VALIDATION OF A HOUSEHOLD FOOD SECURITY SURVEY APPLIED WITH LOW-INCOME HOUSEHOLDS WITH PRE-SCHOOL AGED CHILDREN PARTICIPATING IN THE MANA FOOD SUPPLEMENT PROGRAM IN ANTIOQUIA, COLOMBIA

DISSERTATION

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By

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ABSTRACT

Valid measures of household food insecurity are critical to accurately evaluate the impact of food assistance programs in developing countries. The goal of this dissertation research was to assess the validity of a locally adapted food security survey, the Colombian Household Food Security Scale (CHFSS), used in the 2006 food supplement component evaluation of the Plan for Improving Food and Nutrition in Antioquia, Colombia (MANA - Plan Departamental de Seguridad Alimentaria y Nutricional de Antioquia). The twelve-item household CHFSS was applied to a cross-sectional stratified random sample of 2,784 low-income households with pre-school children receiving MANA food supplements. Internal validity of the CHFSS was established using Rasch Modeling to evaluate the psychometric characteristics of the items through measure and INFIT values. Differences in CHFSS performance were assessed by area of residency, socioeconomic status and number of children enrolled in MANA.

To assess the criterion validity of the CHFSS, households were characterized as food secure, mildly food insecure, moderately food insecure, and severely food insecure based on their survey score. Chi-square tests and ANOVA analyses were used to determine associations between the food security categories and demographic characteristics, food expenditure variables, child anthropometrics, child health status and
food supplement consumption by children in MANA. A multiple linear regression model was developed to determine coefficients of household food expenditure by food security status. Logistic regression models were further developed to assess the risk of negative child health outcomes by household food insecurity status in both bivariate and multiple regression models.

Rasch Modeling revealed that most CHFSS items presented good fitness, with most INFIT values within the adequate range of 0.8 to 1.2. Consistency in item measure values between groups was found for all but two items in the comparison by area of residency. Statistically significant differences were found between household food security status and household size, parental age and income (p<0.0001). Food security status differed by area of residence and gender head of household (p<0.01). Increasingly severe food insecurity status was significantly and inversely correlated with household food expenditures (p<0.0001). Consumption of MANA supplemental foods was positively associated with food insecurity; at higher levels of food insecurity, food supplement intake increased (p<0.001). Statistically significant associations were found between household food insecurity and diagnoses of children’s diarrhea, upper respiratory infection and parasitosis (p<0.0001). The risk for child stunting and underweight increased is a dose-response manner as food insecurity became more severe.

These results indicate that the adapted CHFSS is a valid tool to assess household food security in participants of food assistance programs like MANA, and support the use of the proposed tool to accurately assess the food security status of high risk populations.
in Colombia. Our research establishes an important link between household food insecurity and child nutritional status as well. This research provides agencies and institutions carrying nutrition interventions in similar areas and conditions with a valid tool that can be adapted to specific evaluation needs and describes the methodology to assess the validity of the proposed tool.
Dedicated to my father
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CHAPTER 1
REVIEW OF LITERATURE

INTRODUCTION

Hunger has long been a concern of world leaders, as evidenced by the Universal Declaration of Human Rights, published in 1948 stating that “everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food…” (United Nations, 1948). At the 1996 World Food Summit in Rome, Italy, representatives from 186 countries affirmed that access to adequate, safe and nutritious food is an inherent human right and subsequently established the goal to cut the number of hungry individuals worldwide by 50% before the year 2015 (FAO, 1996). To monitor the goal set at the World Food Summit, accurate tools are needed that measure hunger and food insecurity (Anderson, 1990). Food insecurity is characterized by individuals without access at all times, to enough food for an active, healthy life and occurs when nutritional needs are not met and includes a range of experiences from basic concern over obtaining food to severe malnutrition. The measurement of food insecurity allows governmental and development agencies to estimate the prevalence of this phenomenon, better target high risk populations, and monitor and evaluate the impact of their programs at the household level (Frongillo, 1999). Economic indicators of food
production and food availability have historically been used to assess food insecurity at national and regional levels. Although broadly applied, these methods are expensive, time consuming and not necessarily the most accurate means for measuring food insecurity at the household level (Coates et al, 2006). With the use of a more appropriate measurement tool, organizational resources can be appropriately channeled to reduce epidemic levels of food insecurity and hunger.

HOUSEHOLD FOOD SECURITY

As reported by the Food and Agriculture Organization of the United Nations, food insecurity and hunger are problems that affect over 850 million people world-wide (FAO, 2006). These data do not include the individuals with “hidden hunger,” characterized by vitamin and mineral deficiencies, making the total number of individuals with some degree of undernourishment over 2 billion (Hunger in a world of plenty, 2004). “Hidden hunger” affects over 33% of children in some of the poorest regions (FAO, 2006). Food insecurity and hidden hunger are both situations that are captured within the definition of food insecurity (Anderson, 1990). The phenomenon of household food insecurity involves complex interactions of resources, health, food availability and environmental factors (Cook and Frank, 2007, Yeundall et al, 2007). Food insecurity can affect all members of the household physically, psychologically, socially, developmentally and economically that are explained in the following sections (Radimer, 1990).
Household Food Security and Household Demographics

Household demographic characteristics are strongly associated with household food security (Cook and Frank, 2007). Researchers in Iran found inverse associations of adult food insecurity and child hunger with parental education (Zerafati et al, 2007). Research in rural Ecuador found that the mother’s educational level correlated negatively with household food insecurity level (Hackett et al, 2007). Likewise in the US, low female education level was associated with increased hunger (Olson, 1990). Mexican immigrant households in the US exhibited higher levels of household food insecurity in households with low maternal education and age (Kersey et al, 2006). Household size has also been associated with food insecurity in the US, Venezuela and Iran (Weigel et al, 2007; Jones and Frongillo, 2006; Lorenzana and Sanjur, 1999; Zerafati et al, 2007; Olson, 1990). In addition to education level, size of household and parental age, there are additional demographics that are strongly associated with food security as explained below.

Socioeconomics

Low income is one of the strongest predictors of food insecurity in the US, although poverty is not a sensitive indicator for hunger (Rose, 1999). Reductions in daily per capita food expenditures by food security status were found in convenience samples taken in Bolivia, Burkina Faso and the Philippines (Melgar-Quinonez et al, 2006). Researchers in these countries found variations in purchase patterns of specific food groups by food security status. A dose-dependent relationship between food insecurity and income was evident in Campinas, Brazil where households at lower income strata
were less likely to be food secure (Perez-Escamilla et al, 2004). Poor households in peri-urban Caracas, Venezuela exhibited positive associations of monthly income per person with household food security (Lorenzana and Sanjur, 1999). The less the individuals in the household earned, the more severe the mothers perceived their food insecurity situation.

*Food Supplies and Dietary Intake*

Food insecurity is initially characterized by decreased amounts and varieties of food, but also includes unsuitability of food and the preoccupation with continuing access to food (Hamelin et al, 2002). Food insecure households experiencing hunger in rural Ecuador had lower total food supplies than food secure households as seen in the following groups: meat, vegetables, legumes, oils, processed products, beverages, snacks, and condiments (Hackett et al, 2007). Similarly, in Mexico City, household food insecurity was inversely correlated with household food consumption (Perez-Escamilla, 2005). Specifically, there was a decrease in fruit, fruit juices, vegetable, meats and dairy products as food insecurity increased. In Sierra de Manatlán, Jalisco, Mexico, researchers compared the variety of diet and food supply with levels of food insecurity and found that as food insecurity increased, the variety of diet and food consumption decreased (Melgar-Quinonez et al, 2005). As a coping mechanism frequently used in food insecure households, inexpensive low nutrient dense food replaces other more nutritious options (Cook and Frank, 2007).

The Third National Health and Nutrition Examination Survey (1988-1994) and the Nutrition Survey of the Elderly in New York State (1994) demonstrated that older
adults with food insecurity have lower intakes of energy, vitamin B6, magnesium, iron and zinc (Lee and Frongillo, 2001). In adults in the US, correlations were observed between serum nutrients and corresponding dietary nutrients and food sources of those nutrients, showing a relationship between dietary intake and resulting serum and dietary nutrients (Dixon et al, 2001). Food insecure young adults in the US had intakes below 50% of the RDA of protein, vitamins C, B-6, and folate, magnesium, iron, and zinc. These adults also had lower serum concentrations of carotene, lycopene and vitamins C and E (Dixon et al, 2001).

**Household Food Security and Health**

Poor physical outcomes may be due to a combination of food insecurity and repeated episodes of illness (Mondal et al, 2006). Individuals in food-insufficient households in Canada were more likely to report cases of heart disease, diabetes, high blood pressure and food allergies (Vozoris and Tarasuk, 2003). They also reported restricted activity, poor or fair health, and poor long term health. Food insecure children in the US had significantly higher odds of reporting fair/poor health and of being hospitalized since birth than children in food secure households (Cook et al, 2004). Food insecure children included in the third National Health and Nutrition Examination Survey were significantly more likely to have poorer health status including more frequent stomachaches and headaches than food secure children (Alaimo et al, 2001).

**Protein energy malnutrition**

Food insecurity affects health and well-being throughout the life cycle and has been associated with child dietary intake and weight status (Cook and Frank, 2008; Oh
and Hong, 2003; Perez-Escamilla, 2000). Household food insecurity is associated with protein energy malnutrition (PEM) evident in stunting, wasting and underweight which affects one quarter of the world’s children. (Alvarado et al, 2005; Baig-Ansari et al, 2006; Phengzay et al, 2007).

To evaluate PEM the following data must be collected: height or length, weight and age. Three generally accepted anthropometric indices are used to approximate children’s nutritional status: height-for-age Z-score (HAZ), weight-for-age Z-score (WAZ) and weight-for-height Z-score (WHZ) (WHO, 1983) Computed z-scores allow children’s nutritional status to be compared regardless of gender and age (Mei and Grummer-Stawn, 2007). Z-scores are used to distinguish between normal and risk for stunted/stunted (HAZ <-1), risk for underweight/underweight (WAZ <-1) or risk for wasted/wasted (WHZ <-1) children. Stunting, underweight and wasting in children are the physical manifestations of poor dietary intake (Mei and Grummer-Stawn, 2007). In addition to reductions in food quantity which leads to PEM, many households must alter the quality of their dietary intake which could result in micronutrient deficiencies (Cook et al, 2004).

**Iron Deficiency Anemia**

Iron deficiency is associated with poor dietary intake evident in food insecure households and affects nearly two billion individuals (Matheson et al, 2002; Iannotti et al, 2006). For example, the consumption of animal-source foods of children in urban Uganda was significantly negatively associated with C-reactive protein which was subsequently, negatively associated with hemoglobin (Yeundall, 2007). The results of iron deficiency
include decreased neurological function, stunting, increased susceptibility to disease and lethargy in children (Iannotti et al, 2006). In adults the same abnormalities occur in energy and immune compromization, but there is no decrease in linear growth rates (Killep et al, 2007).

Iron deficiency can be assessed with hemoglobin status, ferritin, zinc protoporphyrin (ZPP), mean red blood cell volume and transferrin receptor levels (WHO, 2004). Ferritin measures iron storage status when an individual is not ill, ZPP reflects the amount of zinc that is incorporated into the protoporphyrin molecule in the place of iron in red blood cells and small mean cell volume also indicates iron deficiency anaemia (WHO, 2004). Transferrin receptor level represents the functional iron compartment and inversely correlates to iron storage levels. This last indicator is considered the best measure of iron status because it is not affected by inflammation (Rimon et al, 2002). Unfortunately transferrin receptor measurement is costly, so most studies depend on ferritin and hemoglobin measurements in developing countries (WHO, 2001). When taking blood samples to assess ferritin and hemoglobin, acute phase protein levels and altitude of residence must also be collected so that iron levels can be adjusted appropriately (Wish, 2006). Hemoglobin can be measured using HemoCue azidemethemoglobin techniques and ferritin can be quantified using chemiluminescent immunoassays (Burgere S and Pierre-Louis, 2003; Stoltzfus et al, 1997). Anemia is established using the cut-off of <11 mg/dl for hemoglobin (WHO, 2001). Children under 5 years old with serum ferritin values less than (12 mg/L) are categorized as anemic (WHO, 1998).
Parasitosis

Diarrheal illness is shown to be related to child malnutrition and is dependent on the cause of diarrhea (Mondal et al, 2006). Infection with *Escherichia coli* has a significant negative effect on linear growth, but diarrhea associated with *Rotavirus* and *Shigella* do not (Mondal et al, 2006). *Giardia* infection causes malabsorption of fat and reduced mucosal disaccharides activity in the small intestine, but the influence on growth is disputed (Farthing et al., 1986; Murry, 1998). *Entamoeba histolytica* is a common pathogen associated with diarrheal morbidity and is considered by WHO to be one of the major health problems in the developing world and is associated with stunting in Bangladesh (WHO, 1997; Mondal et al, 2006). *Entamoeba histolytica* causes local necrosis in the large intestine, intestinal mucosal inflammation, hemorrhage and secondary bacterial infection (Murry, 1998).

Helminths such as hookworm, roundworm and whipworm are also associated with the nutritional status of children (Murry, 1998). Two species of hookworms and whipworm that infect humans contribute to blood loss which can lead to iron deficiency (Hall, 2007). *Unciorias* (hookworm) infection leads to blood loss, emaciation, mental and physical retardation (Murry, 1998). *Trichuris trichiura* (whipworm) causes abdominal pain, distention, bloody diarrhea, weakness and weight loss (Murry, 1998). *Ascaris lumbricoides* (roundworm) affect nutrition by obstruction in various sections of the gut by migration to bile duct, gallbladder, liver and appendix (Murry, 1998). Whipworm and roundworm may not always produce diarrhea, defined as three or more liquid stools in 24 hours, but can limit child growth (WHO, 2002; Mondal et al, 2006). In order to assess
parasitosis fecal samples must be collected, and a classic formalin-ether concentration technique (Ritchie) can be used to analyze the feces (Knight et al, 1976).

**Cycle of Household Food Insecurity**

In addition to the detrimental health consequences of food insecurity previously mentioned, there are also economic aspects that affect individuals and their communities (Figure 1). Poorly nourished individuals have reduced labor productivity that leads to lower per capita income and cycles to a reduced ability to purchase safe, healthy and nutritious food (ADA Position Paper, 2003). This phenomenon affects household members and others who rely on them for support, thus becoming a vicious cycle trapping adults and children with each generation becoming progressively worse nutritionally (Gillespie and Flores, 2006). Because of the wide range consequences of food insecurity, world leaders have declared access to food a human right and a collective responsibility (FAO, 1998).
In response to malnutrition, the departmental government instituted the program Plan for Improving Food and Nutrition in Antioquia (MANA) in 2002 (Gutierrez et al, 2005). MANA aims to resolve the causes of food insecurity in low-income families with pre-school age children. The food supplement component of this program includes the free distribution of basic food supplements for children at high nutritional risk and suffering from poverty until six years of age (Gutierrez et al, 2005).

Figure 1.1 Food Insecurity Life-Cycle (Adapted from UN ACC/SCN 2000).
The supplement consists of basic food items that provide 15% to 20% of daily caloric needs in addition to required vitamins and minerals for this age group (Gutierrez et al, 2005). The supplements are provided seven days a week through the community based MANA and consist of flavored and unflavored powdered milk (Colante: Cooperativa Lechera de Antioquia, Carrera 64C Nº 72-198 Medellín, Colombia) fortified cookies (Nestle, Carrera 42 Nº 79-19 Itagui, Colombia) and a vegetable based flour - Bienestariena (ICBF: El Instituto Colombiano de Bienestar Familiar, Av. Cra. 68 No. 64C – 75 Bogota, Colombia) (Gutierrez et al, 2005). Each child is entitled to one 25 gram package of powdered milk and 30 gram cracker per day. Flavored powdered milk is distributed to the participating families five times a week, and the plain powdered milk is given for two days (Table 1.1).

<table>
<thead>
<tr>
<th>Product</th>
<th>Grams</th>
<th>Energy (Kcal)</th>
<th>Protein (gm)</th>
<th>Fat (gm)</th>
<th>CHO (gm)</th>
<th>Ca (gm)</th>
<th>Fe (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavored Powdered Milk</td>
<td>13.0</td>
<td>64</td>
<td>3.21</td>
<td>3.49</td>
<td>4.87</td>
<td>120.00</td>
<td>0.10</td>
</tr>
<tr>
<td>Powdered Milk</td>
<td>13.0</td>
<td>68.6</td>
<td>3.37</td>
<td>3.75</td>
<td>5.12</td>
<td>126.0</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Table 1.1 Nutritional composition of flavored and unflavored powdered milk.

Bienestarina is a vegetable based flour made up of fortified wheat, fat free soybean flour, powdered milk, and enriched with vitamins and minerals developed by the Colombian Family Welfare Institute (ICBF, 2004). It also provides a balance of proteins that provide all the essential amino acids. This food supplement can be used for infants
over six months of age once the mother has finished breastfeeding the child. As opposed to the powdered milk and crackers, the flour is also recommended and available for malnourished individuals, the elderly, and pregnant or lactating women (ICBF, 2004). Fortified crackers and Bienestarina are also distributed to children participating in MANA (Table 1.2)

<table>
<thead>
<tr>
<th>Product</th>
<th>Energy (Kcal)</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>Fiber (g)</th>
<th>Calcium (mg)</th>
<th>Iron (mg)</th>
<th>Vitamin A (U.I)</th>
<th>Vitamin C (mg)</th>
</tr>
</thead>
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<tr>
<td>Cracker</td>
<td>135</td>
<td>2</td>
<td>4</td>
<td>0.6</td>
<td>n/a</td>
<td>n/a</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bienestarina (per 100 gm)</td>
<td>116.7</td>
<td>8.3</td>
<td>0.2</td>
<td>0.5</td>
<td>300</td>
<td>4.7</td>
<td>666.7</td>
<td>9</td>
</tr>
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Table 1.2 Nutritional composition of MANA cracker and Bienestarina.

In 2006, the first extensive evaluation of the MANA food supplement component was spearheaded by Colombian researchers to determine the current nutritional status and food insecurity of program participants (Gobernacion, 2006). In order to accurately monitor and evaluate the impact of MANA in food insecurity, valid measures are necessary.

HOUSEHOLD FOOD SECURITY SURVEYS

Four measures are commonly used to assess food insecurity: 1) national levels of dietary energy supply; 2) individual food intake reports; 3) anthropometry; and 4) qualitative methods (Smith, 2002). One of the limitations of the first three approaches
includes their reliance on indicators distinct from the conceptualization of household food insecurity and the high cost in resources and time needed. Qualitative measures fill these gaps and accurately capture and quantify the experiences of food insecurity at the household level, while still being inexpensive, easy to use and applicable to diverse populations (Coates et al, 2006). In the US, a Presidential Task Force Report instigated in 1984 the development of reliable direct measures to be used in documenting hunger (Anderson, 1990). Congress enacted the National Nutrition Monitoring and Related Research Act in 1990 to improve the monitoring of US nutritional status and placed the responsibility of developing a standard and consistent food security measure on the government. As a result of this government initiative, qualitative methods to measure food insecurity experiences in questionnaire format were developed and have been validated according to specific parameters for nearly 20 years (Keenan et al, 2003). Descriptions of the most frequently used food security surveys follow below.

**CCHIP Food Security Measure**

One of the first survey modules was developed as part of the Community Childhood Hunger Identification Project (CCHIP) and was based on the Massachusetts Nutrition Survey (1983). Researchers constructed the module specifically for low-income households with children and defined hunger as food insufficiency due to lack of resources (Wehler et al, 1992). This survey consists of eight items and emphasizes coping approaches to food insecurity and the sequential events that take place over the course of mild food insecurity to severe hunger in the twelve months previous to the application of the survey.
Colombian Household Food Security Scale

In Latin America, Lorenzana translated the CCHIP instrument into Spanish, added four items and validated the modified tool in poor peri-urban households of Venezuela (Lorenzana and Mercado, 2002). In 2003-2004, researchers in Antioquia, Colombia, conducted a validation study using the adapted Lorenzana tool (Colombia Household Food Security Survey-CHFSS; Alvarez et al, 2006). This 12-item survey consists of a range of questions about adult, child and household food insecurity conditions experienced during the month previous to the interview. The results of Alvarez’s work led to the inclusion of the tool in the 2005 Colombian National Nutrition Survey and later into the 2006 Evaluation of Plan for Improving Food and Nutrition in Antioquia, Colombia (MANA - Plan Departamental de Seguridad Alimentaria y Nutricional de Antioquia; Gobernación, 2006). Results from the second application are the basis of the work presented in this dissertation.

Radimer/ Cornell Scale

During approximately the same time period that the CCHIP was developed, Radimer and colleagues at Cornell University formulated indicators to assess hunger using open ended questions specific to low-income women that focused on their perceptions about hunger and food insecurity for themselves and their children (Radimer et al, 1990). The conceptual definitions of hunger from these interviews were then validated using quantitative criteria and a survey of 30 questions was developed using the statements of the women. After additional testing using factor and psychometric analysis
techniques, the number of questions was reduced to 12, with an equal number of questions on perceptions of food insecurity and on associated behaviors. The survey questions were created to measure the different components of household, women’s and children’s hunger and capture the level of food insecurity via self-reporting.

**Core Food Security Module**

In 1992, the 18-item Core Food Security Module was developed from the Radimer/Cornell scale and the CCHIP (Hamilton et al, 1997b; Radimer et al, 1990; Radimer et al, 1992). This survey emphasized coping approaches to food insecurity and the sequential events that take place during the previous twelve months in a progression from mild food insecurity to severe hunger.

**US Household Food Security Survey Module**

The tool currently used to measure household food insecurity in the US is known as the US Household Food Security Survey Module (US HFSSM), which includes the 18 questions from the Core Food Security Module. This tool has also been called the US Food Security Supplement and the US Household Food Security Scale (Keenan et al, 2003; Cook et al, 2004). Ten questions are specific to food insecurity experiences of the adults in the household and eight are related to the children. The US HFSSM includes a range of food-related coping strategies from worrying about running out of food to reductions in the quality and quantity of food consumed within the last 12 months.

**Short Household Food Security Survey Module**

The Economic Research Service at the USDA developed a short form that is easier to administer and less expensive to aid program planners monitor and evaluate the
effectiveness of their interventions (Keenan et al, 2003). This shortened questionnaire took parts of the first 10 questions of the US HFSSM to make the 6 question short form to be used when there is neither time nor personnel to do the entire survey. Results of the shortened form are comparable to those obtained when the US HFSSM is applied and is specific to the previous 12 months. One of the limitations of the short form is the lack of questions regarding severe child food insecurity.

**Brazilian Household Food Security Scale**

In Campinas, Brazil, the US HFSSM was translated into Portuguese and adapted for cultural acceptability using in-depth focus groups followed by other validation studies and applications with diverse population groups (Perez-Escamilla et al, 2004; Favaro et al, 2007; Marin-Leon et al, 2005; Melgar-Quinonez et al 2007). The proposed Brazilian Household Food Security Scale (*Escala Brasiliera de Segurança Alimentar* - EBIA) contains 16 questions specific to the previous three months. The EBIA was subsequently included in the 2004 National Household Sample Survey (*Pesquisa Nacional por Amostra de Domicílios* – PNAD) conducted by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro, 2004).

**Latin America and Caribbean Food Security Scale**

In 2007 the first Latin American and Caribbean Food Security Scale (*Escala Latinoamericana y Caribeña de Seguridad Alimentaria* - ELCSA) was proposed at the 1st International Conference to Measure Food Security in Latin America and the Caribbean in Antioquia, Colombia (Perez-Escamilla et al, 2007). The ELCSA was derived from the accumulation of the Brazilian (Hackett et al, 2007), Colombian (Alvarez et al, 2006) and
US household food security scales and experiences in other countries (Hamilton et al, 1997b, Swindale and Bilinsky, 2007; Nord et al, 2002). The ELCSA consists of 15 items referring to the previous three months and was compiled from the previously mentioned food security scales after undergoing a two phase analysis. First the conceptual integrity of the items was compared and then complete Rasch module analysis was done to elucidate and compare item measure values (Melgar-Quinonez, 2007). Researchers in Latin American and the US currently recommend the ELCSA as a base household food security survey that government and nongovernment agencies can adapt and apply to their specific needs in their respective countries.

VALIDATION OF HOUSEHOLD FOOD SECURITY SURVEYS

Questionnaire-based measures of hunger and food insecurity must be validated according to specific parameters to ensure that the tools capture the single underlying construct of household food insecurity (Keenan et al, 2003). The results from these surveys must correspond with empirical data and maintain consistency in patterns of affirmative responses. Criterion validity is measured through comparisons between household food insecurity results and another criterion such as social, economic and demographic factors known to be related to household food insecurity (Frongillo, 1999).

**Internal Validity**

The one-parameter logistic item response model, commonly called the Rasch Model, provides a mathematical framework against which the data can be compared in order to assess the internal validity of questionnaires (Opsomer et al, 2003; Bond and
The Rasch model is a specialized Item-Response-Theory model that takes dichotomous questions (right/wrong) with a range of difficulties and combines them to assess item and person performance (Melgar-Quinonez, 2007). This model has been used extensively to assess exams that test academic abilities (Bond and Fox, 2001). As opposed to other models, Rasch fits the data to the model as opposed to fitting the model to the data. The Rasch Model assumes that the items within the questionnaire are one-dimensional and independent of one another. The first assumption is assessed by FIT statistics, which measure the difference in the expected and the actual responses. These statistics compare the discrimination of each item with the average discrimination of all items. OUTFIT and INFIT values are estimated by squaring the difference between actual and modeled responses, summing the squared differences of all items, averaging the sum and then standardizing the results to approximate a unit normal (z) distribution.

For our study, weighted item INFIT values were assessed which are sensitive to unexpected responses to items near the person’s ability level. In addition, INFIT values are most commonly used in food insecurity scale assessment. OUTFIT values were not assessed because these values are heavily influenced by extreme responses. When the responses fit the model perfectly, the resulting item INFIT value is 1.0, with a recommended range of 0.8 to 1.2 and a wider acceptable range of 0.7-1.3 (Connell et al, 2004). Item INFIT values above 1.0 demonstrate that the respondents performed too well on the item in comparison to their total scores. When item INFIT values are below one, fewer individuals responded affirmatively to the item than would be expected based on
the order in the questionnaire and suggest item redundancy (Connell et al, 2004). In
general, item misfit may result from items that are too complex, confusing or measuring a
different construct (Green, 2002).

Assessment of survey item independence is done using a second statistical
outcome of Rasch modeling called measure value, also known as item severity or
calibration. Measure value outcomes are possible because Rasch Model assumes that the
higher the severity of the item, the less likely it will be answered affirmatively; and the
more food insecure the household, the more likely the respondent will answer
affirmatively to each question (Derrickson et al, 2000). Rasch-model software Winsteps
3.52 (Winsteps, Chicago, IL) uses Exclusory Maximum Likelihood Estimation (XMLE)
methods to estimate the person and item measure values that are most consistent with the
observed responses based on Rasch assumptions (Melgar-Quinonez, 2007). The resulting
measure values constitute an interval-level logit scale that includes the range of item
difficulty estimates captured by the questionnaire.

When the conditions of the Rasch Model have been met, unidimensionality of a
scale can be assessed using Differential Item Functioning (DIF; Lawton et al, 2006). DIF
allows comparisons of each item measure value between specific groups. A DIF contrast
greater than 0.5 logit units is considered substantial and demonstrates that response
probabilities are not fully explained by the latent trait (Wang et al, 2006). This means that
other variables are influencing the response and make comparisons between groups
problematic. DIF effects are computed in Winsteps 3.52 (Winsteps, Chicago, IL) by
subtracting the measure values for two groups and then converting the differences to standard normal variates using a pooled standard error (Cauffman and MacIntosh, 2006).

The results of Rasch Modeling alert survey designers to potential problems with the items, their order within the questionnaire, and score interpretations from the data (Bond and Fox, 2001). Researchers in the US have recommended using the Rasch Model to develop household food security surveys and evaluate the psychometric characteristics of their items (Hamilton, 1997b). Numerous validation studies of adapted household food security questionnaires have been done using Rasch Modeling techniques (Alvarez et al, 2006; Connell et al, 2004; Derrickson et al, 2000; Gulliford et al, 2005; Melgar-Quinonez et al, 2007; Opsomer et al, 2003; Wilde, 2004).

In Mississippi an adapted US HFSSM with eight items was applied and validated with 11-15 year old children (n=345; Connell, 2004). Rasch Modeling resulted with INFIT values within the strictest range of 0.8-1.2 for all but one item, did your meals only include a few kinds of cheap foods because your family was running out of money to buy food. Measurement values followed the appropriate generally increasing trend with two exceptions. Did your meals only include a few kinds of cheap foods because your family was running out of money to buy food and were you hungry but didn’t eat because your family didn’t have enough food had lower measurement values than expected. Additional testing is needed with the question did your meals only include a few kinds of cheap foods because your family was running out of money to buy food based on its poor performance with both outcome measures. Overall the adapted US HFSSM had good fitness for this population of middle-school children.
A sample of Asians and Pacific Islanders was used to determine the validity and reliability of the Core Food Security Measure in Hawaii (Derrickson et al, 2000). All 15 INFIT values were between 0.8 and 1.0, indicating that the items fit the model well. Four items did not follow the general trend of increasing measurement values. There were three gaps in item measure values between the first and second item, the forth and ensuing, and the last item with all other questions.

The initial validation study in Antioquia, Colombia, using the complete CHFSS revealed all item INFIT values between 0.8 and 1.2 (Alvarez et al, 2006). For most items the measurement values followed the expected increasing value in agreement with the increase in item difficulty. The item did an adult go to bed hungry because there was not enough money for the food was outside the pattern of measurement values indicating that it was more difficult to respond affirmatively to that item than expected. There was a single measure value gap between the first item and all remaining items. Overall, researchers confirmed the adjusted CHFSS as a valid measure of household food insecurity in Antioquia, Colombia.

Researchers used a short household food security form in Trinidad & Tobago with 286 households in which Rasch measure values showed a generally increasing value as the severity of the question increased, similar to the performance of the Colombian items (Gulliford, 2004). Good spread of measure values was found at the low end of the short survey, but there were two gaps in measure values where households were not well distinguished between the items. In a later study with adolescents in Trinidad and Tobago, there was one gap across the three ethnic groups of Afro-Caribbean, Indo-
Caribbean and Mixed. All six items in the household food security survey had INFIT values between 0.798 and 1.132, with only one item outside of the strictest range - *did you (or other people in your household) ever cut the size of your (their) meals or skip meals because there wasn’t enough money for food* (Gulliford et al, 2005).

The 15-item Brazilian Household Food Security Scale (EBIA) applied to a regionally representative population in Campinas, Brazil, and analyzed with Rasch, resulting in adult and child items INFIT values between 0.8 and 1.2 for all items except for the adult item *did you ever feel hungry but didn’t eat because there wasn’t enough money to buy food* (Melgar-Quinonez et al, 2007). The locally applied Brazilian and US tools revealed that all items had similar measure values with similar trends of increasing severity for both tools with fewer gaps in the Brazilian analysis than in the Colombia, Hawaii and the US (Melgar-Quinonez, 2007). Using a nationally representative sample in Brazil, three adult (*were you worried that you would run out of food before being able to buy or receive more food, did you ever eat less than what you thought you should because there wasn’t enough money to buy food, and did you lose weight because you didn’t have enough money to buy food*) and two child items (*did any of the children/adolescents not eat enough because there wasn’t enough money to buy food and did you ever reduce the size of meals of your children/adolescents because there wasn’t enough money to buy food*) were outside of the acceptable INFIT range (Hackett et al, 2007). Comparisons between female and male respondents measure values showed that adult items differed only by 0.01 to 0.14 logit units with a mean standard deviation higher than 2.2 for both genders, and that child items differed by 0.01 and 0.13 logit units with a
mean standard deviation of 2.7 (Hackett, 2007). This research demonstrated that the psychometric properties of the EBIA are not affected by respondent gender in Brazil.

**High Risk Groups**

An additional strength of the Rasch Model is that assumptions can be tested with specific high risk groups to determine if the items within the questionnaire are one-dimensional, and are independent of one another regardless of group membership. This component of internal validation enables researchers to assess whether or not a questionnaire can be applied ubiquitously in diverse populations.

It is well known that some high risk populations experience more frequent and severe situations of food insecurity than other groups when quantified by household food security surveys (Nord et al, 2003). For example, most households that suffer from food insecurity live in rural areas (FAO, 2006). In Indonesia, households in rural areas were more likely to be food insecure than their urban counterparts, with rural households responding affirmatively more frequently to all but one item specific to the household’s food insecurity experiences (Usfar et al, 2007). These variations are likely associated with lower income and educational status in rural areas.

Another high risk group for food insecurity consists of low income households (Rose, 1999). Research done in Trinidad and Tobago demonstrated rates of item affirmative responses to a short household food security were higher in households in the lowest income category (Gulliford et al, 2004). In Venezuela, very poor peri-urban households responded affirmatively to more items in a household food security survey, resulting in three times as many household classifications of food insecurity than poor
households (Lorenzana and Sanjur, 1999). Household income was lower in Korean households with children reporting both adult and child food insecurity (Oh and Hong, 2003). Likewise, in rural Tanzanian households, fewer wealth indicators were associated with food insecurity (Hadley, 2007). Similar relationships between food security and socioeconomic status were evident in children in the United States (Rose, 2006).

Another group with a high potential for low food security is large households, especially those with young children (Rose, 1999). Food insecure children, as reported in the Children’s Sentinel Nutrition Assessment Program in the United States, were more likely to live in households with over five members (Skalicky, 2006). Research in Trinidad and Tobago with adolescents demonstrated that overcrowded households had higher rates of food insecurity than those with fewer members (Gulliford, 2005). Results from an indigenous group in Brazil, revealed more reports of food insecurity in larger households and households with more children (Favaro, 2007). A household food security survey applied in Iran showed that individual food insecurity and child hunger were inversely associated with household size (Zerafati, 2007).

These studies demonstrated that rural, low income and large households report higher prevalence of food insecurity. Nevertheless, it is critical to evaluate consistency in a questionnaire’s psychometric characteristics between high risk population groups and their less vulnerable counterparts (Frongillo, 1999; Opsomer, 2003; Derrickson, 2000; Hackett, 2007).
Criterion Validity

Criterion validity is determined by comparing the results from household food security surveys to other indicators known to be associated with food security such as income, current food intake, anthropometrics, health status, biochemical markers of the nutritional status, and household food supply. During the last five years, studies exploring the criterion validity of adapted household food security surveys have been conducted in the following Latin American countries: Venezuela (Lorenzana and Mercado, 2002; Lorenzana and Sanjur, 1999), Colombia (Alvarez et al, 2006; Alvarado et al, 2005), Ecuador (Hackett et al, 2007), Mexico (Melgar-Quinonez et al, 2003; Perez-Escamilla et al, 2005), Brazil (Perez-Escamilla et al, 2004; Favaro et al, 2007), Bolivia (Melgar-Quinonez et al, 2006), and Trinidad and Tobago (Gulliford et al, 2005; Gulliford et al, 2006). Although different criterion variables were used in these studies, the results uniformly confirmed the appropriateness of household food security tools to determine food insecurity levels of the household.

Poor households in peri-urban Caracas, Venezuela, were used as a sampling population to validate the adapted CCHIP survey (n=238) (Lorenzana and Sanjur, 1999). Monthly income per person and poverty level were positively associated with household food security. The less the individuals in the household earned, the more severe the mother perceived their household food insecurity. In addition, households with a greater number of children experienced higher levels of food insecurity. In a later publication, food insecurity was also correlated with food diversity: as food insecurity increased, the diversity of food decreased (Lorenzana and Mercado, 2002).
Based on Lorenzana’s work (2002), two research groups in Colombia adapted and applied the Venezuelan tool. Household food insecurity as determined by the CHFSS was compared to household food supply in Antioquia, Colombia, using a regionally representative sample (n=1,624; Alvarez, 2006). Food insecurity score and food diversity of household food supply (total foods) showed an inverse correlation: as food insecurity increased, diversity of food decreased. In a separate study with Afro-Colombians (n=193) along the Pacific coast, household food insecurity was associated with lower height-for-weight children (Alvarado et al, 2005). In addition, food security was associated with higher income, maternal education and income and decreased social dependency. Both Colombian research groups asserted that an adapted CHFSS is appropriate for measuring food insecurity levels (Alvarez et al, 2006; Alvarado et al, 2005).

Using a relatively small sample of rural households (n=52) in Ecuador, researchers established criterion validity through the comparison of results from an adapted 15-item household food security survey with food inventory at the time of the interview (Hackett et al, 2007). Statistically significant differences in the number of food supplies between food insecure households with and without hunger were found using an adapted household food security survey for the following food groups: meats, vegetables, legumes, oils, processed products, beverages, snacks, and condiments. In addition to household food insecurity, adult and child food insecurity were analyzed separately and correlated to food supplies (Hackett et al, 2007). Increased adult household food
insecurity correlated with lower number of vegetables, beverages, snacks, oils, and processed products. Children food insecurity correlated with decreased number of vegetables, legumes, fruits, and oil in the house.

Food consumption as opposed to household food inventory was used as a criterion variable in Mexico City, Mexico (Perez-Escamilla et al, 2005). In this region, household food insecurity was inversely correlated with household food consumption. Specifically, there was a decrease in fruit, fruit juices, vegetable, meats and dairy products consumption as food insecurity increased. Food staples such as beans, eggs and tortillas were not associated with food insecurity in Mexico City. Researchers in Sierra de Manatlán, Jalisco, Mexico, compared the variety of diet as collected from three day food records and food supply with levels of food insecurity (n=133). As food insecurity increased the variety of diet decreased (Melgar-Quinonez et al, 2003).

In Campinas, Brazil criterion validity of the tool was established using food intake and income strata (n=125; Perez-Escamilla et al, 2004). Researchers in Campinas found a dose-dependent relationship between food insecurity and income and food insecurity and food intake. Households at lower income strata were less likely to be food secure. As food intake decreased, the food security of the household also decreased. The Brazilian tool was then applied to indigenous families in Teréna, Mato Grosso do Sul, Brazil (Favaro et al, 2007). In this region, higher levels of food insecurity were associated with lower per capita income, lower maternal education and larger households. Child food intake was also associated with reported levels of household food insecurity.
In a study conducted in 2003 by the micro-credit non-profit agency Freedom from Hunger in Bolivia, investigators used food expenditure as the criterion variable to assess the validity of a 9-item adapted version of the US HFSSM (Melgar-Quinonez et al, 2006). Food expenditure per capita was significantly correlated to household food insecurity levels. This was particularly evident in total expenditures for food, animal source foods and fruits. These results demonstrated that the adapted household food security survey was appropriate for use in rural and urban settings in Bolivia (n=327; Melgar-Quinonez et al, 2006).

The previously mentioned household food security survey applied to adolescent respondents in Trinidad and Tobago demonstrated that higher levels of household food insecurity were associated with overcrowding and lack of pipe-born water within the household (Gulliford et al, 2005). Low paternal education and high unemployment were also associated with food insecurity. After adjusting for socioeconomic factors, fruit and fish consumption was lower in severe food insecure households as opposed to their less insecure or secure counterparts. Criterion validity of the longer 10-item household food security was established through comparison with income in Trinidad and Tobago. Food insecurity was associated with monthly household income: as income increased, food insecurity decreased (Gulliford et al, 2006). Results of these studies demonstrate the criterion validity of the household food security surveys applied in diverse countries.
SPECIFIC AIMS

The broad purpose of this research is to validate a household food security survey used in Antioquia, Colombia with participants in the MANA food supplement program. Specifically, it sets forth a methodology that can be used to analyze the performance of household food security measures when incorporated into regional food insecurity studies. The specific aims that drive this research are as follows.

1. Determine internal validity of the CHFSS in specific high risk groups using Rasch Modeling analysis.

2. Establish criterion validity of the CHFSS through the correlation of food insecurity to demographics, socio-economic status, anthropometrics and child health status.

The results of this work will increase international awareness of valid household food security tool applications in food assistance programs. In addition, this dissertation research contributes to the further development of a valid and appropriate food security measure that can be used throughout Latin America.
CHAPTER 2
INTERNAL VALIDITY OF A HOUSEHOLD FOOD SECURITY SCALE IN PARTICIPANTS OF A FOOD SUPPLEMENTS PROGRAM IN ANTIOQUIA, COLOMBIA

ABSTRACT

Objective. We assessed the validity of a locally adapted Colombian Household Food Security Scale (CHFSS) used as a part of the 2006 evaluation of the food supplement component of the Plan for Improving Food and Nutrition in Antioquia, Colombia (MANA - Plan Departamental de Seguridad Alimentaria y Nutricional de Antioquia).

Methods. Subjects included low-income families with pre-school age children in MANA that responded affirmatively to at least one CHFSS item (n=1,319). Rasch Modeling was used to evaluate the psychometric characteristics of the items through measure and INFIT values. Differences in CHFSS performance were assessed by area of residency, socioeconomic status and number of children enrolled in MANA. Unidimensionality of a scale by group was further assessed using Differential Item Functioning (DIF).

Results. Most CHFSS items presented good fitness with most INFIT values within the adequate range of 0.8 to 1.2. Consistency in item measure values between groups was
found for all but two items in the comparison by area of residency. Only two adult items exhibited DIF between urban and rural households.

Conclusions. The results indicate that the adapted CHFSS is a valid tool to assess the household food security of participants in food assistance programs like MANA.

INTRODUCTION

Food security has been defined as access by all people at all times to enough food, acquired by socially acceptable means, for an active and healthy lifestyle (Anderson, 1990). Moderate, low and very food security consists of situations that range from mild concern over obtaining sufficient amounts of food to coping mechanisms in which the quality and quantity of food consumed is dramatically decreased. Due to various social, economic and physical disparities, over 850 million people worldwide are hungry (FAO, 2006). At the 1996 World Food Summit in Rome, Italy, world leaders set a goal to reduce the number of hungry people in half by the year 2015 (FAO, 1996). To meet this goal, governmental and non-profit agencies in many regions of the world have joined forces to develop programs to reduce food insecurity in high risk populations. One example is Plan for Improving Food and Nutrition in Antioquia, Colombia (MANA - Plan Departamental de Seguridad Alimentaria y Nutricional de Antioquia), a nutrition intervention begun by the regional government of Antioquia, Colombia in 2002 for low-income households with pre-school aged children (Gobernacion de Antioquia, 2004). In 2006, the first
extensive evaluation of the food supplement component of this program was spearheaded by Colombian researchers to determine the current nutritional status and food security of MANA participants (Gobernacion, 2006).

The measurement of food security is crucial for governmental and development agencies to monitor and evaluate the impact of their programs at the household level (Frongillo, 1999). Historically, four measures have been used to measure food security, including national levels of dietary energy supply, individual food intake reports, anthropometry and questionnaires measuring experiences of food insecurity (Smith, 2002). There are weaknesses in the first three approaches that rely on indicators distinct from the conceptualization of household food insecurity and are costly and time-consuming. Questionnaires included in the last approach fill these gaps and could accurately capture and quantify the experiences of food security at the household level, while relatively less inexpensive, easy to use and applicable to diverse populations (Coates et al, 2006).

For nearly 20 years researchers have created and validated methods to measure food security experiences in questionnaire format (Keenan et al, 2003). One of the first modules developed for the Community Childhood Hunger Identification Project was based on the Massachusetts Nutrition Survey (1983), in which researchers defined hunger as food insufficiency due to lack of resources (Wehler et al, 1992). Lorenzana translated this instrument into Spanish, modified the format and validated it with poor peri-urban households in Venezuela (Lorenzana and Mercado, 2002). In 2003-2004, researchers in Antioquia, Colombia, conducted a validation study using the adapted Lorenzana tool
(Colombia Household Food Security Survey-CHFSS; Alvarez et al., 2006). This 12-item survey consists of a range of questions about adult, child and household food security experiences (Table 2.1). The results of Alvarez’s work led to the inclusion of the CHFSS in the 2006 MANA evaluation (Gobernación, 2006). The novelty of our research expands the application of household food security surveys and demonstrates the tool’s suitability for assessing food assistance programs such as MANA.
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<tr>
<th>Item (keywords)</th>
<th>Yes</th>
<th>No</th>
<th>Frequency</th>
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<tbody>
<tr>
<td><strong>In the last month…</strong></td>
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<tr>
<td>Was there no money to buy food? (<em>no money</em>)†</td>
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<td>Did an adult eat less than they wanted because there was not enough money to buy food? (<em>ate less</em>)</td>
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<tr>
<td>In the household, was the number of normal meals decreased, for example not eating breakfast, lunch or dinner because there was no money to buy food? (<em>meals decreased</em>)</td>
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<tr>
<td>Did an adult not eat breakfast, lunch or dinner because there was no money to buy food? (<em>skipped meals</em>)</td>
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<tr>
<td>Did any adult eat less in the main meal because there was not enough food for everyone? (<em>ate less – main meal</em>)</td>
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<tr>
<td>Did an adult complain of hunger because of lack of food in the house? (<em>hungry</em>)</td>
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<tr>
<td>Did an adult go to bed hungry because there was not enough money for the food? (<em>went to bed hungry</em>)</td>
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<tr>
<td>Did you buy less necessary food items for the children because the money did not last? (<em>buy less staples</em>)</td>
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<tr>
<td>Did any child not eat breakfast, lunch, or dinner because there was not enough money for food? (<em>skipped meals</em>)</td>
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<tr>
<td>Did any child eat less in the main meal because there was not enough food for everyone? (<em>ate less – main meal</em>)</td>
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<tr>
<td>Did any child complain of hunger because of lack of food in the house? (<em>hungry</em>)</td>
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<tr>
<td>Did any child go to bed hungry because there was not enough money for the food? (<em>went to bed hungry</em>)</td>
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</table>

† Not included in analysis because it was used as a filter.

Table 2.1 Adapted Colombian Household Food Security Survey (CHFSS).
When quantifying households by food security status using tools similar to CHFSS, some high risk populations experience more frequent and severe situations of food insecurity than other groups (Nord et al, 2003). Previous research demonstrates that rural, low income and large households report higher prevalence of low food security (Usfar et al, 2007; Rose, 1999). Nevertheless; it is critical to evaluate consistency in the questionnaire’s psychometric characteristics between high risk population groups and their less vulnerable counterparts (Frongillo, 1999; Opsomer et al, 2003; Derrickson et al, 2000; Hackett et al, 2007). The research we present is significant because it explores the variations in questionnaire psychometrics dependent on area of residency, socioeconomic status and number of children participating in MANA. This validation study is a necessary step to develop a household food security survey that can be applied ubiquitously to diverse populations and is critical for food assistance programs similar to MANA that need a valid tool to assess the household food security status of their participants.

MATERIALS AND METHODS

The psychometric properties of the CHFSS were assessed using data collected from a cross-sectional stratified random sample taken from the total population of MANA participants in Antioquia, Colombia. Sample size was calculated by Colombian researchers using Epidat® software (version 3.0, Pan-American Health Organization, Dirección Xeral de Saúde Pública) to determine a representative sample of the 200,000 MANA participants. They allowed for a maximal regional error of 0.05% with a resulting
sample of 2,784 low-income households with pre-school children. The first item was eliminated from analysis because it was used as a filter. Consequently, households that responded negatively to the first item were removed from the analysis, leaving a maximum possible sample size of 1,319 (Bond and Fox, 2001). The ethics committee at The University of Antioquia approved data collection with informed consent collected once the purpose of the study, dispersion of data, participant rights and risks were explained prior to participation. The analysis of the resulting database was approved by the Institutional Review Board at the Ohio State University.

**Rasch model**

Researchers in the US have recommended the Rasch Model to develop household food security surveys and evaluate the psychometric characteristics of their items (Hamilton, 1997b). The Rasch Model belongs to a family of item-response-theory (IRT) statistical scaling models that fits questionnaire items measuring the same underlying construct along a logit continuum (Carlson, 1999). The resulting intervals between items and order alert survey designers to potential problems with the items, their order within the questionnaire and score interpretations from the data (Bond and Fox, 2001).

Numerous validation studies of adapted household food security questionnaires including the US Household Food Security Survey Model have been done using Rasch Modeling techniques (Alvarez et al, 2006; Connell et al, 2004; Derrickson et al, 2000; Gulliford et al, 2005; Hackett et al, 2007; Melgar-Quinonez et al, 2007; Opsomer et al, 2003; Wilde, 2004).
The Rasch Model assumes that the items within the questionnaire are one-dimensional, measure the same construct, and are independent of one another (Bond and Fox, 2001). The first two assumptions are assessed by FIT statistics, which measure the difference in the expected and the actual responses (Jackson et al, 2002). These values are estimated by squaring the difference between actual and modeled responses, summing the squared differences of all items, averaging the sum and then standardizing the results to approximate a unit normal \((z)\) distribution (Green, 2002). For our study, weighted item INFIT values were assessed which are sensitive to unexpected item responses near the person’s ability level. When the responses fit the model perfectly, the resulting item INFIT value is 1.0, with a recommended range of 0.8 to 1.2 and a wider acceptable range of 0.7-1.3 (Connell et al, 2004). Item INFIT values above one demonstrate that the respondents performed too well on the item in comparison to their total scores. When item INFIT values are below one, fewer individuals responded affirmatively to the item than would be expected based on the order in the questionnaire and suggest item redundancy (Connell et al, 2004). In general, item misfit may result from items that are too complex, confusing or measuring a different construct (Green, 2002).

Assessment of survey item independence is done using a second statistical outcome of Rasch modeling called *measure values* that demonstrate the relative severity of each of the questions in correspondence to the actual food insecurity status of the interviewees based on their positive responses. This outcome is possible because Rasch Model assumes that the higher the severity of the item, the less likely it will be answered affirmatively; and the more food insecure the household, the more likely the respondent
will answer affirmatively to each question (Derrickson et al., 2000). Measure values are quantified using the natural log of the odds of the respondent successfully answering the items within the food security questionnaire and are compared along a logit continuum (Jackson, 2002). Measure values allow researchers to evaluate the spread of items along the questionnaire continuum and identify areas of food insecurity that are poorly quantified by the items (Smith et al., 2006). Any large gaps along the measurement value continuum indicate that additional items are needed to distinguish within that particular range of severity. If two different items have the same measurement value, this likely means that the items are measuring the same level and indicates that one of the questions might be dropped in order to decrease the respondent load.

When the conditions of the Rasch Model have been met, unidimensionality of a scale can be assessed using Differential Item Functioning (DIF; Lawton et al., 2006). DIF allows comparisons across groups while holding the level of psychological disturbances constant. A DIF contrast greater than 0.5 logit units is considered substantial and demonstrates that response probabilities are not fully explained by the latent trait (Wang et al., 2006). This means that other variables are influencing the response and make comparisons between groups problematic. DIF effects are computed in Winsteps (Winsteps, Chicago, IL) by subtracting the measure values for two groups and then converting the differences to standard normal variates using a pooled standard error (Cauffman and MacIntosh, 2006).

To fit the data to the Rasch Model, responses to the items were coded as “yes”=1 and “no”=0. The follow-up frequency items were incorporated into the original questions.
as follows: if the individual responded “yes” to the first question and responded “almost
every day” or “on just a few days” to the frequency question, they remained classified as
1. On the other hand, if the respondent answered “yes” to the first answer and “on only
one or two days” to the frequency question, they were reclassified as 0 (Melgar-Quinonez
et al, 2006).

After initial fitting to the Rasch Model was done with all households, the
complete databases were separated into reference and secondary groups to compare
psychometric characteristics of specific sub-populations within this sample. Reference
groups followed by secondary groups were categorized as follows:

- One child participating in MANA (n=713); Multiple children participating
  in MANA (n=604)
- Very low income (n=789); Low income (n=481)
- Urban (n=560); Rural (n=759)

We were interested in differences in CHFSS performance between households
characterized by very low income and low income, localization in urban and rural areas
and one versus multiple children participating in MANA. In Colombia, socio-economic
status is determined and reported as SISBEN- Sistema de Selección de Beneficiarios
(Beneficiary Selection System) by the National Planning Department (Bautista, 2003).
SISBEN levels are assigned to households using the following criteria: quality of the
house and domestic appliances, demographics, income, occupation, education and social
security. Using these indicators as guides, six SISBEN levels ranging from one to six were created. SISBEN one indicates a household in the most indignant economic situation and six signifies the wealthiest. We were interested in differences in CHFSS performance between households in very poor (SISBEN 1) and poor (SISBEN 2) socioeconomic status, urban and rural areas and one versus multiple children participating in MANA. Households were eliminated from the socioeconomic status analysis that reported an income above the criteria level for MANA participation or missing data (n=35). There were two households not included in the one versus multiple children analysis that had missing child data. Differences in measure values between groups should not be larger than 0.05 logit units. Winsteps 3.52 (Winsteps, Chicago, IL) was used to conduct Rasch Model analysis.

RESULTS

Item INFIT values were within the appropriate range for all but two children specific items (Table 2.2). The child item went to bed hungry was the only item below 0.8, for the low income group, but was still within the acceptable range (INFIT=0.78). The child item buy less staples had a range of 1.17-1.36; all were outside of the 0.8-1.2 range except for the low income and rural subgroups. This item was also outside the wider acceptable range of 0.7-1.3 for very low income and urban households.
<table>
<thead>
<tr>
<th>Adult Items</th>
<th>All</th>
<th>One Child</th>
<th>Multiple Children</th>
<th>Very low income</th>
<th>Low income</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ate less</td>
<td>1.09</td>
<td>1.09</td>
<td>1.10</td>
<td>1.10</td>
<td>1.03</td>
<td>1.03</td>
<td>1.14</td>
</tr>
<tr>
<td>Decreased meals</td>
<td>0.93</td>
<td>0.91</td>
<td>0.95</td>
<td>0.87</td>
<td>1.03</td>
<td>0.91</td>
<td>0.95</td>
</tr>
<tr>
<td>Skipped meal</td>
<td>0.87</td>
<td>0.91</td>
<td>0.82</td>
<td>0.92</td>
<td>0.84</td>
<td>0.86</td>
<td>0.89</td>
</tr>
<tr>
<td>Ate less - main meal</td>
<td>0.94</td>
<td>0.95</td>
<td>0.93</td>
<td>0.91</td>
<td>1.00</td>
<td>0.95</td>
<td>0.94</td>
</tr>
<tr>
<td>Hungry</td>
<td>1.03</td>
<td>1.01</td>
<td>1.04</td>
<td>1.01</td>
<td>1.05</td>
<td>1.07</td>
<td>1.00</td>
</tr>
<tr>
<td>Went to bed hungry</td>
<td>0.94</td>
<td>0.91</td>
<td>0.98</td>
<td>0.99</td>
<td>0.84</td>
<td>0.91</td>
<td>0.97</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Children Items</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy less staples</td>
<td>1.26†</td>
<td>1.27†</td>
<td>1.25†</td>
<td>1.31††</td>
<td>1.17</td>
<td>1.36††</td>
<td>1.19</td>
</tr>
<tr>
<td>Skipped meals</td>
<td>0.88</td>
<td>0.88</td>
<td>0.90</td>
<td>0.89</td>
<td>0.87</td>
<td>0.90</td>
<td>0.86</td>
</tr>
<tr>
<td>Ate less - main meal</td>
<td>1.07</td>
<td>1.07</td>
<td>1.08</td>
<td>1.09</td>
<td>1.06</td>
<td>1.03</td>
<td>1.09</td>
</tr>
<tr>
<td>Hungry</td>
<td>0.9</td>
<td>0.90</td>
<td>0.92</td>
<td>0.83</td>
<td>0.98</td>
<td>0.84</td>
<td>0.93</td>
</tr>
<tr>
<td>Went to bed hungry</td>
<td>0.82</td>
<td>0.81</td>
<td>0.81</td>
<td>0.81</td>
<td>0.78†</td>
<td>0.80</td>
<td>0.84</td>
</tr>
</tbody>
</table>

† Outside of range (0.8 - 1.2).
†† Within acceptable range of 0.7 to 1.3.

Table 2.2 INFIT values for adult and child items by groups (n=1,319).
The order of measure values severity for the items was different than the order in the questionnaire for all groups for both adult and child items (Figures 2.1, 2.2, 2.3). Within the adult items, *ate less - main meal (4)* has a measure value lower than the previous item. The children items *ate less - main meal (9)* and *hungry (10)* both have lower values than *skipped meals (8)*. Items were well spread along the measure value continuum for all groups with no gaps.
Figure 2.1 Adapted Colombian Household Food Security Survey (CHFSS) item measure values by number of children enrolled in MANA (n=1,319).
Figure 2.2 Adapted Colombian Household Food Security Survey (CHFSS) item measure values by socioeconomic status (n=1,319).
Figure 2.3 Adapted Colombian Household Food Security Survey (CHFSS) item measure values by area of residency (n=1,319).
DIF analysis showed only two items with DIF between urban and rural households for the adult item *skipped meals* (DIF=-0.61; t=-3.64) and the child item *hungry* (DIF=0.56; t=2.89). The remaining adult and child items showed CHFSS unidimensionality in the other subgroups.

**DISCUSSION**

A limitation with this study is that we relied on secondary data not collected to validate the CHFSS. Consequently there was no control group with which to compare internal validity testing. It would be interesting to evaluate the psychometric characteristics of populations not participating in MANA to determine if the items fit the Rasch Model as well as the sample taken from participants. Another limitation to this study is that the first item was used as a filter, thus cutting the sample size in half. Fortunately, we still had enough individuals who responded affirmatively to the first item that the internal validity of the CHFSS could be assessed.

The item INFIT values demonstrate that the items measure the same construct and unidimensional with the exception of the child items *buy less staples* and *went to bed hungry*. The low item INFIT *went to bed hungry* suggests redundancy in the less poor socioeconomic group, but the value was still within the wider acceptable range. It would not be advisable to remove these items merely because the item INFIT values were below 0.8 or above 1.2, especially for *skipped meal* where “misfit” was only found in one group. A previous CHFSS validation study in Antioquia, Colombia using a representative sample of 1,624 households had all INFIT values within 0.8 and 1.2 (Alvarez et al, 2006).
When the US Core Food Security Measure was applied in Hawaii, all 15 INFIT values were within the 0.8 to 1.2 range (Derrickson et al., 2000). Adolescent respondents to a 6-item household food security survey in Trinidad and Tobago resulted in INFIT values between 0.798 and 1.132. The only item outside of the strictest range was *did you ever cut the size of your (their) meals or skip meals because there wasn’t enough food?* (Gulliford et al., 2005). In Campinas, Brazil, the USDA Household Food Security Survey Module was translated to Portuguese and adapted for cultural acceptability using in-depth focus groups (Pesquisa Nacional de Amostra de Domicílios – PNAD), where it was expanded to 16-items. The results of these studies confirmed the tool’s validity and led to its inclusion in the 2004 National Household Sample Survey (Pesquisa Nacional de Amostra de Domicílios – PNAD). The resulting 15-item Brazilian Household Food Security Scale (EBIA) was then applied to a regionally-representative population in Campinas, Brazil, and analyzed with Rasch. Adult and child items INFIT values were within 0.8 and 1.2 for all items except for the adult item *did you feel hungry but didn’t eat because there wasn’t enough money to buy food* (Melgar-Quinonez et al., 2007). The results of these studies confirmed the tool’s validity and led to its inclusion in the National Household Sample Survey (Pesquisa Nacional de Amostra de Domicílios – PNAD). The results of these studies confirmed the tool’s validity and led to its inclusion in the 2004 National Household Sample Survey (Pesquisa Nacional de Amostra de Domicílios – PNAD).
money to buy food and did you ever reduce the size of meals of your children/adolescents because there wasn’t enough money to buy food) were outside of the range (Hackett et al, 2007).

To our knowledge this is the first large scale DIF analysis to assess cross-sample unidimensionality of a household food security survey in a population receiving food assistance. Analysis of food security using the Rasch Model in the US by subgroups of race/ethnicity, household composition, metropolitan status and region of country revealed consistent patterns in item measure values (Ohls et al, 2001). Previous work in Bangladesh with a locally developed household food security survey had four items with DIF by groups of land ownership status in their scale (Coates et al, 2006). Because DIF was found in one subgroup in Colombia we recommend that the child item skipped meals be removed to improve measurement of the food insecurity construct of this item.

Adult and child item measure value results coincide with the conceptualization of food security as a managed process where minor modifications in dietary intake precede drastic decreases in consumption (Radimer et al, 1992). Our results show that adults will decrease the amount of food at a given meal prior to reducing or skipping meals. Likewise children will eat less food in the main meal before going hungry and skipping meals. It appears that child buffering occurs within this population where decreases of child food intake only occur after adults decrease their food consumption. This pattern is not consistent with results from the study in Antioquia, Colombia where each item
followed the pattern of increasing measure value from beginning to end of the
questionnaire (Alvarez et al, 2006). These differences are likely the result of changes in
item order between the applications of the survey.

The order of measure values did not correspond to question order within the food
security questionnaire administered in Hawaii (Derrickson et al, 2000). Specifically, five
items were out of questionnaire order based on measure values. Brazilian measure values
followed an appropriate increasing pattern for adult and child items when analyzed
separately, with the exception of one adult item, suggesting that the order of items they
used may correspond better with the conceptualization of each item representing a more
severe situation of food insecurity within the questionnaire (Melgar-Quinonez et al,
2007). The variation between the order of the survey items and the actual measure value
of each item suggests the need for a change in item order for the CHFSS to match the
underlying construct, so that the items follow the specific order of severity. Additional
research is needed to determine the implications of modifying item order within the
questionnaire when considering questionnaire item flow.

Rasch Modeling revealed no gaps in CHFSS item measure values. In previous
research in Colombia a gap between the first two items and remaining items was evident.
These results suggest that the CHFSS better differentiates between food security items
with our population than a representative sample from the same region of Colombia
(Alvarez et al, 2006). The Colombian adult and child measure values performed better
than all US items used with a Hawaiian population, which had three gaps and the US
national results of 4 gaps in survey measure values (Derrickson et al, 2000). Researchers
used a short household food security form in Trinidad & Tobago with 286 households in which Rasch measure values showed a generally increasing value as the severity of the question increased as the Colombian items did (Gulliford et al, 2004). Good spread of measure values was found at the low end of the short survey, but there were two gaps in measure values where households were not well distinguished between the items. Using a short household food security survey in Trinidad & Tobago with 1,903 students, Rasch measure values showed a generally increasing value as the severity of the questions increased, as the Colombian items did (Gulliford et al, 2005). There was one gap between items the food that I/we bought just didn’t last, and I/we didn’t have money to get more and did you (or other people in your household) ever cut the size of your (their) meals or skip meals because there wasn’t enough money for food between boys and girls across the three ethnic groups of Afro-Caribbean, Indo-Caribbean and Mixed. The Brazilian and US tools revealed that all items had similar measure values with similar trends of increasing severity for both tools with less gaps in the Brazilian analysis than in the Colombian (Melgar-Quinonez et al, 2007). The Brazilian EBIA child item measure values revealed two clusters of two items: were you unable to offer your children/adolescents a healthy and varied diet because you didn’t have enough money with did any of the children/adolescents not eat enough because there wasn’t enough money to buy food, and did your children/adolescents ever have to skip a meal because there wasn’t enough money to buy food with were your children/adolescents ever hungry but you just couldn’t buy more food (Hackett et al, 2007). Similarly, we had two clusters but with adult items towards the more severe end of the measure value spectrum.
Our results indicate that the adjusted version of the household food security scale is valid for application to diverse low-income households in Colombia, especially in describing the situation of households experiencing severe food insecurity. Additional work is needed to compare the psychometric properties of the tool when applied to program participants versus non-participants. As the CHFSS continues to be validated with new populations, improvements in the tool can be made to capture the actual experience of food insecurity at the household level of MANA program participants. Based on our results, this tool can be used in future program evaluations, thus the CHFSS can play a critical part in policy planning in Colombia. Although this is the first time the CHFSS was used to assess a food supplement program in Colombia, our findings suggest its’ suitability for other food assistance programs.
CHAPTER 3
VALIDITY OF A HOUSEHOLD FOOD SECURITY SCALE IN PARTICIPANTS OF
THE MANA FOOD SUPPLEMENT PROGRAM IN COLOMBIA

ABSTRACT

Objective: To assess the validity of a household food security scale and its associations with household demographics, food expenditure, and consumption of food supplements by children participating in the Colombian Plan for Improving Food and Nutrition in Antioquia - MANA (Mejoramiento Alimentario y Nutricional de Antioquia).

Design: A locally adapted 12-item household food security survey was applied to a cross-sectional stratified random sample of MANA participating households, which were characterized as food secure, mildly food insecure, moderately food insecure, and severely food insecure. Correlations with demographic characteristics, food expenditure variables, and food supplement consumption by children in MANA were used to assess the criterion validity of the proposed tool.

Setting: Department of Antioquia, Colombia.

Subjects: 2,784 low-income households with pre-school children receiving MANA food supplements.
Results: Statistically significant differences existed between household food security status and household size, parental age and income (p<0.0001). Food security status differed by area of residence and gender of head of household (p<0.01). Food insecurity status was significantly and inversely correlated with household food expenditures (p<0.0001). Consumption of MANA supplemental foods was positively associated with food insecurity; at higher levels of food insecurity, food supplement intake increased (p<0.001).

Conclusions: Our findings support the use of the proposed tool to accurately assess the food security status of households targeted by food supplemental programs in Colombia. Future studies should evaluate the relationships of food insecurity measured through the Colombian Household Food Security Scale with indicators of nutritional status.

INTRODUCTION

Food security is defined as the access by all people at all times to enough food, acquired by socially acceptable means, for an active and healthy lifestyle (Anderson, 1990). Conversely, food insecurity consists of situations that range from the concern over obtaining sufficient amounts of food to coping mechanisms in which the quality and quantity of food consumed are decreased. Worldwide, due to various social, economic and environmental disparities, over 850 million people face food insecurity on a regular basis (FAO, 2006).

At the 1996 World Food Summit in Rome, world leaders set a goal to reduce the number of hungry people by half by the year 2015 (FAO, 1996). To meet this goal,
governmental and non-profit agencies in many regions of the world have joined forces to develop programs aiming to reduce food insecurity in high risk populations. In Colombia, the governmental Plan for Improving Food and Nutrition in Antioquia - MANA (Mejoramiento Alimentario y Nutricional de Antioquia) began in 2002 as a nutrition intervention targeting low-income households (Gobernacion de Antioquia, 2004). A critical component of MANA relies in the distribution of food supplements to preschool children, that include enriched and fortified powdered milk, fortified crackers, and the enriched flour Bienestarina (Appendix A). In 2006, the first extensive evaluation of the MANA food supplement component was spearheaded by Colombian researchers to determine the current nutritional status and food insecurity of program participants (Gobernacion, 2006). In order to accurately monitor and evaluate the impact of MANA in food insecurity, valid measures are critical. This paper addresses the validity of a locally adapted household food security scale in the MANA targeted population.

**Household Food Security Measures**

The measurement of food insecurity allows governmental and development agencies to estimate the prevalence of this phenomenon, better target high risk populations and monitor and evaluate the impact of their programs at the household level (Frongillo, 1999). At least four measures have been broadly used to assess food insecurity in the developing world, and include national levels of dietary energy supply, individual food intake reports, anthropometry and qualitative methods (Smith, 2002). The first three approaches rely on indicators distinct from the conceptualization of household food insecurity described above, and are considered costly, and time-consuming.
Qualitative measures such as psychometric questionnaires fill these gaps and accurately capture and quantify the experiences of food insecurity at the household level, while remaining inexpensive, easy to use and applicable to diverse populations (Coates et al, 2006).

For nearly 20 years, researchers have created and validated qualitative methods to measure food insecurity experiences in questionnaire format (Keenan et al, 2003). One of the first modules developed for the Community Childhood Hunger Identification Project was based on the Massachusetts Nutrition Survey (1983), in which researchers defined hunger as food insufficiency due to lack of resources (Wehler et al, 1992). Later, Lorenzana translated this instrument into Spanish, modified the format and validated it with poor peri-urban households in Venezuela (Lorenzana and Mercado, 2002). In 2003-2004, researchers in Antioquia, Colombia, conducted a regional study using the adapted Lorenzana tool (Colombia Household Food Security Survey-CHFSS; Alvarez et al, 2006). This 12-item survey consists of a range of questions about adult, child and household food insecurity experiences (Hackett, 2007). As a consequence of Alvarez’s work, the CHFSS was included in the 2006 MANA evaluation protocol. As a result, data from the MANA assessment were used in this study to address the performance of the proposed household food security tool (Gobernación, 2006).

Criterion validity contributes to the validation of household food security measures in which the responses to the semi-qualitative household food security scale are compared to variables considered to be strongly associated with underlying construct of food insecurity, such as income, food intake, anthropometrics, and household food supply
(Hackett et al, 2007; Melgar-Quinonez et al, 2003). Recently, studies exploring the criterion validity of adapted household food security surveys have been conducted in several Latin American countries: Venezuela (Lorenzana and Mercado, 2002; Lorenzana and Sanjur, 1999), Colombia (Alvarez et al, 2006; Alvarado et al, 2005), Ecuador (Hackett et al, 2007), Mexico (Melgar-Quinonez et al, 2003; Perez-Escamilla et al, 2005), Brazil (Perez-Escamilla et al, 2004; Favaro et al, 2007), Bolivia (Melgar-Quinonez et al, 2006), and Trinidad and Tobago (Gulliford et al, 2005; Gulliford et al, 2006). Although different criterion variables were used in these studies, the results confirmed the appropriateness of household food security tools to determine food insecurity levels of households in diverse populations.

This study expands the scientific assessment of such tools by assessing for the first time its suitability in the evaluation of a food assistance program. Besides building on previous knowledge generated by our group and others, we provide new evidence about the validity and usefulness of locally adapted household food security scales when applied to low-income households with pre-school age children receiving government food assistance. Therefore, the results of this study are of importance to policy makers concerned with the impact of programs aiming to reduce levels of food insecurity in the developing world.

METHODS

Criterion validity of the CHFSS was assessed using data collected from a cross-sectional stratified random sample representative of the 200,000 MANA participants in
the department of Antioquia, Colombia. Sample size was calculated by Colombian researchers using Epidat® software (version 3.0, Pan-American Health Organization, Dirección Xeral de Saúde Pública).

A maximal regional error of 0.05% resulted in a sample of 2,784 low-income households with pre-school children. The ethics committee at The University of Antioquia approved data collection with informed consent collected once the purpose of the study, dispersion of data, participant rights and risks were explained prior to participation. The analysis of the resulting database was approved by the Institutional Review Board at The Ohio State University.

Trained interviewers administered semi-constructive face-to-face questionnaires to child caregivers at local hospitals. The questionnaires include the following items, the CHFSS, length of participation in MANA, consumption of MANA powdered milk packets (25 gm each), MANA crackers (30 gm each) and an enriched flour called Bienestarina. Demographic variables consisted of area of residence (urban/rural), housing characteristics, age of parents and participating child, household size, number of siblings of participating child, and previous month’s income. Data regarding financial savings due to consuming MANA supplemental foods and household expenditures on food were also collected. Based on these two variables and the size of the household, we calculated the proportion of per capita savings with regards to per capita food expenditures.

The household food security questionnaire consisted of twelve questions regarding the experiences of food insecurity as a result of financial constraint. Each item was followed by a frequency of occurrence question, which assessed how often a given
condition occurred. A negative response to the initial item was coded as “0”, and the follow up questions were coded as rarely = “1”, sometimes = “2” and always = “3”. The resulting food security score ranged from zero to thirty six; with zero representing the most food secure and thirty six the least. Based on the raw score, household food security status was categorized using the following cut-off points: 1) Households with a household food security score of zero were considered food secure; 2) Households with a score between 1-17 were labeled as mildly food insecure; 3) Households with scores between 18-26 were categorized as moderately food insecure; and 4) Households responding affirmatively to over 27 items were grouped into a severe food insecurity category (Lorenzana and Mercado, 2000).

Criterion validity of the CHFSS was determined using $\chi^2$ and ANOVA analyses to examine differences in demographic variables, socioeconomic characteristics and participation in MANA by food security status. Demographics, socioeconomics and food consumption were compared with the four-level Food Security Status using one-way ANOVA procedures. Differences among food security categories’ mean values were examined using post hoc tests with Bonferroni adjustments for multiple comparisons. The correlation between the categorical food security status variable and household food expenditure with was examined using a multiple ANOVA model that included several covariates as follows: area of residency, gender of head of household, mothers age, previous month’s income, indoor plumbing, participation in other assistance programs, household size, number of places to sleep, fathers education, number of children in MANA, packets of milk, packets of crackers, grams of Bienestarina, residency in high
risk area, and in-kind payment for work. Using the same covariates, a multiple linear regression model was developed to determine coefficients of household food expenditure by food security status. Descriptive, bivariate, ANOVA and regression analyses were conducted using STATA for Windows (version 8.2, StataCorp, College Station, TX).

RESULTS

Sample characteristics in Table 3.1 show that slightly over one half of the respondents were from the rural regions of Antioquia. Households headed by women were 18.9% and the mean household size was 5.7 individuals. Most households had electricity (86.2%), indoor plumbing (80.5%) and sewage (59.2%). Over half (54.5%) of the households were landowners and 41.6% cultivate and consume the food and animals they produce. Mean income the month prior to the interview was 259,785 Colombian pesos (129.89 USD) and 161,292 (80.65 USD) were used on food. One fifth of the population lived in high risk environmental disaster areas, and 8.11% of the children were refugees. Children consumed in average eight packets of powdered milk, eight crackers, and 170 grams of Bienestarina per week.
Table 3.1 Descriptive statistics of the households (n=2,784).
Food Security Status

Most households were categorized as food secure (48.2%, n=1,343) or mildly food insecure (37.9%, n=1,056). One-tenth (n=280) of the sample were categorized as moderately food insecure households and 3.8% (n=105) exhibited severe food insecurity.

Household Characteristics

Households in rural areas had higher rates of mild and moderate food insecurity than those in urban areas (Table 3.2). Female heads of household were more likely to be food insecure than their male counterparts. No significant differences were evident in food security between female and male children. Mothers’ and fathers’ difference in mean age was significantly lower in the food secure households than the remaining food insecurity categories (Table 3.2). There were not significant differences in child and head of household’s mean age by food security status. Over 50 percent of mothers and fathers partially or entirely completed elementary education (mothers 54.6%; fathers 58.7%). Approximately one third of the parents partially or entirely completed their high school education (mothers 37.9%; fathers 27.6%). Parents with the highest education levels were the most food secure. The majority of women were housewives (78.6%). Households where the mother was permanently employed were more food secure and households with unemployed mothers were more food insecure. Likewise, households with unemployed fathers experienced the highest rates of food insecurity and households with permanently employed fathers were the most food secure. Mean household size and number of siblings was significantly greater in households with greater food insecurity, while significantly fewer places to sleep were reported in food insecure households.
### Table 3.2 Correlation of food security status with social, economic and demographic characteristics.

<table>
<thead>
<tr>
<th></th>
<th>Food Secure</th>
<th>Mild Food Insecurity</th>
<th>Moderate Food Insecurity</th>
<th>Severe Food Insecurity</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of child (months)</td>
<td>40.2 (17.4)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>41.6 (17.3)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.6 (16.8)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>43.5 (16.9)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.0389</td>
</tr>
<tr>
<td>Age of head of household (years)</td>
<td>42.6 (14.8)</td>
<td>43.1 (14.0)</td>
<td>44.0 (12.1)</td>
<td>45.7 (16.5)</td>
<td>0.5244</td>
</tr>
<tr>
<td>Age of father (years)</td>
<td>33.8 (9.4)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>35.2 (9.4)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>36.8 (9.9)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>36.9 (8.9)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Age of mother (years)</td>
<td>28.0 (7.2)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>29.6 (7.3)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.7 (7.3)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>31.3 (8.3)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Household size</td>
<td>5.4 (2.1)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.8 (2.5)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.2 (2.3)&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>6.8 (3.2)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Number of siblings</td>
<td>1.8 (1.9)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.4 (2.2)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.1 (2.3)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.5 (2.7)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Number of places to sleep</td>
<td>2.3 (1.0)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.1 (1.0)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.9 (0.9)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.9 (1.0)&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Different superscripts denote statistically significant differences between food security status categories p < 0.05.
**Socioeconomics**

The previous month’s income and amount of money spent on food was significantly lower in severely food insecure households (Table 3.3). Conversely, the proportion of income spent on food was lowest in the food secure group, although in average these households spent more money on food than the food insecure households. Additionally, the proportion of per capita savings on food expenditures by consuming the MANA supplements was significantly higher among food insecure households.
<table>
<thead>
<tr>
<th></th>
<th>Food Secure</th>
<th>Mild Food Insecurity</th>
<th>Moderate Food Insecurity</th>
<th>Severe Food Insecurity</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
</tr>
<tr>
<td>Previous month’s income †</td>
<td>311306 (197398)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>221218 (171095)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>198715 (133083)&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>153656 (125209)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Household food expenditure in previous month&lt;sup&gt;†, ‡&lt;/sup&gt;</td>
<td>188288 (102010)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>141903 (91832)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>128759 (94321)&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>95427 (70707)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Percentage of per capita food expenditure saved from MANA supplements</td>
<td>6.3 (7.3)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.2 (15.7)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.1 (8.6)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>17.7 (14.6)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Age of child when s/he began MANA (Days)</td>
<td>364 (256)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>391 (262)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>409 (282)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>374 (300)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.0409</td>
</tr>
<tr>
<td>Length of time in MANA (Days)</td>
<td>529 (360)</td>
<td>519 (339)</td>
<td>485 (345)</td>
<td>562 (370)</td>
<td>0.1631</td>
</tr>
<tr>
<td>Number of siblings in MANA</td>
<td>1.43 (0.64)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.54 (0.74)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.64 (0.67)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.86 (1.06)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Amount of supplements the child consumes per week</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MANA milk packets (25 gm/each)</td>
<td>7.96 (3.65)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.22 (4.01)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.45 (4.28)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>9.60 (4.74)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MANA crackers (30 gm/each)</td>
<td>7.62 (3.48)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.00 (3.93)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>8.33 (4.20)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.37 (4.88)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Grams of Bienestarina</td>
<td>158.61 (157.41)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>166.25 (167.62)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>219.11 (232.99)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>211.70 (260.98)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Different superscript denote statistically significant differences between food security status categories p < 0.05.

† Means are reported in local currency (Exchange rate at the time of the study: Colombian Pesos 2000/US$1).

‡ Multiple ANOVA adjusted by area of residency, gender of head of household, mothers age, previous month’s income, indoor plumbing, participation in other assistance programs, household size, number of places to sleep, fathers education, number of children in MANA, packets of milk, packets of crackers, grams of Bienestarina, residency in high risk area, and in-kind payment for work.

Table 3.3 Comparisons of food security status with MANA compliance, social, economic and demographic characteristics.
In multiple ANOVA models, significant differences in food expenditures were maintained after adjusting for several covariates. Predictors of household food expenditure included food security status, area of residency, gender of head of household, household size, number of places to sleep, previous month’s income, indoor plumbing and participation in other assistance programs (Table 3.4). The adjusted R-square for this regression model was 0.52.

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Coefficient (Colombian Pesos)</th>
<th>Standard Error</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Security Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Secure</td>
<td>36640</td>
<td>9740</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mild Food Insecure</td>
<td>22095</td>
<td>9612</td>
<td>0.022</td>
</tr>
<tr>
<td>Moderate Food Insecure</td>
<td>12897</td>
<td>10420</td>
<td>0.216</td>
</tr>
<tr>
<td>Severe Food Insecure Reference</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>-14635</td>
<td>3576</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Rural</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male Head of Household</td>
<td>14122</td>
<td>5331</td>
<td>0.008</td>
</tr>
<tr>
<td>Female Head of Household</td>
<td>Reference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mothers Age (Years)</td>
<td>393</td>
<td>232</td>
<td>0.091</td>
</tr>
<tr>
<td>Household Size (# of members)</td>
<td>3266</td>
<td>833</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of Places to Sleep</td>
<td>5432</td>
<td>1781</td>
<td>0.002</td>
</tr>
<tr>
<td>Previous Months Income</td>
<td>0.35</td>
<td>0.01</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Indoor Plumbing</td>
<td>11569</td>
<td>4226</td>
<td>0.006</td>
</tr>
<tr>
<td>Other Assistance Programs</td>
<td>-10833</td>
<td>4872</td>
<td>0.026</td>
</tr>
</tbody>
</table>

† Adjusted additionally by fathers education, number of children in MANA, packets of milk, packets of crackers, grams of Bienestarina, participation in other assistance programs, in-kind payment for work and residency in high risk area.
‡ Coefficients are reported in local currency (Exchange rate at the time of the study: Colombian Pesos 2000/US$1).

Table 3.4 Multiple regression coefficient of food expenditures in previous month †, ‡
**MANA participation**

The length of time that the child participated in the MANA program was not associated with food security status (Table 3.4). The number of siblings participating in MANA increased as the level of food insecurity worsened. Statistically significant differences were evident in number of siblings between food secure and severe food insecure. Child food supplement consumption differed by food security status.

**DISCUSSION**

The purpose of this study was to test an adapted version of the CHFSS for appropriateness in measuring household food insecurity of MANA participants in Antioquia, Colombia. A limitation of this research is that we relied on secondary data. Limitations of the scale include that questions were only asked specific to food insecurity as a result from financial constraints and were are only regarding the previous month. Regardless of these limitations, conclusions can still be drawn from this work. Two novel outcomes of this work include quantification of food supplement consumption and food expenditure by food security status within a food assistance population. Our research demonstrated higher rates of food supplement intake by children in food insecure households when compared to children living in food secure households. Additional research evaluating more comprehensibly the diet of the children and its correlation to food security status would be important to further understand how households cope with food insecurity.
Socioeconomic indicators and food security status were strongly correlated within this population. Even among the lowest socioeconomic strata in Colombia, where over 60% of income is used to purchase food, food expenditure significantly differed by food security status. Similar reductions in daily per capita food expenditures by food security status were also found in convenience samples taken in Bolivia, Burkina Faso and the Philippines (Melgar-Quinonez et al, 2006). Researchers in these countries found variation in purchase patterns of specific food groups by food security status. A limitation of our work is that data related to expenditures on specific food groups were not available. This additional information may be useful to understand the financial coping mechanisms specific to food expenditure incorporated in Colombia when households experience various levels of food insecurity.

MANA participants reported approximately a ten percent higher prevalence in food insecurity than nationally representative samples of Colombian households (Instituto, 2006). This result was expected because self-selected food assistance participants typically have higher levels of food insecurity than non-participants (Holben et al, 2004). The high prevalence of food insecurity in the MANA population is consistent with research done in Los Angeles County that demonstrated that levels of food insecurity were higher in households receiving public assistance (Furness et al, 2004). Households with evidence of hunger in Massachusetts reported participation in more food assistance programs than their non-hungry counterparts (Kleinman et al, 2007). Specifically, the hungry households were more likely to participate in the US Food Stamp Program, non-governmental community-based programs and community
food assistance programs. In the Appalachian regions of Ohio, food insecurity was
associated with participation in more food assistance programs, but the association was
not statistically significant (Holben et al, 2004). For MANA, the higher food insecurity
prevalence in program participants is relevant because it reflects how well it reaches the
targeted population groups. A limitation of this study is that there was no control group
that was not participating in MANA.

Household educational factors were strongly associated with MANA participants’
food security status, consistent with research in other countries (Alvarado et al, 2005;
Lorenzana and Sanjur, 1999; Melgar-Quinonez et al, 2006; Rose, 1999; Tingay et al,
2003). Researchers in Iran found inverse associations of adult food insecurity and child
hunger with father’s education and mother’s education, similar to our results (Zerafati et
al, 2007). Research in rural Ecuador found that the mother’s educational level, but not the
father’s, correlated negatively with household food insecurity level (Hackett et al, 2007).
In the U.S., Mexican immigrant households showed maternal education and age
negatively associated with household food security levels (Kersey et al, 2006). Consistent
with our results, household food insecurity was inversely associated with household size
in Iran (Zerafati et al, 2007). Large households on the US border also had higher odds of
being food insecure than their smaller counterparts (Weigel et al, 2007). Results from the
Panel Study of Income in the US showed that food insecure women had more family
members and children (Jones and Frongillo, 2006).

Our research presents an important description of the current food security status
of households participating in a food assistance program in Colombia. Furthermore, the
results of this research showed that even with a fairly homogeneous population the proposed CHFSS was able to differentiate households by food security status. Our results affirm the criterion validity of the CHFSS with this high risk population. The implications of this study are critical for governmental and non-governmental agencies that need valid tools to measure the food security status of households participating in nutrition interventions. Future studies need to evaluate the correlation of the food insecurity questionnaire with the total food intake of children participating in food assistance programs, per capita food expenditure by food groups, and the current nutritional status of the child.
CHAPTER 4

HOUSEHOLD FOOD INSECURITY IS ASSOCIATED WITH STUNTING AND UNDERWEIGHT AMONG PRE-SCHOOL CHILDREN IN ANTIOQUIA, COLOMBIA

ABSTACT

Background: Valid measures of household food insecurity are critical to accurately evaluate food assistance programs in developing countries.

Objective: To assess criterion validity of a household food security scale through its associations with child health status in participants of the Colombian Plan for Improving Food and Nutrition in Antioquia (Mejoramiento Alimentario y Nutricional de Antioquia - MANA).

Design: A twelve-item household food security survey (CHFSS) was applied to a cross-sectional stratified random sample of 2,784 low-income households with pre-school children receiving MANA food supplements in Antioquia, Colombia. Anthropometrics and health status of the children were also assessed. Chi-square tests were used to initially compare child health status and household food security status. Logistic regression models were further developed to assess this relationship in both bivariate and multiple regression models.
Results: Statistically significant associations were found between household food insecurity and diagnoses of children’s diarrhea, upper respiratory infection and parasitosis (p<0.0001). The risk for child stunting and underweight increased in a dose-response way as food insecurity became more severe.

Conclusions: Our research establishes an important link between household food insecurity and child nutritional status in participants of a food assistance program. The results affirm the criterion validity of the CHFSS, establishing the proposed instrument as a valid measure for food insecurity with high risk populations. This validation research provides nutrition interventions worldwide with a tool that can be adapted to their specific evaluation needs.

INTRODUCTION

Food insecurity is defined as “limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways” (Anderson, 1990). Food insecurity affects health and well-being throughout the life cycle and has been associated with child dietary intake and weight status (Cook and Frank, 2008; Oh and Hong, 2003; Perez-Escamilla, 2000). Household food insecurity may be related to protein energy malnutrition (PEM) evident in stunting, wasting and underweight which affects one quarter of the world’s children. (Alvarado et al, 2005; Baig-Ansari et al, 2006; Phengzay et al, 2007).

Food security is of great significance worldwide as governmental and nongovernmental agencies rally to reach the Millennium Development Goal to reduce
hunger in half by the year 2015 (FAO, 2006). In order to meet this goal in Colombia, the regional government of Antioquia began the Plan for Improving Food and Nutrition in Antioquia, Colombia (Plan Departamental de Seguridad Alimentaria y Nutricional de Antioquia - MANA) in 2002. This nutrition intervention targeted pre-school aged children in low-income households (Gobernacion de Antioquia, 2004). In 2006, Colombian researchers spearheaded the first extensive evaluation of the food supplement component of MANA to the current nutritional and food security status of MANA participants (Gobernacion, 2006).

Valid measures of food security form a critical component of monitoring the progress and achievement the Millennium Development Goal. The measurement of food security allows governmental and development agencies to estimate the prevalence of this phenomenon, better target high risk populations and evaluate the impact of their programs at the household level (Frongillo, 1999). With the use of a valid tool, organizations can appropriately channel resources to reduce epidemic levels of food insecurity and hunger. To our knowledge, this paper presents the first criterion validation research project on a household food security scale applied to participants of a food assistance program by comparing food insecurity measures to health conditions in children.

METHODS

Criterion validity of the Colombian Household Food Security Scale (CHFSS) was assessed using data collected from a cross-sectional stratified random sample
representative of the 200,000 MANA participants in the department of Antioquia, Colombia. Sample size was calculated by Colombian researchers using Epidat® software (version 3.0, Pan-American Health Organization, Dirección Xeral de Saúde Pública). A maximal regional error of 0.05% resulted in a sample of 2,784 low-income households with pre-school children. Trained interviewers met with child caregivers at local hospitals to administer semi-constructive face-to-face questionnaires after consent had been given. The ethics committee at the Faculty of Medicine at The University of Antioquia approved data collection, and analysis of the resulting database was approved by the Institutional Review Board at The Ohio State University.

**Household Demographics**

The following components were included in the questionnaires in addition to the CHFSS: participation in other assistance programs, consumption of MANA powdered milk packets (25 gm each), MANA crackers (30 gm each) and grams of fortified vegetable flour (Bienestarina). Demographic variables consisted of area of residence (urban/rural), housing characteristics, age of parents and participating child, household size, number of siblings in the household, and previous month’s income.

**Anthropometrics**

Child height was measured using a portable stadiometer sensitive to the nearest 0.1 cm. Weights were obtained using a portable electronic scale (Tanita) sensitive to the nearest 100 gm. Length of children from 6 to 23 months were measured using portable aluminum infantometer designed for the study with a sensitivity of 0.1 cm. Three generally accepted anthropometric indices were used to approximate children’s
nutritional status: height-for-age Z-score (HAZ), weight-for-age Z-score (WAZ) and weight-for-height Z-score (WHZ) (WHO, 1983). Z-score was used to distinguish between normal and risk for stunted/stunted (HAZ <-1), risk for underweight/underweight (WAZ <-1) or risk for wasted/wasted (WHZ <-1) children for the logistic regression and chi-square tests.

Child Health Status

Caregivers were also asked if the target child had suffered from either diarrhea (defined as three or more liquid bowel movements within 24 hours) or acute upper respiratory infection in the previous two weeks (WHO, 2002). Possible acute upper respiratory infections included rhinopharyngitis, common cold, ear or sinus infection, laryngitis, bronchitis, pharyngoamigdalitis, croup, bronchiolitis, and pneumonia. Blood samples were collected from the child to assess hemoglobin and ferritin levels. Hemoglobin was measured using HemoCue azidemethemoglobin techniques and ferritin was quantified using chemiluminescent immunoassays (Burgere S and Pierre-Louis, 2003; Stoltzfus et al, 1997). Anemia was established using the cut-off of <11 mg/dl hemoglobin. Fecal samples were collected from every child at the time of the interview and assessed at the Intestinal Parasite Lab at the University of Antioquia, Department of Medicine. A classic formalin-ether concentration technique (Ritchie) was used to analyze the feces (Knight et al, 1976). Any type of parasite (helminthes, protozoan or ameba) found in the child’s stool resulted in a positive coding for parasites.
Household Food Security Scale

For nearly 20 years researchers have created and validated qualitative methods to measure food security experiences in questionnaire format (Keenan et al, 2003). One of the first modules developed for the Community Childhood Hunger Identification Project (CCHIP) was based on the Massachusetts Nutrition Survey (1983), in which researchers defined hunger as food insufficiency due to lack of resources (Wehler, 1992). In 2003-2004, researchers in Antioquia, Colombia, conducted a validation study using this tool, the CHFSS, previously translated, modified and applied in Venezuela (Alvarez et al, 2006).

The CHFSS consisted of twelve questions regarding the experiences of food insecurity as a result of financial constraint over the previous month. Each item was followed by a frequency of occurrence question, which assessed how often a given condition occurred. A negative response to the initial item was coded as “0”, and the follow up questions were coded as rarely = “1”, sometimes = “2” and always = “3”. The sum of all responses gave a food security score ranging from zero to thirty six, with zero representing the most food secure and thirty six the least. Based on this raw score, household food security status was categorized using the following cut-off points: 1) Households with a household food security score of zero were considered *food secure*; 2) Households with a score of 1-17 were labeled as *mildly food insecure*; 3) Households with scores of 18-26 were categorized as *moderately food insecure*; and 4) Households with scores of 27-36 were grouped into a *severe food insecurity* category (Lorenzana and Mercado, 2002).
Statistics

These data were analyzed by using STATA for WINDOWS software version 8.2, StataCorp, College Station, TX). Descriptive statistics were calculated for demographic, anthropometric, child’s health and food insecurity variables. The relation of child health outcomes to food insecurity was examined by using the Mantel-Haenszel chi-square test for ordered categorical variables. Logistic regression procedures (LOGISTIC) were used in both the bivariate and multivariate analysis to examine risk of malnutrition by food insecurity level. We report results as significant at 95% confidence intervals (Kahn HA, 1989).

RESULTS

Mean income the month prior to the interview was 259,785 Colombian pesos (129.89 USD). Sample characteristics in Table 4.1 show that participating children had an average hemoglobin of 12.9 mg/dl and average ferritin of 28.5 µg/L. The majority of the households had homes with access to water (80.5%), sewage facilities (59.2%) and electricity (86.2%). Less than half of the households were categorized as food secure (48.2%) and over one third were mildly food insecure (37.9%). One-tenth of the sample was categorized as moderately food insecure households and 3.8% exhibited severe food insecurity. Most children had a positive diagnosis for parasites (70.8%) and reported upper tract respiratory infections within the two weeks previous to the interview (57.7%). Only 22.7% of the children had diarrhea within the same time frame, and only 7.0% were diagnosed as anemic.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (Standard Deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child’s Age (months)</td>
<td>41.1 (17.3)</td>
</tr>
<tr>
<td>Child’s Hemoglobin (mg/dl)</td>
<td>12.9 (1.3)</td>
</tr>
<tr>
<td>Child’s Ferritin (µg/L)</td>
<td>28.5 (20.0)</td>
</tr>
<tr>
<td>Powdered Milk Packets Consumed ¹ (no/wk)</td>
<td>8.2 (3.9)</td>
</tr>
<tr>
<td>Crackers ¹ (no/wk)</td>
<td>7.9 (3.8)</td>
</tr>
<tr>
<td>Bienestarina ¹ (g/wk)</td>
<td>169.7 (176.1)</td>
</tr>
<tr>
<td>Urban Area of Residence</td>
<td>46.3 (1,287)</td>
</tr>
<tr>
<td>Food Security Status</td>
<td></td>
</tr>
<tr>
<td>Food Secure</td>
<td>48.2 (1,343)</td>
</tr>
<tr>
<td>Mildly Food Insecure</td>
<td>37.9 (1,056)</td>
</tr>
<tr>
<td>Moderately Food Insecure</td>
<td>10.1 (280)</td>
</tr>
<tr>
<td>Severely Food Insecure</td>
<td>3.8 (105)</td>
</tr>
<tr>
<td>Child Illnesses ²</td>
<td></td>
</tr>
<tr>
<td>Respiratory Infection</td>
<td>57.7 (1,605)</td>
</tr>
<tr>
<td>Acute Diarrhea</td>
<td>22.7 (631)</td>
</tr>
<tr>
<td>Parasites</td>
<td>70.8 (1,460)</td>
</tr>
<tr>
<td>Anemia</td>
<td>7.0 (194)</td>
</tr>
</tbody>
</table>

¹ Per week
² Within two weeks previous to the interview

Table 4.1 Descriptive statistics of the households (n=2,784).

**Anthropometrics**

Table 4.2 shows that most children presented with normal HAZ (57.8%), WAZ (70.2%) and WHZ (57.6%). Missing data accounted for the loss of 62 children in the analysis. The prevalence of risk for stunting/stunting was 42.1%, while the prevalence of risk for underweight/underweight was 37.5%. The prevalence of risk for wasting/wasting
was 18.7%. A small percentage of the sample was characterized as overweight (9.8%) or obese (1.3%) as measured by WAZ. When using WHZ, even smaller percentages of the sample were overweight (4.2%) or obese (0.7%).

<table>
<thead>
<tr>
<th>Anthropometric Measure (Z-score)</th>
<th>% (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Height for Age</strong></td>
<td></td>
</tr>
<tr>
<td>Normal (&gt; -1)</td>
<td>57.8 (1,574)</td>
</tr>
<tr>
<td>Risk of Stunting (-1 and -2)</td>
<td>31.0 (845)</td>
</tr>
<tr>
<td>Stunting (&lt;-2)</td>
<td>9.7 (265)</td>
</tr>
<tr>
<td>Severe Stunting (&lt;-3)</td>
<td>1.4 (38)</td>
</tr>
<tr>
<td><strong>Weight for Height</strong></td>
<td></td>
</tr>
<tr>
<td>Normal (±1)</td>
<td>70.2 (1,912)</td>
</tr>
<tr>
<td>Overweight (+1 and +2)</td>
<td>9.8 (266)</td>
</tr>
<tr>
<td>Obese (&gt;+2)</td>
<td>1.3 (36)</td>
</tr>
<tr>
<td>Risk of Wasting (-1 to -2)</td>
<td>14.4 (391)</td>
</tr>
<tr>
<td>Wasted (-2)</td>
<td>2.9 (80)</td>
</tr>
<tr>
<td>Severely Wasted (&lt;-3)</td>
<td>1.4 (37)</td>
</tr>
<tr>
<td><strong>Weight for age</strong></td>
<td></td>
</tr>
<tr>
<td>Normal (±1)</td>
<td>57.6 (1,568)</td>
</tr>
<tr>
<td>Overweight (+1 and +2)</td>
<td>4.2 (115)</td>
</tr>
<tr>
<td>Obese (&gt;+2)</td>
<td>0.7 (18)</td>
</tr>
<tr>
<td>Risk of Underweight (-1 and -2)</td>
<td>25.9 (705)</td>
</tr>
<tr>
<td>Underweight (&lt;-2)</td>
<td>9.3 (254)</td>
</tr>
<tr>
<td>Severely Underweight (&lt;-3)</td>
<td>2.3 (62)</td>
</tr>
</tbody>
</table>

Table 4.2 Anthropometrics of children participating in the MANA food supplement program (n=2,722).
Household Food Security Status

Household food security status was statistically significantly associated with child parasites, respiratory infections, and diarrhea (Table 4.3). Missing data for the following variables caused a decrease in sample: parasites (n=6), diarrhea (n=5) and respiratory infections (n=3). Higher percentages of these illnesses were found in severely food insecure households. Risk of stunting/stunting, as well as risk of underweight/underweight, showed a statistically significant inverse association with household food security status: the more food insecure the household, the higher the prevalence of risk of stunted/stunted and risk of underweight/underweight children. In contrast, wasting and risk of wasting did not show a significant association with food security status.
<table>
<thead>
<tr>
<th></th>
<th>Food Secure</th>
<th>Mild Food Insecurity</th>
<th>Moderate Food Insecurity</th>
<th>Severe Food Insecurity</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunting or Risk of Stunting ¹</td>
<td>38.0 (498)</td>
<td>43.4 (450)</td>
<td>49.5 (136)</td>
<td>63.4 (64)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Underweight or Risk of Underweight ¹</td>
<td>34.6 (453)</td>
<td>38.5 (399)</td>
<td>41.8 (115)</td>
<td>53.5 (54)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Wasting or Risk of Wasting ¹</td>
<td>18.9 (248)</td>
<td>18.5 (192)</td>
<td>17.1 (47)</td>
<td>20.8 (21)</td>
<td>0.84</td>
</tr>
<tr>
<td>Parasites ²</td>
<td>66.7 (652)</td>
<td>72.6 (577)</td>
<td>77.4 (164)</td>
<td>82.7 (67)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Acute Diarrhea ³</td>
<td>18.3 (245)</td>
<td>24.4 (257)</td>
<td>32.5 (91)</td>
<td>36.2 (38)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Respiratory Infection ⁴</td>
<td>52.4 (703)</td>
<td>62.5 (659)</td>
<td>61.8 (173)</td>
<td>66.7 (70)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

¹ n=2,722; ² n=2,062; ³ n=2,779; ⁴ n=2,781

Table 4.3 Bivariate associations between potential risk factors and varying levels of food security in Antioquia, Colombia.
Covariates in a multiple logistic regression model included anemia, parasites, diarrhea, gender of head of household, area of residency, household size, father’s age, mother’s age, income, animals in the house, refugee, high risk area, sewage, water in house, electricity, water in kitchen, type of house, number of milk packets consumed per week, grams of Bienestarina consumed per week and packets of crackers consumed per week (Table 4.4). Approximately one half of sample (n=1,299) was lost in the model because of missing item responses. Following a dose-response pattern, children in food insecure households (mild, moderate and severe) showed a statistically significant higher risk for risk of stunting/stunting in the multiple logistic regression model when compared to children in food secure households (p<0.05). Children living in moderately and severely food insecure households also showed statistically significant higher risks for risk of underweight/underweight than those living in food secure households (p<0.05).
<table>
<thead>
<tr>
<th></th>
<th>% (n)</th>
<th>Odds Ratio (95% CI)</th>
<th>Adjusted Odds Ratio (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stunting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Secure</td>
<td>38.0 (498)</td>
<td>1.00 (ref. category)</td>
<td>1.00 (ref. category)</td>
</tr>
<tr>
<td>Mild Food Insecure</td>
<td>43.4 (450)</td>
<td>1.25 (1.06, 1.48)</td>
<td>1.28 (1.00, 1.63)</td>
</tr>
<tr>
<td>Moderate Food Insecure</td>
<td>49.5 (136)</td>
<td>1.60 (1.23, 2.07)</td>
<td>1.58 (1.08, 2.31)</td>
</tr>
<tr>
<td>Severe Food Insecure</td>
<td>63.4 (64)</td>
<td>2.82 (1.85, 4.29)</td>
<td>2.65 (1.37, 5.14)</td>
</tr>
<tr>
<td><strong>Underweight</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Secure</td>
<td>34.58 (453)</td>
<td>1.00 (ref. category)</td>
<td>1.00 (ref. category)</td>
</tr>
<tr>
<td>Mild Food Insecure</td>
<td>38.51 (399)</td>
<td>1.18 (1.00, 1.40)</td>
<td>1.11 (0.87, 1.42)</td>
</tr>
<tr>
<td>Moderate Food Insecure</td>
<td>41.82 (115)</td>
<td>1.36 (1.04, 1.77)</td>
<td>1.47 (1.01, 2.15)</td>
</tr>
<tr>
<td>Severe Food Insecure</td>
<td>53.47 (54)</td>
<td>2.17 (1.45, 3.27)</td>
<td>1.89 (1.00, 3.55)</td>
</tr>
</tbody>
</table>

*Adjusted for anemia, parasites, diarrhea, gender of head of household, area of residency, household size, father’s age, mother’s age, income, animals in the house, refugee, high risk area, sewage, water in house, electricity, water in kitchen, type of house, number of milk packets, grams of Bienestarina and packets of crackers.

<table>
<thead>
<tr>
<th></th>
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<th>Odds Ratio (95% CI)</th>
<th>Adjusted Odds Ratio (95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stunting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>1.00 (ref. category)</td>
<td>1.00 (ref. category)</td>
</tr>
<tr>
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<td>1.58 (1.08, 2.31)</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>Underweight</strong></td>
<td></td>
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<td></td>
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<tr>
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</tr>
</tbody>
</table>

*Adjusted for anemia, parasites, diarrhea, gender of head of household, area of residency, household size, father’s age, mother’s age, income, animals in the house, refugee, high risk area, sewage, water in house, electricity, water in kitchen, type of house, number of milk packets, grams of Bienestarina and packets of crackers.

Table 4.4 Associations of household food security status with stunting and underweight (n=1,485).

CONCLUSIONS

The purpose of this study was to test an adapted version of the CHFSS for appropriateness in measuring household food insecurity of MANA participants in Antioquia, Colombia. This validation research provides nutrition interventions worldwide with a tool that can be adapted to their specific evaluation needs. The broader implications of this study address the need for measures of food insecurity for nutrition interventions in the developing world. A novel outcome of this study includes the quantification of child stunting and underweight by food security status within a food assistance population when adjusted for associated covariates. An unexpected result of
In Bogota, Colombia, food insecure children were almost three times more likely to be underweight than food secure children, while stunting was not significantly associated with food security when controlling for covariates (Isanaka et al, 2007). The prevalence of food insecurity in Bogota was 24% higher than the rates in the MANA sample. This large difference may be associated with differences in the tool applied in the two settings. Whereas for our study researchers in Antioquia applied a locally adapted tool derived from the CCHIP instrument, in Bogota researchers applied the US Household Food Security Survey Module. The later contains 16 items, some of which are different from the ones included in the CHFSS. In addition, the children sampled in Bogota were not participating in a food assistance intervention like the Antioquian children.

Comparatively, in Guapi, Colombia, food insecurity status showed a positive association with both stunting and wasting of Afro-Colombian children (Alvarado et al, 2005). The differences in the association of wasting with food insecurity may be the result of differences in recall time of the questionnaires used in the respective studies or definitions of wasting. The Guapi survey used a recall time of six months, and the Antioquia study asked the caregivers about the situation in the previous month. The difference in associations observed may indicate that participation in the MANA food supplement program played a role in protecting the children against wasting.
In our sample, the highest proportions of stunted, underweight and wasted children were found in the most food insecure households. Likewise in Pakistan, household food insecurity was statistically significantly associated with child stunting (Baig-Ansari et al., 2006). Conversely, in Korea the households with mildly food insecure and hungry children had the largest proportion of overweight children (Oh and Hong, 2003). This difference could be due to the small subsample of overweight or obese children in our study, which is one of the limitations of our results.

The high prevalence of children with parasites in this study is consistent with research in Mexico where over half of the school children had intestinal parasitic infections and poly-parasitosis (Quihui-Cota L et al., 2003). One limitation to our research is the lack of information about which specific parasitic infections were diagnosed. Such data would have enabled us to add to the model only parasites known to compromise nutritional status. Nevertheless, the presence of any parasite indicates poor housing, sanitation, water supplies, health care, education and personal earnings (Crompton, 1999). Another limitation of this study is that the data on illnesses were reported by the caregivers. Nevertheless, the questions were specific and interviewers explained the symptoms of the respective illness conditions that constituted a response as positive.

This research presents an important comparison of household food security status and child nutritional status of participants of a food assistance program in Colombia. Our findings affirm the criterion validity of the CHFSS with this high risk population. Consequently, this tool may be of great use to other food assistance programs regardless of country or continent. The implications of this study are critical for governmental and
nongovernmental agencies throughout the world that need valid, easy to apply and inexpensive tools to measure household food security status of high risk populations. As different institutions assess household food insecurity to determine prevalence and vulnerability, as well as to evaluate the impact of their interventions, a measurement tool with validity in diverse settings allows comparability of the data. Future studies are needed to evaluate the proposed food insecurity instrument at different points in time before, during and after intervention projects are carried out to determine whether this tool represents a reliable option to assess nutrition interventions.
CHAPTER 5
CONCLUSIONS AND EPILOGUE

Using different approaches to assess the performance of the proposed tool, this research found that the CHFSS applied to MANA participants in Antioquia, Colombia, is valid in assessing food security status at the household level. Internal validity testing showed good fitness of the scale to the one parameter Rasch Module. In addition, subgroups within the sample interpreted the CHFSS in similar manners regardless of variations in area of residency, socioeconomic status and the number of children enrolled in MANA. Criterion validity testing demonstrated that results from the CHFSS were consistent with variables known to be associated with household food security. In specific, monthly food expenditures per capita and food supplement consumption showed strong correlations to household food security status. Additionally, food security status correlated with child illness, stunting and underweight status. The most surprising results of this work were that anemia and wasting status were not associated with household food insecurity.

The research presented here inspires additional research questions, especially based on the previously mentioned limitations. It would be of great importance for the next evaluation of the CHFSS to apply the scale before and after participation in the
program. At this point the data collected from the CHFSS is merely descriptive and does not allow the food insecurity of this sample to be compared to the remaining population that does not participate in MANA. Control groups are particularly important if food assistance programs’ attempt to use this scale to demonstrate the effectiveness of their interventions.

In order to add weight to the internal validation of this study, in the future I would not use the first item as a filter. One of the weaknesses of this research is that households that responded negatively to the first item could not be included in the test of internal validity. Omitting items from the CHFSS may result in households not being characterized accurately. Each item within the scale captures a different aspect of the food insecurity construct and a negative response to one item does not necessarily mean that the households are not experiences a different component of food insecurity. I would suggest that if researchers and government officials feel that the CHFSS is too long with 15 items that they shorten it as has been done in the US, instead of using a filter question.

As part of future studies, the complete food consumption of the child would be useful to assess variations in dietary and supplement intake. Thus food assistance programs such as MANA could be more specific in their supplements and mechanisms of delivery. Comparisons of food consumption by members of the same household would be important in assessing who experiences food security and the coping mechanisms in this sample. Perhaps in this manner additional items could be added to the CHFSS that capture moderate food insecurity.
One of the novel findings of my research is that child stunting and underweight status are associated with household food security status. A larger child sample size might allow us to tease out variations in wasting, overweight and obesity status by food security status. As supplemental information, the weight status of other family members could also help broaden our understanding of the physical effects of food security in the household.

In conclusion, our research has provided many novel analyses of the CHFSS. Future work is needed to continue improving the measurement of household food security in high risk population groups, especially those participating in food assistance programs.
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