

# Dietary Diversity Associated with Ngöbe Nutritional Status in La Casona

By Jacob Ball  
Tulane University

In conjunction with Emily Larkin, Lisa Podolsky, and Katie Strandberg

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## *Abstract*

The following research was conducted in Costa Rica through Duke University and the Organization of Tropical Studies. The objective of this study was to determine if there is a relationship between dietary diversity and nutritional status of the indigenous Ngöbe population of La Casona, located in the Coto Brus cantón in Puntarenas, Costa Rica. Seventy-five adult subjects, ages 18 to 77 years, completed a verbal questionnaire of 50 questions and free-listing section to assess the nutritional domain of their diet. Height and weight were measured for each subject to compute Body Mass Index (BMI), an indicator for assessing nutritional status. The study aimed to prove that greater dietary richness correlates with a BMI closer to or within normal range. However, richness of food groups and gender were found to be positively correlated with BMI (adjusted  $R^2=0.09$ ,  $p=0.013$ ). Simpson's Diversity Index was used to determine the diversity within each food group. The most diverse group was vegetables and the least diverse was grains. Large proportions of proteins and grains suggest sufficiency in zinc, iron, vitamin C, and folic acid. The Ngöbe diet includes vitamin B<sub>6</sub> from grains and fruits, but the low amount of fruit in the diet makes it difficult to determine if these levels are sufficient. Because greater proportions of protein come from beans rather than red meat, adequacy of vitamin B<sub>12</sub> in the diet is inconclusive. Due to an overall lack of fruits, vegetables, and dairy, it can be suggested that the Ngöbe diet is also insufficient in calcium and vitamin A. Future research can focus on these potential nutrient deficiencies in order to improve overall nutritional status of the community.

## ***Introduction***

Proper nutrition is an asset to human life. Scientific evidence has shown that early nutrition affects key risk factors for developing chronic degenerative diseases during middle and late life (Dwyer 2006). Overall, good nutrition can reduce the risk of common diseases, including cancer, type II diabetes, and obesity. Through nutrition, management of symptoms for already existing health issues is possible (FDA 2010). The direct influence of nutrition on health status and morbidity makes longer life feasible, while minimizing chronic disability. A more diverse diet is necessary to obtain suggested levels of micronutrients, rather than from a single food item. Zinc, iron, calcium and folic acid, along with vitamins A, B<sub>6</sub>, B<sub>12</sub> and C can be used as indicators of overall micronutrient intake (Daniels 2009).

In recent years, the entire Latin American population has experienced an increasing prevalence of chronic diseases in association with changes made to the traditional diet, which consists of cereals, vegetables, legumes, roots, and grains. There has been a gradual transition from these foods to foods that are high in sugars and fats (Bermudez 2003). Like many indigenous groups, the Ngöbe population of La Casona, in the Coto Brus *cantón* of Puntarenas, Costa Rica is isolated both physically and culturally from mainstream Latin American communities, limiting access to nutrient-rich and diverse foods (Hollowed 2009). It has been shown that nutritional deficiencies tend to be more prevalent in rural and marginalized communities and populations with a lower socioeconomic status, such as La Casona (Bermudez 2003). Thus, we expect to find a deficiency of one or more micronutrients in the Ngöbe diet according to internationally recommended intake values.

Currently, no research exists on nutritional deficiencies in the Ngöbe population of La Casona. In studying dietary diversity in relation to BMI, one can gain an understanding of nutritional status, an indicator of the risk to develop certain nutritional diseases (FDA 2010). This study also uses adherence to internationally recognized food group (WHO 2000) and micronutrient intake standards (FAO 2007) as proxies for nutritional status.

The objectives of this study were to determine if greater dietary diversity correlates to a BMI closer to or within normal range, and to determine if divergence from the recommended dietary intake indicates potential micronutrient deficiencies.

## ***Methods***

### *Literature Analysis*

Literature was reviewed in order to acquire knowledge on nutritional habits of the indigenous Ngöbe people of Costa Rica from an OTS student project by Madolyn Hollowed from the spring of 2009. Previous studies were consulted to determine which micronutrients would be useful in assessing deficiencies as well as standards for which to compare daily food consumption (Daniels 2009).

### *Sampling and Interviews*

Households in La Casona were selectively sampled to complement Hollowed's previous data collection. A goal sample size of 113 was determined to obtain a 9% confidence interval, using Creative Research Systems survey software. In total, 107 adults, 18 years of age and older, both male and female, were sampled. Only information from 75 individuals ( $n_f=40$ ;  $n_m=35$ ) was used to conduct analysis, due to incomplete data.

The majority of interviews were conducted at households in various neighborhoods, including La Casona, Caño Bravo, Pita, and Las Vegas. Additionally, convenience sampling

was used to interview respondents following community events, such as church services and English classes, in hopes of reaching male respondents who are absent from households during the week.

Structured interviews, consisting of a questionnaire and a free-listing section, were conducted after obtaining verbal assent. The questionnaire lasted about 15 minutes and contained questions regarding gender, age, number of children, access to health care, household food preparation, daily food intake, and anthropometric factors. The free-listing technique was used to record all food eaten the previous day, specifically at breakfast, lunch and dinner, in hopes of determining the scope of the respondents' dietary domains.

#### *Body Mass Index*

Data collection for Body Mass Index (BMI) was carried out using measurements of height and weight ( $\text{kg}/\text{m}^2$ ), using a measuring tape and a scale. Percentage of body fat was not measured due to clinical restraint and lack of resources. Nevertheless, BMI was an adequate measure to provide an estimate of body composition (American Heart Association 2010).

Although waist circumference is a more accurate determinant of nutritional status for males, BMI was used for both male and female for consistency.

#### *Analysis of Data*

Following the completion of fieldwork, data was compiled into a spreadsheet using Microsoft Office Excel<sup>®</sup>. All food items mentioned were classified into different food groups according to WHO and FAO guidelines (Table 1). Simpson's diversity index for all food groups was then calculated to illustrate the food variety within the population. Linear regressions were performed to understand if there were relationships between richness of food groups and BMI and between richness of food items and BMI. Multi-linear regressions were performed with SPSS software. All regression results were compared to a significance of  $p = 0.05$ .

Percent composition of respective food groups in the observed diet of the population was determined. This was compared to the CINDI Dietary Guide recommended percent composition of food groups (WHO 2010). The micronutrient composition of the most prominent foods in each food group was qualitatively assessed to determine potential nutrient deficiencies (FAO 2010).

### ***Results***

The calculated BMIs were separated by gender and categorized as “underweight”, “normal weight”, “overweight”, or “obese” by the WHO BMI classification system (Table 2). The distribution of BMI classification in the different genders (Figure 1) was then plotted. 63% of females and 43% of males are either overweight or obese. No females are underweight.

Women are more likely to be obese than men.

The number of items in each food group, the food group’s richness, can also be seen in Table 1. Richness of food groups mentioned per respondent was calculated and related to BMI using linear regression. There is a general positive correlation, going against this study’s hypothesis. However, this factor alone was not statistically significant. When a multi-linear regression was performed, it was determined that richness of food groups has a significant, positive correlation to BMI when gender is taken into account ( $p=0.013$ ). An adjusted  $R^2$  value of 0.09, 9% of the BMI distribution can be explained by richness of food groups when gender is factored in.

A Simpson’s diversity index was calculated for each food group and then graphed in order to compare the relative distribution of foods throughout the community (Figure 2). Vegetables are the most diverse with a value of 0.608, while grains are the least diverse with a value of 0.444.

Using frequency of times mentioned and number of portions eaten per day, the percent of the overall diet that each food group constitutes was calculated. This was then compared to the WHO CINDI recommended diet composition (Figure 3).

The diet consists of 1.68% dairy, just over 10% of the daily recommended intake; fruits and vegetables are present in approximately half and 42% of the daily recommended quantity, respectively. Proteins, grains, and fats are in excess in the Ngöbe diet. The Ngöbe diet does not meet or even approach the recommendations set by the World Health Organization (WHO).

Using the percent composition of each food in every food group and literature analyses, a qualitative assessment of micronutrient intake was possible, which was then compared to the Food and Agricultural Organization (FAO) and WHO recommendations. There are potential vitamin A and calcium deficiencies in the diet, while iron, zinc, folic acid and vitamin C are suspected to be present in sufficient levels. It is inconclusive whether or not potential deficiencies in vitamins B<sub>6</sub> and B<sub>12</sub> exist (FAO 2002).

### ***Discussion***

The comparison of the food group make-up of the Ngöbe diet to WHO recommendations suggests that there is an imbalance in the dietary intake, and potentially in the level of the micronutrients that correspond to the various groups. The cognitive domain of the Ngöbe regarding food diversity in the community is low, having only 32 total food items mentioned. This speaks to a potential problem in the community with accessibility to dietary variety, reasons for which could be financial or geographical. As previously stated, food diversity in a diet increases the likelihood of meeting suggested micronutrient levels (Daniels 2009). Because of the limited cognitive domain and the noted food group imbalance, overall dietary richness is low which increases the likelihood of having micronutrient deficiencies in the diet.

All of the micronutrients assessed in this study were selected based on previous research, and, like all micronutrients, have important physiological roles. Vitamin A is important in retinal function, red cell production, and gene expression. Vitamin A is found mainly in vegetables, which the Ngöbe do not receive in sufficient quantity, making a deficiency likely.

Calcium is an essential component of the teeth and bone structures, which help give humans the ability to pursue subsistence. It is often found in dairy, the food group of which the Ngöbe only receive 10% of the daily recommended values; therefore, it is suspected that their diet has a calcium deficiency.

Vitamin B<sub>6</sub> is involved in neurological function and development. It is found in high quantities in plantains and bananas, which constitute the majority of the fruit food group in their diet. But because they do not meet the recommended intake of fruits, no conclusion can be made as to whether or not there is a potential vitamin B<sub>6</sub> deficiency.

Vitamin B<sub>12</sub>, too is involved in cognitive function, but also plays a role in red blood cell formation and DNA synthesis. The micronutrient is mostly found in red meats, which make up a small percentage of the overall protein consumption. However, it is also present in some grains such as rice, and in yucca, which are eaten in excess, making the determination of a potential deficiency inconclusive.

Zinc, iron, folic acid and vitamin C have been determined to be present in sufficient amounts in the Ngöbe diet. Zinc aids in the protein synthesis, wound healing, and is part of many enzymes. Iron is part of hemoglobin, which enables red blood cells to carry oxygen throughout the body. Folic acid helps in DNA synthesis and repair, and it is also a cofactor in many chemical reactions. Vitamin C is involved in synthesizing collagen, which makes up a lot of body tissue, as well as boosts the immune system.

One reason for the positive correlation between dietary diversity and BMI could be that after naming a grain and protein, usually rice and beans, the next item mentioned is a member of the “fats and sugars” group, or an item without substantial nutritional value. The linear regression was significant when gender was taken into account. The women in the La Casona Ngöbe community suffer from obesity in a greater proportion than men. Most of the men in the community are employed in jobs requiring labor-intensive work in agriculture fields or otherwise, which could explain the relatively low obesity incidence in the population. The women are responsible for cooking, taking care of the children and the home during the day while the man works. In general the Ngöbe women have sedentary lives, only leaving the home to purchase groceries or socialize with neighbors. Without exercise there is a low caloric expenditure, and gaining weight is possible.

Teenage motherhood and multiple pregnancies are common in the Ngöbe community. If the sedentary lifestyle of a house wife starts at a young age, it is possible that the baby weight gained from each pregnancy is not lost, and that the weight compounds with each additional pregnancy.

### ***Conclusion***

#### *Limitations*

There are a variety of possible errors in the execution of this study, and in the statistical analysis. During data collection there was no Ngöbere-Spanish translator, making communication with some respondents difficult. Spanish was a second language for both the researchers and for many of the respondents, so information was bound to be lost in translation. The interviews had to be done within a short time frame, consisting of two weekdays and a weekend, making reaching the target sample size difficult due to the geographic distribution of



houses in La Casona. The interview itself, written by Fullbright Fellow Madoyln Hollowed, contained many questions not pertinent to this study.

There was resistance by the Ngöbe men in participating in the interview, wary of the research intent and of divulging personal information to non-community members. Of five researchers four are female, including Hollowed. As a result, societal gender roles may have further discomforted the men of the community. One researcher is male, making it inappropriate for him to take the measurements of female respondents. These limitations in giving surveys slowed down the data collection process further.

When organizing the data, one researcher was inputting the data while the rest read aloud numbers and food names. It would have been very easy for an input error or a misreading to have occurred, and because of the nature of the original spreadsheet it would have been near impossible to find and correct any mistake.

Additionally, the qualitative assessment of micronutrient deficiencies is possibly indicative of true deficiencies in diet, and thus an area to look into for future research. Clinical restraints prevented blood work from being done as to find the exact amount of each micronutrient that the community is receiving.

#### *Future Research and Recommendations*

This study should serve as the foundation for the Health Area of Coto Brus and the La Casona EBAIS for future research into the nutritional status of the Ngöbe people. Looking into quantifying the micronutrient analysis through clinical work would allow for a definitive conclusion as to whether nutrient deficiencies exist. Additionally, a longitudinal study should be conducted following the Ngöbe school children, who eat 2 balanced meals daily at school. They could be followed through adulthood to see if and how their diets change. An investigation into

the distribution of food purchased at *pulperías* versus home-grown sources could yield interesting results.

A possible intervention that could help improve the overall nutritional status of the La Casona community is encouraging home-cultivation of vegetables and fruit trees, like banana. Nutrition education classes stressing nutrition impact on health could aid in empowering the community to eat better and live healthier lives. A governmental intervention to subsidize or improve access to dairy and fresh produce could improve overall health status and have an impact on obesity prevalence.

### ***Concluding Points***

Dietary diversity in the Ngöbe community of La Casona is positively correlated with a higher BMI. The burden of obesity is unequally shared between men and women. Adherence to WHO guidelines for food group intake is a useful indicator for potential micronutrient deficiencies and for overall nutritional status.

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## Appendix

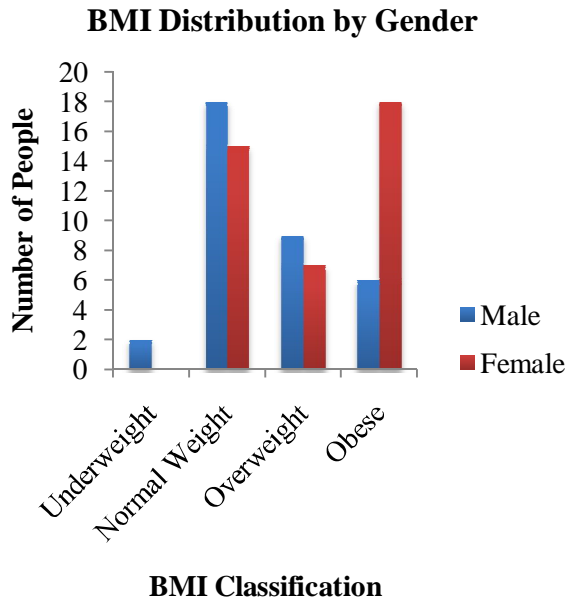


Figure 1. Gender comparison of BMI distribution in La Casona.

## Diversity Within Food Groups

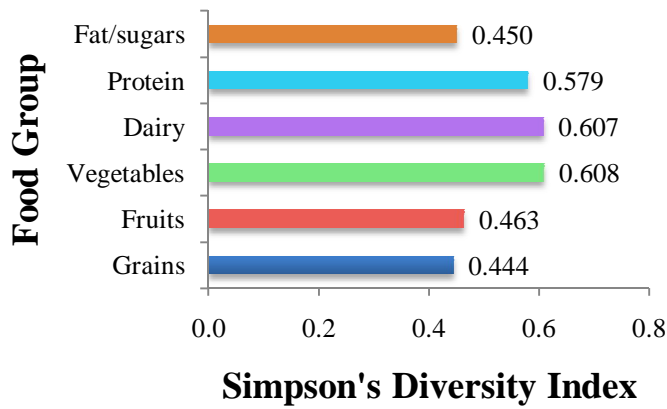


Figure 2. Comparison of diversity within food groups using Simpson's Diversity Index.

## Food Group Consumption in the Ngöbe Community Compared to Recommended Daily Consumption (WHO)

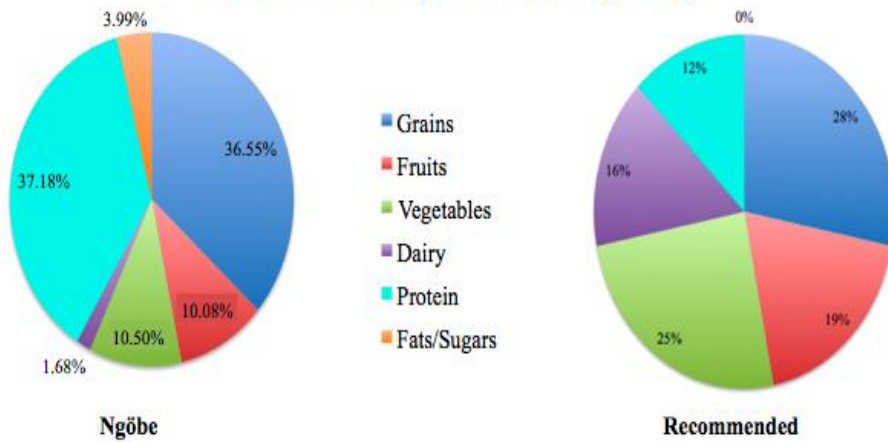


Figure 3: Comparison of Ngöbe food group intake to WHO CINDI recommendations

Grains	Fruits	Vegetables	Dairy	Proteins	Fats & Sugar
Bread	Banana	Chayote	Cheese	Beans	Candy
Cassava	Lime	Chili pepper	Milk	Chicken	Chips
Cracker	Pineapple	Maize	Sour cream	Eggs	Fruit juice
Flour	Plantain	Mixed vegetables		Fish	Soda
Pancake		Tomato		Beef	
Potatoes				Pork	
Rice				Tuna	
Spaghetti					
Tortilla					

Table 1. Dietary richness and domain: Thirty-two food items mentioned, categorized by food group.

Classification	BMI (kg/m <sup>2</sup> )
Underweight	< 18.5
Normal range	18.5 to 24.9
Overweight	25.0 to 29.9
Obese	30+

Table 2: WHO classification body type system based on BMI

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