Coll. Antropol. **31** (2007) 2: 403–411
Original scientific paper

Impact of a Nutrition Intervention Program on the Growth and Nutritional Status of Nicaraguan Adolescent Girls

Lisa Renee Pawloski[1] and Jean Burley Moore[2]

[1] Department of Global and Community Health, George Mason University, Fairfax, Virginia, USA
[2] School of Nursing, George Mason University, Fairfax, Virginia, USA

A B S T R A C T

This research examines the impact of a nutrition education intervention program on the nutritional status and knowledge of Nicaraguan adolescent girls. Anthropometric measurements, hemoglobin values, and data concerning nutritional knowledge were collected from adolescent girls living in Managua, Nicaragua. Using a pre-test/post-test design, data are compared prior to and after the nutrition intervention program. When using Mexican American reference data, statistically significant differences in height-for-age z-scores and weight-for-age z-scores were found when comparing the entire sample of baseline data with data collected after three years of the nutrition intervention program (p<0.05). Significant improvement was also found concerning the indicators of nutritional knowledge (p<0.05). However, hemoglobin data revealed a significant decrease which may be due to specific environmental factors and pubertal changes. This research has implications concerning the development of successful adolescent focused nutrition intervention programs in Nicaragua, and examines the possibility that catch-up growth occurs during adolescence.

***Key words**: nutrition education, adolescent girls, Nicaragua, growth, hemoglobin*

Introduction

Adolescent girls have high-energy and micronutrient needs due to pubertal development and the adolescent growth spurt. Many adolescent girls have, or are preparing to have children which also increase their nutrient requirements. In Nicaragua, as in many other developing countries, adolescent girls are a nutritionally at risk group. Elsewhere in Central America, specifically in Guatemala, there have been a significant number of studies which have examined the nutritional situation of adolescent girls in Guatemala[1–5]. These findings have reported poor nutritional status among girls of low socioeconomic status. Further, studies throughout Central and South America have pointed to the growing prevalence of obesity in addition to micronutrient deficiencies among women[6–9].

Nutrition intervention programs have been generated in developing countries to try to counter these deficits. Most nutrition intervention programs today are focused on micronutrient deficiencies. These programs range from supplementation programs to fortification programs to education programs. In the past, programs were primarily focused on protein and energy consumption. More recently, data have revealed that most diets in developing countries are often sufficient in calories; however they are lacking in variety and nutrient density and thus interventions focusing on improving micronutrient consumption are now more common[10].

While many studies have pointed to indicators which suggest nutrition related problems among adolescent girls in Central America, very few nutrition intervention programs have attempted to improve their nutritional situation. The few programs which do exist, have initiated supplementation or fortification programs. Martorell and Scrimshaw[4] discussed the results of a longitudinal study which involved a nutrition supplementation program among children in Guatemala. Their findings revealed that when compared to United States' (US) girls, no catch-up growth was evident. When compared to

Received for publication August 9, 2004

Mexican American girls from the Hispanic Health and Nutrition Examination Survey (HHANES) data, however, catch-up growth was evident, suggesting that the nutrition supplementation programs during childhood may improve growth during adolescence. Interventions using supplementation are often limited by resources and cost, and more feasible nutrition interventions include nutrition education programs aimed at teaching affordable healthy eating.

In Nicaragua, few interventions have been initiated trying to improve the nutritional situation of women and children. None have focused on adolescent girls. It is important to examine the impact of a nutritional intervention program on adolescents to determine if programs targeted at adolescents can be effective. If such programs targeted at adolescents are ineffective, (a) programs should be revised to increase their efficacy or (b) programs should be focused on other stages of the lifecycle to prevent malnutrition.

Regarding nutrition intervention programs existing in Nicaragua, one of the most recent intervention programs has attempted a vitamin A sugar fortification program. While this appears to be an effective means of improving the vitamin A status of Nicaraguans, it again comes at fairly high cost. The effectiveness of this program has not yet been examined[11]. The Ministry of Health in Nicaragua created a five-year comprehensive micronutrient program in which it gave Vitamin A supplements to children 6 months to 10 years and iron supplements were also given to pregnant and lactating women. This program reported an average coverage of 69% in Nicaragua[12,13]. Another nutrition intervention program targeted at Nicaraguan children has been initiated by a non-governmental organization, SOYNICA. This program has been focusing on supplementing school children's meals with a leaf extract high in micronutrients and has found significant decreases in anemia[14]. Another type of intervention, namely *nutrition education programs,* have been attempted recently in Nicaragua, but none, until this one, targeted adolescent girls, a group that, as mentioned above, has particularly important nutritional needs. Thus this study provides one of the first evaluations of a nutrition education intervention program which is targeted on adolescent girls in Central America.

Background on Nicaragua

Nicaragua is considered to be the poorest country in Central America. World Bank[15] data reveal that Nicaragua has the lowest per capita income in Central America at less than $745 US per year[15]. Malnutrition is quite prevalent throughout the country. Approximately seventeen percent of children under-three years of age suffer from severe malnutrition and infant mortality is 33 out of 1000 births[16]. Nicaragua has been plagued by poverty, wars, hurricanes, and earthquakes which have inhibited any long-term economic recovery. These factors have all significantly contributed to the high numbers of malnourished children and high mortality rates.

The majority of nutritional information in Nicaragua has concerned primarily young children. Capucci et al.[17] examined a sample of children 6 months to 6 years in Nicaragua and found them to be shorter and lighter than the reference population. Capucci[17] also hypothesized that stress created by the civil war in Nicaragua contributed to poor growth among young boys. The Ministerio de Salud in Nicaragua (MINSA)[16] has reported poor nutritional status among young children and mothers over the age of 15.

Purpose

The purpose of this study is to determine the effectiveness of a nutrition education program that focuses on Nicaraguan adolescent girls from a very poor neighborhood. This study will explore the following two hypotheses namely, that after the implementation of the nutrition intervention program:

1. Nicaraguan adolescent girls will exhibit improved indicators of nutritional status after the implementation of the nutrition intervention program in terms of growth and hemoglobin status.
2. Nicaraguan adolescent girls will exhibit improved indicators of nutrition knowledge after the implementation of the nutrition intervention program.

Methods

Study site and participants

This study was conducted in the Zone 3 of the Axom Villa Libertad barrio in Managua, the capital of Nicaragua. Data analyzed here were collected from a sample of 186 adolescent girls ages 10 to 17 years at three consecutive dates, two prior to the participation in the nutritional education program, in January 2001, January 2002, and one two years into their participation into those programs, January 2004. Data from January 2001, provide baseline anthropometric data and January 2002 provided baseline hemoglobin data prior to the nutrition intervention program and data collected in January 2004 provide data after two years of the nutrition intervention program. The data collection and the nutrition interventions were conducted in a nursing center which was established by the nursing school at the Universidad de Politecnica de Nicaragua. The center is centrally located in the barrio and is run by local community health workers.

The Barrio

The Axom Villa Libertad barrio is a typical squatter community within the Managua city limits. The most recent local census data determined the population in the barrio to be 1906 in 1996. The roads within the barrio are not paved and while electricity is readily available, phone lines are not and most do not have access to running potable water. The families living in this barrio moved to Managua from rural surrounding communities approximately 10 years before the beginning of the study to escape poor conditions in the rural areas brought about by natural and political disasters. Thus, most families have had to develop new relationships with their neighbors and have very few relatives living within the barrio.

The high rate of attrition of the girls in the nutrition education programs is due to the fact that many girls would travel to visit their relatives living in rural areas. While many girls attend school, they do not attend regularly. Again this is due to the fact that many girls visit relatives, but others often must stay home to take care of their younger siblings or work to make ends meet within the family. In addition, school is not free. In Nicaragua, children must pay for tuition, books, and uniforms, and many girls cannot afford to attend each year. However, most girls were able to read and write at a primary school level.

Research design and data collection

This study utilized a pre-test post-test design, such that the indicators of nutritional status and knowledge are compared before and after the implementation of the nutrition intervention program. Regarding anthropometric status, pre-test data were collected in 2001 and in 2004, post-test data were collected. For hemoglobin data, pre-test data were collected in 2002 and then in 2004. An experimental design was not feasible in this population because it was too difficult to find a sample of girls in this barrio who had no exposure to the nutrition education program.

For the anthropometric data, our initial sample size was 97 girls; however, of those girls, only 40 girls had heights and weights taken who remained at the end of the nutrition intervention program. Regarding hemoglobin data, baseline data were collected from 100 girls, and only 60 of those girls had hemoglobin data taken who remained at the end of the program. Lastly there were 9 nutrition intervention sessions during the program; for each session, 60–90 girls participated. All of the girls between the ages of 10 to 17 years were invited to participate within this specific barrio, thus a convenience sample was taken.

The assessment of the nutritional status of Nicaraguan girls was made primarily from anthropometric indicators. Additional data concerning nutritional status included hemoglobin status. Measurements of nutritional knowledge were determined from pre-test and post-test questionnaires distributed at each intervention between 2001 and 2004.

The tempo of growth appears to be one of the first things that is affected by poor nutrition. Growth deficiencies give the initial warning signs of malnutrition. Delayed growth and development may be determined from anthropometric measurements as well as maturational data and comparisons them with reference data. For example, stunting, or low height-for-age, predicts chronic malnutrition, and has been shown to be marker of many adverse consequences such as increased risk for disease and poor performance in school[18,19]. Low weight-for-age gives evidence of acute malnutrition (wasting or underweight) and measuring the ratio of muscle to fat can give an indication of protein-energy malnutrition.

The anthropometric measurements in this study were taken by one investigator in a clinical setting using methodologies described by Lohman, Roche, and Martorell[20]. Anthropometric measurements examined here included height, weight, and triceps skinfold measurements. Heights were measured in centimeters using a movable field anthropometer with the subject standing on level ground. Weights were measured with girls wearing light clothing in kilograms using an electronic scale (Brand name, Tanita) placed on level ground. Subjects did not wear shoes or socks for the height and weight measurements.

Iron is a micronutrient that is commonly deficient in women and young girls. It is one of the most common micronutrient deficiencies in the world. Iron is critical for the transfer of oxygen from the lungs to tissues throughout the body and is important regarding the girls' activity levels and their immune system[21]. Iron status was determined by using the HemoCue b-Hemoglobin System. This system assesses hemoglobin levels and requires a small blood sample from simple finger sticks. The results are immediate and no additional laboratory assessment is required[22].

Z-scores were generated for each of the height and weight data which allowed for comparisons with a reference population such that a z-score of »0« represents the mean of the reference population. Some researchers in Latin America have made comparisons with the Mexican American data published in the HHANES data collected from a large sample of healthy, well-nourished individuals of Mexican descent living in the United States. These data were compared in terms of z-scores to the Mexican HHANES data to provide a reference population with a more similar genetic background[25]. Comparisons were made with this reference population because there are no healthy well-nourished reference populations in Nicaragua with which to make comparisons[24]. These kinds of large scale reference data are commonly used in studies throughout the world and facilitate comparisons between samples [24]. Most commonly, data are compared with data collected from the National Center for Health Statistics (NCHS), which is a reference population recommended by the World Health Organization (WHO). For the body mass index (BMI) data, the anthropometric data were entered into Epi Info, which generated BMI- -for-age z-scores (BMIZ) using the CDC 2000 reference data[23].

To determine nutritional knowledge, girls were given pre-tests and post-tests during each of the nutrition intervention programs. The programs were nutrition education programs which were given quarterly throughout the year. The content covered materials which were relevant to the girls' nutritional risk. For example, baseline data determined that many girls did not consume enough fruits and vegetables because they were considered to be too expensive, and thus the education programs taught girls about the importance of fruits and vegetables and their accessibility in the barrio. The tests consisted of ten questions appropriate to each teaching session. An example of the questionnaire is included in Figure 1.

Nombre________________________ Apellido ________________________
Fecha de Nacimiento ____________________________ Codigo __________________________

Cuesionario de Pos-Examen – July, 2003

1. Water that hasn't been boiled can cause you to have diarrhea. Si/No/No Se
2. You should drink at least 10 cups of water every day. Si/No/No Se
3. Water should be boiled for 15 minutes in order to kill bacteria. Si/No/No Se
4. Lead is poisonous to the body. Si/No/No Se
5. Anemia is a caused by eating too much iron. Si/No/No Se
6. There is more iron in beans, fruits and vegetables than in meat. Si/No/No Se
7. Drinking coffee doesn't allow your body to absorb iron efficiently. Si/No/No Se
8. During menstruation females should avoid iron. Si/No/No Se
9. When you don't get enough iron, you feel tired, weak, dizzy, unable to concentrate and may lose your appetite. Si/No/No Se
10. Soaking beans and discarding the water afterwards is a way of increasing iron absorption. Si/No/No Se

Fig. 1. Example of pre-test post test questionnaire to determine nutritional knowledge.

Knowing the reading level of this community, we created appropriate questionnaires. To further ensure that girls could answer the questionnaires, we read the questions aloud. If any girl could not read, our research assistants helped with reading and answering the questionnaires or consent forms.

All of the participants and their parents gave informed assent and consent respectively. The methodology used in this study was approved by the George Mason University's Human Subjects Review Board.

Reliability

Intra-observer reliability of anthropometric measurements were determined by the author and are included in an earlier publication[26]. The reliability data fell within acceptable ranges when compared with other research[20].

Regarding hemoglobin assessment. A control cuvette was measured before and after each data collection period to ensure the validity and reliability of the HemoCue instrument. At each data collection period, the readings for the control cuvette were within the recommended ranges.

Results

For the entire sample (Table 1), the height-for-age z-score (HAZ) prior to the intervention program was –1.34 and after the intervention program it was –0.87. For the weight-for-age data (WAZ), the 2001 mean was –0.74 and the mean in 2004 was –0.53. T-tests revealed statistically significant differences for HAZ and WAZ before the intervention and after the intervention ($p< 0.05$), such that HAZ and WAZ had values closer to 0 after the intervention program.

When broken down by age, HAZ and WAZ data revealed that these girls were shorter and lighter than Mexican US girls at most ages. These data are presented in Figure 2 and Figure 3. Both figures reveal graphs of girls' z-scores by age in years calculated based on the

TABLE 1
ANTHROPOMETRIC INDICATORS USING HHANES* REFERENCE DATA BEFORE AND AFTER THE NUTRITION INTERVENTION

Variables	X	n	t	df	p
HAZ after nutrition intervention	–0.8721	40	4.084	39	0.000
HAZ before nutrition intervention	–1.3413	40			
WAZ after nutrition intervention	–0.5296	40	2.527	39	0.014
WAZ before nutrition intervention	–0.7402	40			
BMI after nutrition intervention	20.99	37	3.52	36	0.001
BMI before nutrition intervention	19.68	37			
BMIZ score after nutrition intervention	0.049	37	–1.272	36	0.211
BMIZ score before nutrition intervention	0.181	37			
hemoglobin before nutrition intervention	13.13	61	–3.57	60	0.001
Hemoglobin after nutrition intervention	12.46	61			

Statistically significant relationships are at ($p<0.05$), HHANES – Hispanic Health and Nutrition Examination Survey, HAZ – Height for age z-scores, WAZ – Weight for age z-scores, BMI – Body mass index, BMIZ – Body mass index for age z-score

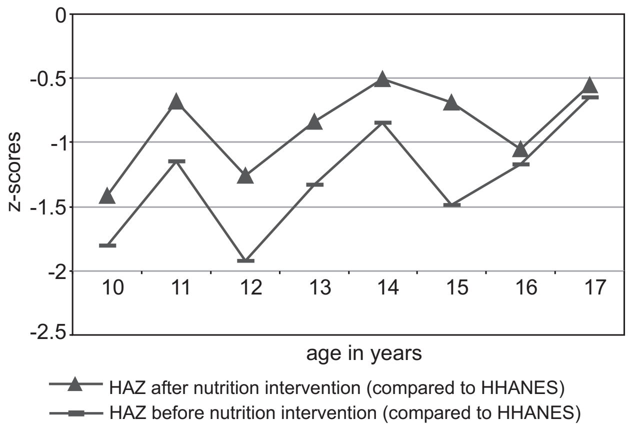

Fig. 2. Height-for-age z-scores (HAZ) by age before and after nutrition intervention.

HHANES Mexican-US data. These graphs show z-scores that are closer to »0« at each age in 2004 (after the intervention) when compared to data from 2001 (prior to the intervention).

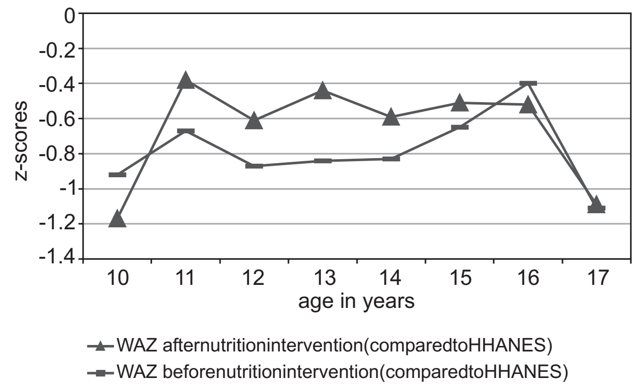

Fig. 3. Weight-for-age z-scores (WAZ) by age in years before and after nutrition intervention.

T-test analyses revealed statistically significant differences only at ages 15 years for the HAZ and at 11 and 16 years for the WAZ data ($p<0.05$). These data are presented in Table 2 and Table 3.

BMI-for-age z-scores are presented in Figure 4, and these data show that the Nicaraguan girls have BMI-for-

TABLE 2
MEAN HAZ BEFORE AND AFTER NUTRITION INTERVENTION PROGRAM

Age (years)	Mean HAZ before the nutrition intervention	SD	Mean HAZ after the nutrition intervention	SD	t	p-value
10	–1.80	1.60	–1.42	1.78	1.90	0.197
11	–1.15	0.35	–0.68	0.87	1.34	0.230
12	–1.92	0.89	–1.26	1.33	1.10	0.320
13	–1.33	2.30	–0.84	1.42	0.959	0.439
14	–0.85	0.82	–0.51	0.69	2.40	0.053
15	–1.49	0.83	–0.69	0.68	7.58	0.001
16	–1.17	0.62	–1.05	0.89	0.633	0.641
17	–0.65	1.29	–0.55	1.40	1.24	0.432

Statistical significance is at $p<0.05$, HAZ – height for age z-score

TABLE 3
MEAN WAZ* BEFORE AND AFTER NUTRITION INTERVENTION PROGRAM

Age (years)	Mean WAZ before the nutrition intervention	SD	Mean WAZ after the nutrition intervention	SD	t	p-value
10	–0.92	0.30	–1.17	0.71	0.97	0.431
11	–0.67	0.51	–0.38	0.47	2.72	0.035
12	–0.87	0.94	–0.61	1.10	0.771	0.476
13	–0.84	0.99	–0.44	0.56	1.39	0.298
14	–0.83	0.72	–0.59	0.72	2.04	0.087
15	–0.65	0.26	–0.51	0.65	0.504	0.635
16	–0.40	0.78	–0.52	0.79	49.3	0.013
17	–1.11	0.44	–1.09	0.43	3.34	0.185

Statistical significance is at $p<0.05$, WAZ – weight for age z-score

-age z-scores that fall close to the reference population at most ages both in 2001 and in 2004, and there is no statistically significant difference between these data for each age (Table 4).

Further, there is no statistically significant difference between the overall mean BMI-for-age z-scores from the 2001 data compared to the 2004 data (Table 1). There is a statistically significant difference (p=0.001) between the BMI data from 2001 and 2004, such that the BMI increases from 2001 to 2004 (Table 1).

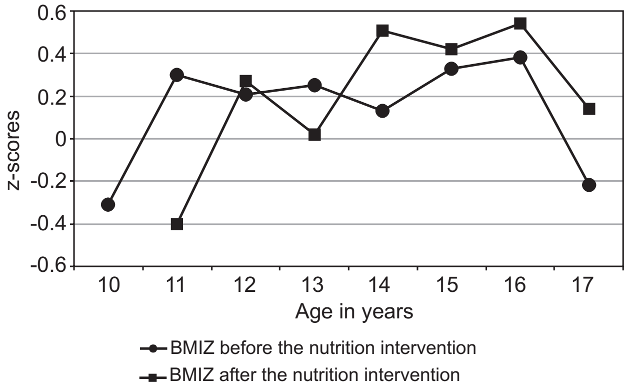

Fig. 4. BMI for age z-scores (BMIZ) by age in years before and after nutrition intervention.

The hemoglobin data (Table 1) revealed a mean of 13.01 g/dL prior to the intervention and a mean of 12.46 g/dL in 2004. T-tests revealed a statistically significant difference in which the mean from 2002 was actually greater than the mean in 2004 ($p<0.05$).

T-test analyses of the nutritional knowledge evaluation instrument showed that post-test scores were significantly higher than pre-test scores in 2002, 2003, and 2004. To exemplify these findings, paired samples t-tests are presented in Table 5.

Discussion

Overall, the adolescent Nicaraguan girls in this study exhibit growth and hemoglobin indicators which suggest that these girls are undernourished. Poor height-for-age and weight-for-age data suggest that these girls suffer from both chronic and acute malnutrition. When the mean height and weight data are compared in regards to

TABLE 4
MEAN BMIZ* SCORES BEFORE AND AFTER NUTRITION INTERVENTION PROGRAM

Age (years)	Mean BMIZ before the nutrition intervention	SD	Mean BMIZ after the nutrition intervention	SD	t	p-value
10	0.167	0.67	–0.36	0.66	–0.88	0.473
11	0.25	0.64	0.43	0.68	0.98	0.365
12	0.15	1.07	0.10	1.17	–0.20	0.848
13	0.25	0.46	0.41	0.39	0.66	0.577
14	0.12	0.63	–0.13	0.86	–1.63	0.154
15	0.35	0.48	–0.02	0.75	–0.83	0.454
16	0.48	0.64	0.21	0.58	–1.54	0.264
17	–0.69	0.25	–1.28	0.25	–2.95	0.208

Statistical significance is at $p<0.05$, BMIZ – body mass index for age z-scores

TABLE 5
PAIRED SAMPLES TESTS FOR PRE-TESTS AND POST-TESTS

Nutrition session	Mean paired difference (pre-test/ post-test)	SD	t	p
January 2004	–1.46	1.64	–8.53	0.00
October 2003	–1.92	1.65	–9.34	0.00
July 2003	–0.62	1.53	–3.44	0.00
April 2003	–1.52	1.84	–7.59	0.00
January 2003	–1.83	1.74	–10.55	0.00
October 2002	–0.39	1.35	–2.16	0.04
July 2002	–1.44	1.61	–6.87	0.00
April 2002	–0.23	0.69	–30.04	0.00
January 2002	–1.54	1.32	–9.81	0.00

Statistically significant relationships are those in which ($p<0.05$).

the intervention program, it appears that the girls are significantly taller and heavier after the nutrition intervention than before the nutrition intervention. However, when these data are broken down by age, significant differences are only found at a few ages. The growth curve of the HAZ (Figure 2) before the intervention shows a pattern climbs closer to the second curve at ages 16 and 17 years, which may suggest that the girls without the nutrition intervention may eventually catch-up in height.

BMI data revealed a significant increase between 2001 and 2004, however this is expected due to the fact that these girls were still growing from 2001 to 2004. The growth charts (Figures 2, 3 and 4) also reveal that the girls without the nutrition intervention program had lower BMIZ for each age than those who had the nutrition intervention. When BMIZ were analyzed, no significant differences were found before and after the intervention. The BMIZ-score graph does reveal growth curves that climb above the reference mean by age 11 and 12 years, suggesting that these girls' weights are greater than the reference population when compared to their heights. Looking at a growth curve that is above the reference population might suggest that these girls have little risk for being undernourished, therefore it is important to also look at the HAZ and WAZ data and not the BMI data alone to gain a better understanding of these girls' overall nutritional status.

Finally, the pre-test post-test data also suggest that there is significant improvement in nutritional knowledge two years after the nutrition intervention program was initiated. While knowledge is an important step for this program, it does not necessarily indicate changes in nutrition behavior, and thus an overall change in nutritional status.

Growth data

The use of the Mexican-American reference dataset may be more appropriate than the US data with this Nicaragua population due to closer genetic ties. It should be noted here that, when examining height and weight data among Latin American populations, several researchers have suggested that Latin American populations appear more stocky in relationship to those of European descent[27], and thus the BMI data may not make the best indicator of nutritional status in this population. Martorell and Scrimshaw[5] found similar results when comparing Guatemalan growth data prior to and after a nutrition intervention program. He found that catch-up growth, or growth following a period of growth restriction, appeared to be evident only when comparisons were made with a Mexican-American reference population rather that a US reference population. Catch-up growth may be suggestive of improved nutritional status. While these data show some evidence of better growth indicators after the nutrition intervention program, there is little evidence of catch-up growth that is specific to those girls.

The overall means show statistical significant improvement in HAZ and WAZ after the nutrition intervention program and may be indicative of an effective nutrition intervention program. However, when broken down by age, these differences are not as evident, thus these data not appear to support part of the first hypothesis, which suggests that the nutrition intervention program will improve nutritional status. Further, these data do not support improvement in hemoglobin status and in fact, hemoglobin levels drop after the intervention program. These data do support the second hypothesis which suggests improvement in nutritional knowledge. While the nutrition intervention program appears to have some impact on nutritional status and knowledge, there are many limitations regarding the data described, and they are discussed next.

Limitations

Growth Data. In many studies in developing countries, growth data are used as indicators of nutritional status. Growth and development of children and adolescents is affected by poor nutrition because the body places higher priorities on fighting diseases, maintaining a basal metabolism, and providing energy for physical activity before expending energy on growth. During adolescence, poor nutrition can lead to a delayed adolescent growth spurt and delays in pubertal development. In order to best examine delays in the adolescent growth spurt, longitudinal data are needed. Thus, while these cross-sectional data may suggest the presence of catch- -up growth, additional examinations of longitudinal growth patterns are better to more fully examine the impact of the nutrition intervention program on growth.

If in fact catch-up growth truly occurs, it may be influenced by the nutrition intervention program. However, it appeared that catch-up growth also may have occurred among the girls before the nutrition intervention. Further, catch-up growth during adolescence has not fully been defined and the degree to which catch-up growth can compensate for previous losses is uncertain. Cameron[28] has suggested that catch-up growth requires some kind of stressor that inhibits normal growth velocity as well as an alleviation of that stressor. Largo[29] has suggested that there may be two kinds of compensating mechanisms that occur among malnourished populations during the adolescent growth spurt. These mechanisms may be more genetically based rather than influenced by improvements in the environment. Therefore, these data suggesting catch-up growth occurs may be due to a natural compensatory growth that occurs during adolescence rather than the major influence of the nutrition intervention program. Again, additional longitudinal data need to be examined to more fully understand the impact of the intervention program on the girls' growth.

Hemoglobin data. While the growth data may suggest improvement in nutritional status, the hemoglobin data have revealed the opposite results such that the mean hemoglobin values for the girls have significantly decreased after two years of the nutrition intervention program. Low hemoglobin values are affected by several factors. From a nutritional stand-point, low iron intake and an increase in the consumption of foods which inhibit iron absorption can affect hemoglobin status. In Nicaragua, girls are at risk of low iron stores because of the low consumption of meat and other high heme sources and the high consumption of tannins in coffee which inhibit iron absorption. Further, very few fresh fruits containing vitamin C (which can assist in the absorption of iron) are consumed among adolescent girls in Nicaragua. These fruits are often replaced with high calorie low nutrient dense sodas and juices. Because of this risk of poor iron intake, much of the content of the nutrition education program was focused on improving iron intake. Suggestions were made concerning increasing iron rich foods, increasing vitamin C rich foods with non-heme sources of iron, increasing heme sources of iron in combination with non-heme sources, and decreasing coffee consumption during mealtimes.

Among these girls in this community, there are other factors which may affect the girls' hemoglobin status. These include parasite infections, hydration status, smoking, pregnancy, menstruation, and the rapid growth occurring during the adolescent growth spurt. These data have been collected and need to be more fully examined to determine potential reasons for significant decreases in hemoglobin values. An initial examination of parasite infection, revealed that approximately 80% of the girls who had been classified as having anemia, were also positive for parasites (Lumbi, personal communication, 2004). Therefore, hemoglobin status, may not necessarily be the best biochemical indicator of poor micronutrient intake.

Nutritional knowledge indicators. While nutritional status is examined, one other indicator of the effectiveness of the nutrition intervention program is also presented here, nutritional knowledge. These data suggest that girls did significantly improve their nutritional knowledge before and after the nutrition interventions. While these indicators suggest that girls are learning about healthy eating habits, the translation of these data into behavior also need to further be explored. Behavioral indicators are critical for understanding how the girls may translate their knowledge into practice, so that we can more fully understand, if this program truly does impact nutritional status.

Conclusions

These findings are the first to report the impact of a two-year nutrition intervention program targeted at adolescent girls in Nicaragua. These data show that the nutrition intervention program may have a small impact on girls' nutritional status related to height and weight, but not hemoglobin status. Further, these data show improvement in nutritional knowledge after the implementation of the nutrition intervention program. These data suggest that adolescence may not be too late concerning the implementation of nutritional intervention programs. However only further investigations concerning longitudinal growth data and behavioral data can more fully provide details related to the impact of the nutrition intervention program on adolescent girls.

This study provides clues that the nutrition education program may have an impact on girls' nutritional status as well as their nutritional knowledge. These findings, while with limitations, are important evidence to suggest that nutritional intervention programs can make an impact on adolescents. Most of the nutritional intervention programs today in developing countries are focused on young children and mothers in order to try to assist in preventing nutritional problems early on. These data support the importance of intervening during adolescence as well as early childhood, particularly among those at risk of malnutrition. Additional research that also examines the impact of these girls' mothers may provide other clues to understanding their nutritional situation and the impact of future nutrition intervention programs.

Acknowledgements

This study was made possible by grants from the George Mason University College of Nursing and Health Science and from a grant from the George Mason University Provost's Office. We would like to thank our research assistants Laura Lumbi, Claudia Rodriguez, and Johanna Cruz. We would like to thank the Escuela de Enfermeria at Universidad Politecnica de Nicaragua, and particularly Carmen Benvenides and Lidya Zamora for their continuous support and assistance. Finally we would like to thank Kalpana Ramiah, Karen Whitt, and Diana Louder for their assistance with the data organization and data entry.

REFERENCES

1. BOGIN B, WALL M, MACVEAN RB, Am J Hum Biol, 2 (1990) 271. — 2. BOGIN B, WALL M, MACVEAN RB, Am J Phys Anthropol, 89 (1992) 447. — 3. MARTORELL R, SCHROEDER DG, RIVERA JA, KAPLOWITZ H, J of Nutr, 125 (1995) 1060S. — 4. MARTORELL R, SCRIMSHAW NS, J Nutr Suppl, 125 (1995) 1060S. — 5. JOHNSTON FE, WAINER H, THISSEN D, MACVEAN R, Am J Phys Anthropol, 44 (1976) 469. — 6. PENA M, BACALLAO J, Obesity and Poverty: A new Public Health Challenge. (Pan American Health Organization, WHO, Washington DC, 2000). — 7. MARTORELL R, KHAN LK, HUGHES ML, GRUMMER-STRAWN LM, J of Nutr, 128 (1998) 1464. — 8. UAUY R, ALBALA C, KLAIN J, J of Nutr., 131(2001) 893S. — 9. DUFOUR DL, STATEN LK, REINA JC, SPURR GB, Coll Antropol, 21(1997) 29. — 10. LH ALLEN, J of Nutr, 133 (2003) 3875S. — 11. OMNI, Omni Micronutrient Fact Sheets: Nicaragua, Available from: www.mostproject.org/Nicarag.htm, accessed January 1, 2006. — 12. MINISTERIO DE SALUD, Encuesta Nacional sobre Deficiencia de Micronutrientes en Nicaragua (Managua. Managua, Nicaragua: Ministerio de Salud; 1993). — 13. MORA JO, GUERI M, MORA OL, Pan Amer J Public Health, 4 (1998) 178. — 14. TOULBOU S, L'EXPÉRIENCE DE L'ASSOCIATION SOYNICA AU NICARAGUA, Available from: http://www.novethic.fr/novethic/site/dossier/ index.jsp?id=17273&dos=17271, accessed August 12, 2004. — 15. WORLD BANK. 2003 World Development Indicators. (World Bank, Washington DC, 2003.). — 16. MINISTERIO DE SALUD. ENCUESTA NICARAGUENSE DE DEMOGRAFIA Y SALUD (ENDENSA) 1998, Demographic and Health Surveys. (Instituto Nacional de Estadisticas y Censos (INEC), Managua, Nicaragua, 1999). — 17. CAPUCCI E, RICERCHE

ANTROPOLOGICHE IN UNA COMUNITA DEL NICARAGUA, NOTA II – Antropometria dei soggetti in accrescimento (6 mesi–6 anni). In: V. CORRENTI (Ed.), Rivista di Antropologia Vol. LXIV. (Istituto Italiano di Antropologia Citta Universitaria, Rome, Italy, 1986.). — 18. MARTORELL R, RIVERA J, KAPLOWITZ H, POLLITT E, Long-term consequences of growth retardation during early childhood. In: HERNANDEZ, ARGENTE (Eds.): Human Growth: Basic and Clinical Aspects. (Elsevier Science Publishers, Amsterdam, 1992). — 19. MARTORELL R, KHAN LK, SCHROEDER DG, Eur J Clin Nutr, 48 (1994) 545. — 20. LOHMAN G, ROCHE AF, MARTORELL R, Anthropometric Standardization Reference Manual. (Human Kinetics Books, Chicago, 1988). — 21. WHITNE EN, CATALDO CB, ROLFES SR, Understanding Normal and Clinical Nutrition 6th Edition. (Wadsworth/Thomson Learning, Belmont, 2002). — 22. BURGER SE, PIERRE-LOUIS JN, How to assess anemia and use the Hemocue. (New York, Hellen Keller Worldwide, 2002). — 23. DEAN AG, DEAN JA, COULOMBIER D, BRENDEL KA, SMITH DC, BURTON AH, DICKER RC, SULLIVAN K, FAGAN RF, ARNER TG, Epi-Info: a word processing, database, and statistics program for public health on IBM compatible computers. (CDC, Atlanta, 1995). — 24. DEONIS M, HABICHT JP, Anthropometric reference data for international use: Recommendations from a WHO Expert Committee, Amer J Clin Nutr, 64 (1997) 650. — 25. HISPANIC HEALTH AND NUTRITION EXAMINATION SURVEY (HHANES). Plan and Operation of the Hispanic Health and Nutrition Examination Survey, 1982–84, (CDC, Atlanta, 1985). — 26. PAWLOSKI LR, MOORE JM, LUMBI L, RODRIGUEZ C, Annals Hum Biol, 31 (2004) 647. — 27. EVELETH PB, TANNER JM: Worldwide variation in human growth. (Cambridge University Press, Cambridge, 1990.). — 28. CAMERON N, Am J Phys Anthropol, 193 (1994) 307. — 29. LARGO RH, GASSER T, PRADER A, STUTZLE W, HUBER PJ, Annals Hum Biol, 5 (1978) 421.

L. R. Pawloski

Department of Global and Community Health, College of Health and Human Services, George Mason University, MSN 5B7 4400 University Drive, Fairfax, VA 22030, USA
email: lpawlosk@gmu.edu

UTJECAJ PROGRAMA PREHRAMBENE INTERVENCIJE NA RAST I PREHRAMBENI STATUS NIKARAGVANSKIH DJEVOJAKA

S A Ž E T A K

Ovo istraživanje proučava utjecaj interventnog programa prehrambene edukacije na prehrambeni status i znanje nikaragvanskih adolescentica. Antropometrijska mjerenja, vrijednosti hemoglobina i podaci koji uključuju prehrambeno znanje dobiveni su od adolescentica u Managui, Nikaragva. Koristeći uzorak testa prije/poslije, uspoređeni su podaci prije i nakon programa prehrambene intervencije. Koristeći meksičko-američke preporuke, nađene su statistički značajne razlike u z-vrijednostima visina/godine i z-vrijednostima težina/godine, koje su usporedile uzorak početnih vrijednosti podataka s podacima sakupljenim nakon 3 godine prehrambenog interventnog programa ($p<0,05$). Značajno poboljšanje također je utvrđeno kod indikatora znanja o prehrani ($p<0,05$). Međutim, vrijednosti hemoglobina pokazale su značajan pad, što se može pripisati specifičnim faktorima okoliša i promjenama tijekom puberteta. Ovo istraživanje sadrži implikacije vezane uz razvoj uspješnog prehrambenog interventnog programa u Nikaragvi, fokusiranog na adolescente, te proučava mogućnost pojave nadoknadnog rasta tijekom adolescencije.