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UNIVERSITY OF BOTSWANA
DEPARTMENT OF HOME ECONOMICS EDUCATION, CHILD DEVELOPMENT CONCENTRATION
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Effect of Dietary Protein Enrichment Pilot Program on the Growth of Under-Five Children in Day Care Centers in Gaborone, Botswana

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Abstract
A pilot evaluation of the addition of soy protein to the diet of children attending day care centers in Gaborone, Botswana showed encouraging results in both acceptability of products and in improvement of nutritional status markers. Measures included height and weight at -3 months, 0 months, and +3 months of intervention. Anthropometric failures seen at -3 months and at 0 months were reversed in all but one child who remained stunted. At -3 months 4/27 had anthropometric failure, including 1 stunting and underweight and 3 stunting only. At month 0 there were 5/21 with anthropometric failures, including 1 wasting only, 1 wasting and underweight, 2 wasting, underweight, and stunting, and 1 stunting only. After 3 months of intervention only 1/20 experienced anthropometric failure as stunting only. Mean Z values remained static throughout for wasting (-0.41 at baseline to -0.55 at month +3), but tended to improve in both stunting (-0.95 at baseline and -0.32 at month +3) and underweight (-0.82 at baseline and -0.53 at month +3). The use of the Composite Index for Anthropometric Failure (CIAF) more clearly identified risk levels with mutually exclusive categories to identify both prevalence and higher nutritional risk with multiple anthropometric failures.

Introduction

Botswana is about the size of Texas with a population of 1.6 million people. The HIV infection prevalence rate is estimated at over 24% for adults, the second highest prevalence country in the world today. Life expectancy at birth has dropped to less than 40 years old, an estimated 28 years less than if HIV was not an issue. A review of the history of HIV/AIDS in Botswana, its impact and challenges, and efforts to contain the epidemic can be found at: http://www.avert.org/aidsbotswana.htm.

Around 120,000 children in Botswana have lost one or both parents to HIV/AIDS. The rate of orphaned children in Botswana is among the highest and orphanages have become overloaded. A program designed by the government places these new orphans into existing families with a food basket and subsidy for daycare to defray the burden. Children orphaned by HIV/AIDS may be more likely to experience chronic under-nutrition early in life and the life-long health issues associated with this problem. A study of the current population's nutritional status also showed that children were hardest hit by nutrition-related problems in both urban and rural areas.[1] This study suggested that about one quarter of children under five were stunted, wasted, and/or underweight. Because daycare centers in the urban areas have a high prevalence of HIV/AIDS orphans who may be at even higher risk than the general population and one congregate meal per day is provided for children under five years of age who attend, this venue was chosen to pilot the use of value-added soy products (VASPs).

Background

Nutrient intake affects many aspects of child development including growth, cognitive functions, and social function.[2 3 4 5] Inadequate nutrient intake can lead to deficits in each of these areas including growth retardation or failure, mental retardation and sub-optimal cognitive development, and long-term social dependency and diminished potential. Nutrient needs particular to children include a higher level of calories and protein per kilogram of body weight, additional micronutrients (such as zinc to support height, iron to prevent anemia, and calcium and phosphorus for bone growth), and a plentiful and safe supply of fluids to prevent dehydration. An additional long-term concern is chronic generational malnutrition, where malnutrition is perpetuated from one generation to the next in a downward cycle.

Adequate nutrient intake requires attention to fluids, calories, protein, and micronutrients to support growth and development. While fluids and calories top the priorities for nutrient intake, adequate high-quality protein is essential for growth and development in children as well as maintenance and restoration of survival-linked lean tissues.[6] Diminished linear growth in children has been related to a diminished cognitive development.[7] Adequate high-quality protein is essential to linear growth, cognitive development, health, and survival.

Most high-quality proteins are animal product-based, such as eggs, dairy products, and meats. Soy is a unique plant-based high quality protein comparable to the biological value of meats to human bodies.[1] Soy can easily be incorporated into a number of existing, culturally acceptable food items to enhance the value of usual food choices in an economically feasible way. Currently utilized soy products such as defatted soy flour (DSF), soy protein concentrates and isolates, and texturized soy protein (TSP) allows for the expansion of nutritious and highly acceptable food choices. There are additional potential benefits in the use of the

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[1] **Protein Quality**. Substitution of soy protein for a proportion of the animal protein content of the U.S. diet will change the amino acid composition of the diet. Because lower biological values have been attributed to plant protein, this change may be a cause of concern for some individuals. The validity of these concerns can be challenged on face value by the more optimal health status found among vegetarians compared with the general U.S. population (White and Frank, 1994). Furthermore, the biological value of soy protein is superior to other plant proteins and is equivalent to animal protein sources (FAQ/WHO, 1991). The quantities and proportions of essential amino acids provided by soy protein are sufficient to meet human needs from age 2 to adulthood. The previously-held belief that soy protein had a lower biological value than animal protein was based on analytical data demonstrating that methionine was a limiting amino acid in soy protein. However, these data were derived from older methods of assessing protein quality that are not the standards used today. Prior to 1993, protein quality was evaluated by calculating a protein efficiency ratio (PER) which measured the growth response of weanling rats fed different levels of a protein. This index substantially underestimates the quality of soy protein because the requirement for sulfur-containing amino acids is much higher for rats than for humans. Rapidly growing rats need greater amounts of methionine than do humans to support growth of body hair (Steinke and Hopkins, 1983). Consequently, it is estimated that the amount of methionine needed to meet human growth requirements are as much as 50% lower than the requirement for animals.Since 1993, protein quality has been evaluated by use of the protein digestibility-corrected amino acid score (PDCAAS), which was adopted by FDA to replace the PER for food labeling purposes. The PDCAAS is recognized by the Food and Agriculture Organization and the World Health Organization as a more accurate standard for assessing protein quality than the previously used PER. The PDCAAS takes into account protein digestibility, amino acid profile, and the ability of the amino acid profile to meet the needs of 2-5 year old children, the population subgroup having the highest protein needs other than infants. Using the PDCAAS, the protein quality of isolated soy protein is identical to that of casein and egg white, and higher than that of proteins found in beef, kidney beans, pinto beans, lentils, peanuts, and wheat (FAOIWHO, 1991).

plant-based protein soy compared to meat-based proteins that are more associated with long-term and chronic diseases, such as heart disease, cancers, and others.[8]

This pilot study was undertaken to evaluate the potential for effect on growth parameters in under-five children attending daycare centers in Gaborone, Botswana. In addition, this pilot may help to define expected outcomes of high-quality protein fortification of the diet for a population that has a relatively high rate of malnutrition.

Methods

The protocol was developed in collaboration between the World Initiative for Soy in Human Health (WISHH) and the University of Botswana, Department of Home Economics Education, Child Development and approved by the University Administration and the Botswana Ministry of Health for ethics and other considerations. The Gabaresepe daycare center received textured soy protein (TSP) and defatted soy flour (DSF) to include in their daily meal. Each week, defatted soy flour (DSF) and textured soy protein (TSP) products were measured and distributed to the daycare center. The decision to measure soy products for the centers was made to ensure measurements were consistent throughout the process and to make it easier for staff who were not confident to do the measuring. Each child received 10g of soy as a part of a daily meal provided in the day care settings. Baseline measures included height, weight, and other anthropometry. Follow-up measures included anthropometry and acceptability of rations. Z values for children under five were compared between pre-intervention baseline (months -3 to 0) and follow-up measures (months 0 to +3). Measures were categorized according to the Composite Index for Anthropometric Failure (CIAF) to identify overall prevalence and severity of nutritional risk (see Table 1).[9]

Table 1. Composite Index of Anthropometric Failure (CIAF) Categories

Category	Description
A. No failure	Adequate height and weight (above -2 Z scores)
B. Wasting only	Low wt for ht
C. Wasting and underweight	Low wt for age and low wt for ht
D. Wasting, stunting, and underweight	Low wt for age, low wt for ht and low ht for age
E. Stunting and underweight	Low ht for age and low wt for age
F. Stunting only	Low ht for age
Y. Underweight only	Low wt for age

Key: wt = weight; ht = height

Results and Discussion

Thirty children from 36-60 months of age were targeted for measurements at pre-intervention, intervention baseline, and follow-up, including 16 boys and 14 girls. At month -3 there were 27 evaluable measures, at month 0 there were 21 evaluable measures, and at month +3 there were 20 evaluable measures. At month -3 there were 4/27 children who were identified with anthropometric failure according to the standards recommended by World Health Organization (WHO) of <-2Z score on any one or more of the following: height for age (stunting), weight for age (underweight), or weight for height (wasting). There were 5/21 with one or more failure by month 0. After intervention was initiated for 3 months measures showed 1/20 children remained with a single anthropometric failure of stunting. Table 2 summarizes the details of the measurement evaluation.

Table 2. CIAF Evaluation of Serial Measures

Category	-3 month (pre-intervention)	0 month (baseline)	+3 month (during intervention)
A	23	12	20
B	0	1	0
C*	0	1	0
D*	0	2	0
E*	1	0	0
F	3	1	1
Y	0	0	0

* Multiple failure categories suggest higher nutritional and health risk

There was a slight decrease in the mean of weight for height Z-scores between the first and second pre-intervention measures with subsequent improvement after three months of intervention (Figure 1). Height for age tended to improve for each serial measure with the largest improvement after intervention (Figure 2). Changes in mean values of weight for height Z scores were more subtle (Figures 3).

Figure 1.

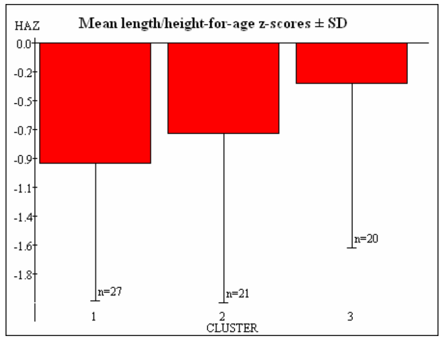

Figure 2.

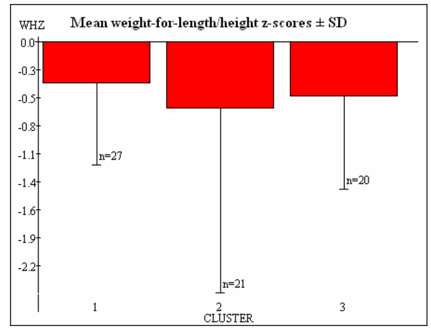

Figure 3.

Because meals outside of the daycare setting were not controlled, the addition of a pre-baseline study was added to help to anticipate growth channels and changes without the addition of VASPs to the diet. The group studied was small and the time period for intervention was short. An extended study that enrolls more children should include additional factors that may be related to nutritional and health impact indicators, such as illness and social factors. The children who attended day care centers were provided with a meal each day of attendance prior to the initiation of the study and there was no baseline data available to characterize nutritional status of the children before their attendance.

Conclusions

The use of the CIAF methods to categorize undernutrition provided a better understanding of the risk associated with undernutrition, such as a greater risk with multiple anthropometric failures. CIAF also provides a more accurate picture of overall incidence and prevalence of nutritional problems through the use of mutually exclusive categories.

The results suggest that there may be good reason to further study the addition of an economical high-quality protein to the diet of children in urban settings attending day care centers who may be at risk for malnutrition. This study suggests that a particular role for the addition of high quality protein in the diet of under-fives is the potential improvement of height levels toward the reduction of the incidence of stunting as well as a smaller effect on underweight and wasting. The change from higher risk categories of undernutrition to lower risk categories may be even more important as an outcome than improving a more general picture of incidence and prevalence. Larger studies with extended time periods for intervention will be necessary to more clearly establish the roles of both CIAF as a method of categorization and high-quality protein supplementation with value added soy products in high risk populations.

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