018	86,0	94,1	0,075
Fortified cereals [j]	86,0	95,1	0,039	72,7	98,0	0,000
Vitamin C-rich foods [k]						
Collard greens or other leafy greens	44,1	70,8	0,002	35,1	67,7	0,001
Broccoli	25,4	58,3	0,000	36,8	51,0	0,068
Tomato or tomato juice	32,2	43,8	0,110	17,5	47,1	0,000
Cantaloupe	25,4	18,8	0,798	40,4	9,8	1,000
Honeydew melon	15,3	4,2	0,978	14,0	9,8	0,752
Orange or orange juice	79,7	85,4	0,215	91,2	90,2	0,573
Watermelon	32,2	2,1	1,000	54,4	11,8	1,000
Cabbage	30,5	29,2	0,560	47,4	35,3	0,900
Strawberry	23,7	12,5	0,938	29,8	19,6	0,893
Kiwi	5,1	14,6	0,052	10,5	13,7	0,306
Grapefruit or grapefruit juice	15,3	8,3	0,870	15,8	11,8	0,729
Other vitamin C fortified juices	89,8	97,9	0,034	86,0	90,2	0,248
Fast food restaurant [l]	88,1	64,5	0,998	87,7	98,0	0,015

[a] P-values were obtained by a one sided test for two proportions
[b] Adequate consumption according to WIC guidelines was defined as minimum of 8 servings per day
[c] Adequate consumption according to WIC guidelines was defined as minimum of 5 servings per day
[d] Adequate consumption according to WIC guidelines was defined as minimum of 3 servings per day
[e] Adequate consumption according to WIC guidelines was defined as minimum of 2 servings per day
[f] Adequate consumption according to WIC guidelines was defined as maximum of 12 ounces per day
[g] Adequate consumption according to WIC guidelines was defined as minimum of 3 servings per day
[h] Adequate consumption according to WIC guidelines was defined as maximum of 3 servings per day
[I] Adequate consumption was defined as minimum of 1-2 servings per day
[J] Adequate consumption was defined as minimum of 3-4 servings per week
[k] Percentages represent children who consumed foods in each category on average at least twice a week
[l] Adequate consumption was defined as eating a meal at a fast food restaurant no more than 1-2 times per week

such as African American children (Crockett & Sims, 1995), children of low-income adolescent mothers (Venkateswaran *et al*, 1998; Gupta *et al*, 1999), as well as for children from ethnic minority groups (Childs *et al*, 1997; Kahn *et al*, 2002), parents require more targeted and intensive nutrition education measures.

Pre-school age children generally interact more with their parents compared to older children. It is reasonable to assume that knowledge of iron nutrition among low-socioeconomic parents would affect their dietary behaviour and the types of foods consumed by their pre-school age child. Parents who do not practice good nutritional behaviour have been identified as a barrier to consumption of fruits and vegetables in children (Reicks & Hanyes, 1994). We observed a tendency toward attainment of a higher post-trial iron nutritional knowledge score by mothers who had received nutrition education regarding iron content of foods prior to this study. This indicates that reinforcement plays a positive role in mothers retaining this information.

Our criteria to assess dietary sufficiency were based on published nutritional guidelines routinely used in WIC program offices across Michigan (Michigan Department of Community Health, 2001). Analysis of dietary intake data indicates an improvement in adequacy of consumption of iron-rich foods and vitamin C-rich foods for both control and intervention group children. This is not consistent with the much greater improvement in iron nutritional knowledge score of the mothers and blood Hb concentration of children in the intervention group. A possible confounder is the known limitation of measuring children's habitual food intake by relying on the parent to recollect child's intake accurately (Goran, 1998). Baranowski *et al* (1991) reported that 50% of mothers of preschool children who were not at home for more than four hours per day could not accurately recall the child's food intake. The latter observation is pertinent to our study population as single mothers constituted the majority of participating moms, necessitating the need for employment outside home. As well food fads and food refusals are common among toddlers, and pre-schoolers. This may have affected actual consumption of foods versus what was offered to the children by parents.

Being that the follow up data were collected in late fall, the reported decrease in consumption of some of the vitamin C rich fruits (watermelon, honeydew melon, and cantaloupe) for both the control and intervention group children may be due to seasonality, eg high cost of these fruits when purchased out of season as well as unavailability in all supermarket chains.

In viewing the data presented here several factors should be taken into account. First, the size of the sample at follow-up was small due to lack of further participation, or change in residential status. Second, Hb was measured in our WIC program offices by HemoCue method, this practice has been shown to result in slightly lower values when compared to Coulter counter measurement (Bogen *et al*, 2001). However, in reality this practice is widely used in WIC program offices, paediatric offices, and health centres in United States. Third, we used Hb as an indicator of red blood cell iron status. It is generally difficult to determine which children have iron deficiency based on haemoglobin alone (Earl & Woteki, 1993: 4; Kleinman, 1998). Common childhood infections and the associated inflammation, eg otitis media, pharyngitis, as well as asthma and allergies can interfere with the child's appetite and limit consumption of nutritious iron rich foods. These conditions have been shown to affect Hb values. Although we questioned parents about current or recent infections by giving specific examples, the possibility of some inaccurate recall can't be ruled out. Fourth, Presence of thalassemia trait is another variable that can affect Hb values (Abilson, 2001; Oski, 1993). Both a - thalassemia trait and b-thalassemia trait can reduce Hb levels. We screened all children in this study by questioning parents about knowledge of presence of haemoglobinopathies, eg sickle cell trait and thalassemia trait. We also corroborated the accuracy of parents' responses by a thorough review of the children's medical records. However, it is possible that some of these children had undiagnosed haemoglobinopathies and hence did not experience an elevation in Hb levels during the course of the study. Due to these difficulties in assessing iron status, it has been suggested to screen all children initially with a complete blood count (CBC) (Bogen *et al*, 2001), since it provides the red blood cell indices, mean corpuscular volume (MCV), and red cell distribution width (RDW), to aid in the diagnosis of IDA as the cause of anaemia. A low MCV and RDW can help to differentiate IDA from acute infection, where MCV and RDW should be normal, and from thalassemia trait, where the MCV should be low and the RDW normal.

Given the fact that prevalence of anaemia among African American children is as high as 25% (US Department of Health and Human Services, 1998), compared to national rates as low as 1%, and considering that iron deficiency with or without anaemia can affect intellectual development, more effective primary preventive measures for this population of children are needed. Although WIC has been instrumental in improving nutritional status and reducing anaemia rates among children, our results illustrate that children at high nutritional risk such as low-income African American children can benefit from additional targeted nutrition education interventions than what is currently offered through the WIC program. It is therefore imperative to explore alternative means of delivering nutrition education for high prevalence populations.

REFERENCES

ABILSON, R. 2001. Complexities in recognizing and treating iron deficiency anemia. *Archives of Pediatrics & Adolescent Medicine* 155:332-333.

ADISH, A, ESREY, SA, GYORKOS, TW, JOHN-BAPTISTE, J & ROJHANI, A. 1999. Consumption of foods cooked in iron pots improves iron status and growth of preschool children: a randomized trial. *Lancet* 353:712-716.

BARANOWSKI, T, SPRAGUE, D, BARANOWSKI, J & HARRISON, J. 1991. Accuracy of maternal dietary recall for preschool children. *Journal of the American Dietetic Association* 91: 669-674.

BOGEN, DL, KRAUSE, JP & SERWINT, JR. 2001. Outcome of children identification as anemic by routine screening in an inner-city clinic. *Archives of Pediatrics & Adolescent Medicine* 155: 366-371.

BUSHNELL, FKL. 1992. A guide to primary care of iron deficiency anemia. *Nurse Practitioner* 17 (11): 68-74.

CHILDS, F, AUKETT, A, DARBYSHIRE, P, ILETT, S & LIVERA LN. 1997. Dietary education and iron deficiency anemia in the inner city. *Archives of Diseases in Childhood* 76:144-147.

CHWANG, LC, SOEMANTRI, AG & POLLITT, E. 1988. Iron supplementation and physical growth of rural Indonesian children. *American Journal of Clinical Nutrition* 47:496-501.

CROCKER, B. 1999. *Betty crocker's kids cook*. New York. Macmillan.

CROCKETT, SJ & SIMS, LS. 1995. Environmental influences on children's eating. *Journal of Nutrition Education* 27(5): 235-249.

DORLAND-DARLING, J. 1997. *Better homes and gardens new junior cookbook*. Des Moines. Meredith.

EARL, R, & WOTEKI, C (eds). 1993. *Iron deficiency anemia: recommended guidelines for prevention, detection, and management among U.S. children and women of childbearing age*. Food and Nutrition Board, Institute of Medicine.Washington, DC. National Academy Press.

FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS (FAO). 1988. *Requirements of Vitamin A, Iron, Folate and Vitamin B_{12}.* A Joint FAO/WHO Expert Consultation Report. Rome.

GORAN, MI. 1998. Measurement issues related to studies of childhood obesity: Assessment of body composition, body fat distribution, physical activity and food intake. *Pediatrics* 101:505-518.

GUPTA, S VENKATESWARAN, R GORENFLO, DW & EYLER, AE. 1999. Childhood iron deficiency anemia, maternal nutritional knowledge, and maternal feeding practices in a high-risk population. *Preventive Medicine* 29:152-156.

HALLBERG, L. 1994. Prevention of iron deficiency. *Bailliere's Clinical Haematology* 7(4): 805-814.

JAMES, J & LAING, G. 1994. Iron deficiency anemia. *Current Pediatrics* 4:33-37.

JAMES, J LAWSON, P MALE, P & OAKHILL, A. 1989. Preventing iron deficiency in pre-school children by implementing and educational and screening program in an inner city practice. *British Medical Journal* 299:838-840.

JOBE, JB & MINGAY, DJ. 1989. Cognitive research improves questionnaires. *American Journal of Public Health* 79:1053-1055.

JOHNSON, CS.1996. *Iron Deficiency anemia in low-socioeconomic preschool children and parental knowledge of iron-rich foods.* Masters thesis. St. Paul Minnesota. The College of St. Catherine.

JONIDES, L RUDY, C & WALSH, SW. 1993. Pallor and pica. *Journal of Pediatric Health Care* 157:173-174.

KAHN, JL, BINNS, HJ, CHEN, T, TANZ, RR & LISTERNICK, R. 2002. Persistence and emergence of anemia in children during participation in the special supplemental nutrition program for women, infants, and children. Archives of Pediatrics & Adolescent Medicine 156: 1028-1032.

KITTLER, PG & SUCHER, KP. 2001. Food and Culture. 3rd *ed. Belmont,*CA. Wadsworth.

KLEINMAN, R.1988. Iron deficiency. In Kleinman, R. (ed). *Pediatric nutrition handbook*. Elk Grove Village, Illinois. American Academy of Pediatrics.

LOOKER, AC, DALLMAN, PR, CARROLL, MD, GUNTER, EW & JOHNSON, CL. 1997. Prevalence of iron deficiency in the United States. *Journal of the American Medical Association* 227 (12): 973-976.

LOZOFF, B, JIMENEZ, E & WOLF, AW. 1991. Long-term developmental outcome of infants with iron deficiency. *New England Journal of Medicine* 325:687-694.

MICHIGAN DEPARTMENT OF COMMUNITY

HEALTH. 2001.*WIC program food frequency questionnaire*. Lansing, Michigan.
MILLER, V, SWANEY, S & DEINARD, A. 1985. Impact of the WIC program on iron status of infants. *Journal of Pediatrics* 75:100-105.
MINITAB INC. 2000. Minitab statistical software. Release 13.1.
OSKI, FA. 1993. Iron deficiency in infancy and childhood. *New England Journal of Medicine* 329(3): 190-193.
RASTRELLI, GL.1994. *The effect of nutrition education on anemic African American children enrolled in the WIC program*. Masters thesis. Denton, Texas. Texas Women's University.
REICKS, M & HAYNES, BJ. 1994. Factors affecting consumption of fruits and vegetables by low income families. *Journal of* the *American Dietetic Association* 94:1309-1131.
US DEPARTMENT OF HEALTH AND HUMAN SERVICES.1998. *Recommendations to prevent and control iron deficiency in the United States*. Atlanta, Georgia. Centers for Disease Control and Prevention. Morbidity and Mortality weekly Report.
US DEPARTMENT OF AGRICULTURE AND US DEPARTMENT OF HEALTH AND HUMAN SERVICES. 2000. Nutrition and your health: dietary guidelines for Americans. Home and Garden Bulletin no.232. Washington, D.C.
VASQUEZ-SEOANE P, WINDOM, R & PEARSON, HA. 1985. Disappearance of iron deficiency anemia in a high- risk infant population given supplemental iron. *New England Journal of Medicine* 313:1239-1240.
VENKATESWARAN, R EYLER, AE & GORENFLO, DW. 1998. Iron deficiency and maternal feeding practices among high-risk urban population. *Journal of Health Care for the Poor and Underserved* 9(4): 381-394.
WALTER T, DE, ANDRACA, I, CHADUD, P & PERALES, CG. 1989. Iron deficiency anemia: adverse effects on infant psychomotor development. *Journal of Pediatrics* 84:7-17.
WASKERWITZ, MJ. 1983. Iron deficiency anemia in children. *Journal of Comprehensive Pediatric Nursing* 6: 283-294.
WHITNEY, EN & ROLFES, SR. 2002. *Understanding nutrition*. 9th ed. Belmont, California. Wadsworth.
WILLIS, GB. 1994. *Cognitive interviewing and questionnaire design: A training manual*. National Institutes of Health (NIH). National Center for Health Sciences, Office of Research and Methodology. Hyattsville.