Dietary Change in Ribeirinha Women:
Evidence of a Nutrition Transition in the Brazilian Amazon?

Thesis

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By
Sofia A. Ivanova, B.A.
Graduate Program in Anthropology

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Thesis Committee:
Barbara A. Piperata, Ph.D., Advisor
Douglas E. Crews, Ph.D.
Kristen J. Gremillion, Ph.D.
Abstract

Research suggests Brazil is undergoing a nutrition transition. However, few studies have examined its occurrence in rural communities in the Amazon. Since the nutrition transition is driven by changes in diet and activity patterns, I compared the dietary intakes of n=54 women collected in 2009, with data on n=23 women in the same communities in 2002. Data were collected over three consecutive days in both 2002 and 2009 using the weighed inventory method. Intakes of energy and all macronutrients were 13-30% lower in 2009. In 2002 mean energy intake was 1805 kcal (32.9g fat, 330g carbohydrates, and 47.6g protein). In 2009 mean energy intake was 1335 kcal (26.4g fat, 232.1g carbohydrates, and 41.9g protein). Energy from fat and protein increased, while energy from carbohydrates decreased. In 2002 local foods provided 65-84% of energy and all macronutrients; in 2009 48% of total energy, 66% of fat, 45% of carbohydrates, 42% of protein came from purchased foods. Manioc products were still the primary source of energy (46.9%) and carbohydrates (65.3%). Local fish was still the primary source of protein (31.4%). The primary source of dietary fat in 2009 was not local fruit, as in 2002, but oil and margarine (23.9%). All local foods except game meat contributed less to the diet in 2009 as intake of purchased foods (beans, rice, baked goods, sugared coffee, oil and margarine, preserved meat, pasta, milk) increased. One factor contributing to the consumption of purchased foods may be receipt of cash from the Bolsa Família program: all receiving households reported spending part of their benefit on food. This
study demonstrates a shift from traditional subsistence toward reliance on income and purchased foods, despite scarce and unreliable opportunities to secure income and purchase food. The population’s rural location and historic marginalization creates problems of access at all steps of the process. They have moved in the direction of a nutrition transition by shifting toward a Western diet and lifestyle, but are unable to participate in a sufficiently permanent and reliable way in the market economy to be able to subsist on those earnings, leaving them in a position of high food insecurity.
Dedication

I dedicate this manuscript to my mother, Anna Dlougoleskaia, who has and will always drive me to succeed, and to my partner, Doc Manning, whose support of my work and studies cannot be overemphasized.
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Vita

June 2002…………………….Myers Park High School
2006……………………………..B.A. English, University of North Carolina, Greensboro
2006……………………………..B.A. Anthropology, University of North Carolina, Greensboro
2009 to present………………...Graduate Teaching Associate, Department of Anthropology, The Ohio State University

Presentations at Professional Meetings

2010…………………………..Dietary Change in Ribeirinha Women: Evidence of a Nutrition Transition in the Brazilian Amazon? Paper at annual meeting of Human Biology Association, Albuquerque, NM.
2008…………………………..What Food Stamp Recipients Expect and What They Get from the Food Stamp Nutrition Education Program. Paper at annual meeting of Society for Applied Anthropology Memphis, TN.
2007…………………………..Immigrant Experiences of Food, Cooking, and Grocery Shopping in the US. Paper at annual meeting of Society for Applied Anthropology in Tampa, FL.

Fields of Study

Major Field: Anthropology
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INTRODUCTION

Economic change driven by exposure to and incorporation into local market systems has been linked around the world with changes in diet, health, and nutritional status (Godoy et al., 2005). Integration into the market affects the source, availability, and cost of, as well as attitudes toward, food. This dietary transition, defined broadly as a shift in food consumption from locally produced plant foods to imported and processed animal foods (Sobal, 1999) was noted by economists as early as the 1940s (Bennett, 1941). These trends, particularly the relationship between industrialization and diet, are part of a larger global phenomenon called the nutrition transition (Popkin, 2001). As Latin America undergoes rapid economic change, countries such as Brazil, with emerging market economies, experience demographic, epidemiologic, and nutrition transitions (Riveira et al., 2004). Rural areas have not escaped change – participation in local markets and wage labor is driving lifestyle changes broadly referred to as Westernization (Doak et al., 2000; Murrieta et al., 1999, 2008; Piperata, 2007; Silva et al., 2006). This paper tests the hypothesis that economic change in the rural Amazon is driving dietary change in the region.

Nutrition Transition

The term nutrition transition refers to a pattern of diet and activity changes associated with transition to a Western lifestyle. It is as a sum of economic, demographic, environmental, and cultural changes (Popkin, 2003). Associated dietary changes include
increased consumption of energy-dense foods, refined carbohydrates, oil, and animal products, in association with reduced fiber, fruit, and vegetable intakes (Popkin, 2001). Edible oil is an important source of additional calories in developing countries, where its consumption typically increases dramatically at the start of the nutrition transition (Popkin, 2003). Increased fat intake in developing countries occurs secondary to increased availability of high-fat, energy-dense foods for purchase (Popkin, 2003). The nutrition transition leads to changes in health and nutritional status and, in some cases, to obesity and associated health risks such as diabetes, hypertension, and cardiovascular disease (Popkin, 2003). Increased prevalence of chronic disease may be related to increased lifespan (Astrup et al., 2008; Popkin and Gordon-Larsen, 2004; Yusuf et al., 2001), which, along with decreased child mortality, has been extensively documented in association with the nutrition transition (Albala et al., 2002; Benjelloun, 2002; Kim et al., 2000; Kosolwat, 2002; Shetty, 2002). Other driving factors include reduction in physical activity and transition to energy-dense diets (Rivera et al., 2004).

The nutrition transition is often linked with the emergence of market economies which bring opportunities for wage labor and market exchange to rural areas. This type of economic change has been linked around the world with changes in diet, health, and nutritional status (Godoy et al., 2005). Globalization, or the worldwide linkage of previously local, national, and regional markets and institutions, is associated with changing incomes and lifestyles (Sobal, 1999). Integration into the global market affects not only the source, availability, and cost of foods but also attitudes toward and desirability of foods (Hawkes, 2006). Opportunities, such as access to food, education, and modern healthcare, that come with the participation of rural populations in an
emerging market economy can lead to better nutrition and healthcare, which directly benefit nutritional status and health (Akin et al., 1985). In one example, economic growth and associated nutrition policy and healthcare changes in Vietnam were linked with an 8% drop in stunting in children (O’Donnell et al., 2009). In other cases, integration into the market economy can have adverse effects on health, which are exacerbated when disruption of traditional subsistence systems undermines the ability of traditional strategies to maintain health (Armelagos, 1990; Coimbra et al., 2002; Lawrence et al., 1980; Wirsing, 1985).

**Nutrition Transition in Latin America and Brazil**

Social, economic, and demographic transformations of the last two decades are linked to changes observed in Latin Americans’ eating patterns and epidemiological profiles (Peña and Bacallao, 2000; Rivera et al., 2004). Latin American countries are at different points of the nutrition transition and characteristics of these transitions are specific from country to country. Globalization and urbanization are having dramatic effects on dietary patterns among Latin America’s traditional populations and many have experienced an increased prevalence of overweight and obesity (Bermudez and Tucker, 2003; Peña and Bacallao, 2000). Percentage of daily energy intake from fat is increasing in low-income urban sectors in many Latin American countries (Bermudez and Tucker, 2003). Foods with high energy density, especially those high in fats and sugars, offer pleasing taste, relatively low cost, and an ability to satiate, making them attractive to the poorest groups (Peña and Bacallao, 2000). Differential diets associated with socioeconomic status were documented in Latin America as early as the 1980’s: processed foods began to dominate the diets of the wealthier segment of the population,
while poorer groups adhered to a more traditional diet of cereals, roots, and vegetables (Bermudez and Tucker, 2003; Tagle, 1988). Over the last two decades a larger portion of the population has entered the market and begun to rely on processed foods (Bermudez and Tucker, 2003).

Major dietary trends in Latin America include declines in consumption of cereals, complex carbohydrates, and fiber, paired with increased consumption of refined foods, animal products, and fats (Albala et al., 2001; Bermudez and Tucker, 2003). Brazil and Mexico have shown large declines in proportion of energy from cereals and increased consumption of animal products at the expense of plant protein (Bermudez and Tucker, 2003; Rivera et al., 2004). Chile has shown a similar trend of more meat and less cereals in the diet (Vio and Albala, 2000). Fat has increased in the Latin American diet, with Brazil showing the most dramatic change in the last 30 years (Albala et al., 2001; FAO, 2001). Changes in consumption of fruits and vegetables are varied – energy contributed by vegetables has declined in Central America, but increased in Brazil and Mexico paired with decreased intake of starchy roots and fruits (Bermudez and Tucker, 2003).

Brazil, in particular, is shifting from a problem of dietary deficit to one of dietary excess linked to urbanization and the involvement of increasing portions of its population in the market economy (Monteiro et al., 2004). Undernutrition was already declining by the 1990s and even the poorest Brazilian women showed a 9.7% prevalence of obesity, no longer protected from overweight by their economic status (Monteiro et al., 1995). While in 1975 there were almost two cases of underweight per one case of obesity, by 1997 the trend reversed, with over two cases of obesity per one case of underweight (Monteiro et al., 2004). By the 1990s, Brazilian low-income women were more
susceptible to both underweight and obesity than high-income women, reflecting the
effects of economic transition on low-income populations (Monteiro et al., 2004). These
and other studies build a convincing case to show that Brazil is undergoing a nutrition
transition.

While undernutrition, not yet eradicated completely, is declining in most Latin
American countries, rates of non-communicable chronic diseases are increasing, likely
due to dietary changes (Campos et al., 1991; DeStefani et al., 1997, 2001; Ford and
Mokdad, 2001; Marshall et al., 1991; Schaefer, 2002; Williams et al., 1999) and
increased life span (Astrup et al., 2008; Bermudez and Tucker, 2003; Popkin and
important to characterize these changes and understand their potential effects on the
development and progression of chronic diseases if Westernization and urbanization are
to have a positive effect on the health of indigenous and rural populations. In many cases,
countries undergoing these transitions face a double burden as increased chronic diseases
are affecting health systems still coping with malnutrition and infectious disease
(Bermudez and Tucker, 2003).

**Nutrition Transition in the Amazon**

While the nutrition transition is better documented in urban settings, studies
investigating the nutrition transition globally warn of rapid increase in poor diets,
se dentism, and obesity in poor, rural populations (Popkin, 2003). Studies show that rural
Ribeirinho communities are changing economically: participation in wage labor and
involvement in the local market is increasing, and some households are now receiving
cash from the *Bolsa Família* conditional cash transfer program (Murrieta et al., 1999,
Most studies assessing nutritional status in *Ribeirinhos* use anthropometric indicators (height- and weight-for-age). These are reasonably reliable indicators for assessing deprivation and poverty in developing countries, making them well suited to examining food security, nutrition, and health (Heltberg, 2009). However, directly measuring diet provides a more direct way of examining these aspects.

Because of their remote location, *Ribeirinhos*, whose economic conditions are quickly changing, are often overlooked by larger national surveys of health, nutritional status, and food insecurity. A review of existing literature strongly suggests that this population may be undergoing a nutrition transition. Longitudinal studies such as this are the key to tracking the economic and dietary changes taking place in the rural Amazon.

**Traditional populations in the Brazilian Amazon**

Traditional populations in the Brazilian Amazon demonstrate a broad range of subsistence practices and vary significantly in primary crops and prey utilized (Milton et al., 1991). This variation has confounded single-factor models attempting to explain dietary ecology in the Amazon (Gross, 1975; Meggers, 1954, 1971). Historically, a highly variable diet with fluctuating nutritional content was common among traditional Amazonian populations practicing slash-and-burn agriculture and depending on starchy crops as the principal source of calories and meat and fish as the main sources of protein (Boza and Baumgartner 1962; Coimbra, 1985; Coimbra et al., 2002; Dufour, 1983; Flowers 1983; Hodges and Dufour, 1991; Lizot, 1977; Smole, 1986; Werner, 1983).

Based on BMI – weight (kg)/height (m²) (Susanne and Bodzsár, 2004) – and assessment of clinical signs of undernutrition, nutritional status of adults in traditional Amazonian
groups is generally considered to be adequate at least in energy and macronutrients (Dufour, 1992, 1995; Holmes and Clark, 1992). Some scholars have suggested that nutritional status among indigenous Amazonian populations is highly variable and on the whole poorer than that of the rest of the Brazilian population (Santos, 1993; Santos and Coimbra, 1994, 1998). Many native Amazonian children display undernutrition, expressed by low height-for-age growth curves and a reduction in attained stature in adulthood; however they are usually within normal range of weight-for-height (Dufour, 1983, 1994; Flowers, 1983; Oritz, 1981; see Berlin and Markell, 1977; Holmes, 1985; Jelliffe, 1966 for exceptions). Particularly in groups whose diets are based on boiled and baked manioc and manioc beer (high in bulk but low in energy density) the volume of food young children must consume to meet their energy and nutrition needs is a potential constraint for their growth and development (Dufour, 1994). Disease stress and parasite load play important roles as well (Benefice and Barral, 1991; Dufour, 1994). Some of these trends continue today; however, many indigenous groups now mix traditional and Western dietary practices (Montenegro and Stephens, 2006).

**Ribeirinhos of the Brazilian Amazon**

*Ribeirinhos*, also referred to as Caboclos, of the Brazilian Amazon are a population of mixed ethnicity peasants (Indigenous Amazonian, European, and African). They have been described as a product of the destruction of native Amerindian societies and the influence of market economies on rural populations (Schmink, 2003). They are no longer traditional subsistence farmers but are not quite agriculturalists or modern workers (Schmink, 2003). *Ribeirinhos* live in small communities and towns that fall along a continuum from rural to urbanized (Piperata, 2007; Piperata and Dufour, 2007).
At the turn of the 21st century, the *Ribeirinho* economy was based on fishing, hunting, slash-and-burn and intensive agriculture, and extraction and commercialization of forest products – a mix of Amerindian subsistence strategies and European social institutions (Moran, 1974; Parker 1985).

For the most part this description is still true of *Ribeirinho* communities today, with a greater emphasis on commercialization and participation in local markets (Murrieta et al., 1999; Piperata, 2007). The population relies on the same staple crops and resources. However, differential participation in markets and sparse employment opportunities (Pollard et al., 1991), receipt of cash from the *Bolsa Familia* conditional cash transfer program (Lindert et al., 2007; Sousa and Santos, 2009), and, in some cases, seasonality (Silva et al., 2006) affect the degree to which individual households rely on purchased foods. Their overall economic conditions tend to be characterized by stagnation punctuated by an occasional boom fueled by extraction of forest commodities (Schmink, 2003). In 2002, 100% of the households assessed in the present study reported trading for food and household products in *farinha*, and 20% reported trading in *açaí*. Males in a few households were working in wage-labor jobs (Piperata, 2007). Another study in the same communities in the same time period reported 19% of total energy intake coming from purchased foods (Murrieta et al., 2008).

Despite representing the largest proportion of the Amazonian population, *Ribeirinhos* have been largely ignored in academic research in the Amazon in favor of native and urban groups (Nugent, 1993). Some scholars argue that they have been assigned a passive role in social dynamics of the Amazon because their various and non-
specialized livelihoods make them largely insignificant in national economics and trade (Nugent, 1993). However, their role in the extraction of forest commodities represents a vital part of the regional economy and development (Moran, 1981; Nugent, 1993; Parker, 1985). Culturally, *Ribeirinhos* tend to be associated with backwardness and underdevelopment and are victims of negative racial and cultural stereotypes which sometimes affect perspectives on their society (Nugent, 1993). Nearly half a century ago, Wagley (1964) attributed sustained malnutrition, preventable and treatable illness, and lack of development in the Amazon to economic and cultural factors. Because this population, largely invisible in Amazonian academic literature, represents a large portion of the Amazonian population and now plays a prominent role in Brazil’s emerging market economy, their changing lifestyle, health, and economic activities should be considered in current Amazonian studies. Studies of diet and activity pattern changes among rural Amazonian *Ribeirinhos* are few (Adams, 2007; Piperata, 2007)), but most report signs of a nutrition transition (Murrieta et al., 1999, 2008; Piperata, 2007; Silva et al, 2006). Murrieta et al. (2008) confirm the central roles of fish, manioc, and *açaí* in the diet of *Ribeirinhos* in some of the communities included in the present study (13.9%, 43.7%, and 17% of energy, respectively). However, Murrieta et al. (2008) also stress the important roles of sugar and other industrialized products (6.3% energy is derived from sugar, 15% from “other” sources which include purchased industrialized items such as beans, oil, and margarine). Several studies in the rural Amazon among *Ribeirinhos* over the last decade show an introduction of industrial, processed foods into the diet (Murrieta et al., 1999; Piperata, 2007; Silva et al., 2006). While the population still relies heavily on agriculture (foods obtained through agricultural activities represent 35.9% of total energy
intake) and local social and economic networks (gifts of food contribute 10.9% of total energy) for subsistence, Murrieta et al. (2008) suggest that a nutrition transition and erosion of local subsistence systems are responsible for the high reliance on non-local foods (19% of total energy intake). The importance of social networks to resource acquisition has been documented (Santos and Coimbra, 1998).

Few recent studies look for signs of a nutrition/dietary transition from the perspective of physical indicators of health; most focus on children (Silva and Crews, 2006). However, there is indication that overall health and nutrition has improved in the last 50 years (Silva and Padez, 2006). In the same Ribeirinho communities assessed by the present study Piperata (2007) found a high incidence of stunting in adults (60% of males and 70% of females). She also demonstrated that the nutritional status of adult males participating in wage labor (working consistently outside the home for at least 4 months of the year) showed signs of a nutrition transition (Piperata, 2007). Adult males participating in wage labor had significantly higher weight, BMI, upper-arm muscle area, and percent body fat than adult males not participating in wage labor. Rates of obesity in these adult Ribeirinho men are similar to the recent national average. Piperata (2007) demonstrated a correlation between obesity and lifestyle changes—especially in diet and activity—largely driven by participation in wage labor.

The Ribeirinhos have a long history of flexibility with the market – since the late 1800s they have moved between cycles of economic “booms” followed by retreat to subsistence agriculture (Parker, 1985). In recent years, funds from Bolsa Família, a conditional cash transfer program and major driver of economic and dietary changes
(discussed in greater detail later), have begun to orient Brazilian Amazonian economies toward the market (Hall, 2006; Sousa and Santos, 2009). *Bolsa Família* may represent a new “boom” in the cycle of *Ribeirinho* economy. However, it is also possible that this population is too permanently integrated into the local market economy to return to a subsistence-based economy as they have in the past should support be cut off.

**Bolsa Família**

Conditional Cash Transfer programs aim to reduce poverty by making receipt of funds conditional on the beneficiary’s actions, usually regarding health or education (Nigenda and Golzález-Robledo, 2005). Brazil’s *Bolsa Família* program is the largest conditional cash transfer program in the world (Hall, 2006), having reached over 11 million households in 2006 (Soares et al., 2007). This program emerged in 2004 from a merger of existing conditional and unconditional cash transfer programs: *Bolsa Escola*, *Bolsa Alimentação*, *Fome Zero*, and *Vale Gás*. The goal of *Bolsa Família* is to reduce short-term poverty by providing direct cash transfers to poor (defined as having a household income below R$ 129, or US$ 66, per capita) and extremely poor (household income below R$ 60, US$ 33) households. Its long-term goal is to break the intergenerational cycle of poverty by investing in children’s health and education.

Conditionalities attached to the receipt of funds include keeping children 6-15 years of age in school, regular checkups and immunizations for children up to six years, and regular checkups for pregnant women (Lindert et al., 2007). Both poor and extremely poor households are eligible to receive R$ 18 (US$ 10) for each pregnant woman and each child under 6 years to a maximum of three children. Extremely poor households are also eligible for an additional benefit of R$ 58 (US$ 32). The maximum benefit for poor
households is R$ 54 (US$ 30) and for extremely poor households, R$ 112 (US$ 61) (Soares et al. 2007). Payments are made preferentially to women, as international experience and early tests of the program suggest that women were more likely to invest the additional income into improving the health and education of their families, particularly children (Lindert et al., 2007).

Major criticisms of Bolsa Família stress its insufficient coverage and inclusion of non-eligible households in the program. An estimated 59% of eligible households do not receive benefits, and 49% of households receiving benefits do not qualify (Soares et al., 2007). Few studies have explored the program’s effectiveness in achieving its stated goals (Hall, 2006; Sousa and Santos, 2009). There is a concern that instead of breaking the cycle of poverty the program is creating a permanent population economically dependent on the government (Hall, 2006). Because home visits, especially in rural areas, can present costly logistic difficulties, data on program outcomes are often collected in public locales or formal offices (Lindert et al., 2007). This strategy exploits opportunities offered by vaccination campaigns, which mobilize a large portion of the poor and extremely poor population and create a large, but non-random study group (Soares et al., 2007; Sousa and Santos, 2009). According to the few studies available, no significant impact on child health or immunizations was noted, despite the program’s focus on health (Soares et al., 2007). Although Bolsa Família has increased awareness about the importance of public health services and child immunizations, access to health services is limited in many areas, such as rural parts of the Amazon (Soares et al., 2007). A major critique of the program is that sufficient infrastructure does not exist to enable compliance with conditionalities (Soares et al., 2007).
This study is taking advantage of the few available pre-\textit{Bolsa Família} assessments of this population and comparing that data with post-\textit{Bolsa Família} conditions seven years later to identify dietary changes occurring secondary to economic and social change in the rural Amazon. I examine how women’s dietary intakes have changed in the seven years since initial data collection by comparing energy and macronutrient intakes and dietary contributions of specific foods as well as local and purchased food sources. I anticipate finding 1) increased intake of energy, 2) increased intake of all macronutrients, with fat showing the greatest increase, 3) increased consumption of oil, animal products, and refined carbohydrates, 4) decreased consumption of fruits and vegetables, and 5) increased reliance on purchased foods. If true, this indicates that Ribeirinha women are experiencing a nutrition transition. I also anticipate finding that 6) households receiving \textit{Bolsa Família} benefits will show these changes to a greater degree, as receiving the \textit{Bolsa Família} benefit increases their ability to purchase food. Questions examined include: What dietary changes occurred in this population? Are observed changes indicative of a nutrition transition? This study tests the hypothesis that Ribeirinha women are experiencing a nutrition transition.
MATERIALS AND METHODS

Field Site and Subjects

Study participants were self-identified Ribeirinhos living in seven communities in and around the Caxiuanã National Forest in the Brazilian State of Pará (Fig. 1). The communities were rural, located 8–10 hours by small motorboat from the nearest town, Portel, and two days by much larger boat from Belém, the state capital. In 2002, 42% of families had access to electricity via solar panels or generators, and water for cooking was collected from the river or, in a few cases, hand-dug wells (Piperata, 2007). In 2009, 66% of families used electricity to power lights, televisions, and stereos in the evenings. While some had access to well-water, most collected water from the river. Few had access to running water or pit toilets in 2002, using the forest and river for waste disposal (Piperata, 2007). This situation had not changed considerably in 2009. Trash was still burned, buried, or dumped in the river. Homes sat on stilts, and were made of wood and covered with palm fronds, ceramic tile, or an industrialized, fire retardant material referred to as Brasilite. Most were approximately 300 square feet and consisted of three small rooms, including a kitchen, bedroom, and living room. At night, all living space was converted into bedrooms as people hung their hammocks to sleep.

In 2002, the local population practiced traditional slash and burn agriculture with bitter manioc as their staple crop, consumed primarily in the form of farinha, a toasted
meal. Manioc was the most important source of energy in the diet; local fish and hunted game were the main sources of protein, and açai (*Euterpe oleracea*), a local palm fruit consumed primarily in the form of a juice and an important source of dietary fat, provided an additional seasonal source of nutrients (Murrieta and Dufour, 2004; Piperata, 2005, 2007). The population cultivated, fished, hunted, and collected the majority of the food they consumed. They were also involved in and dependent upon the regional market economy primarily through the trade of *farinha* and *açai*, either in the town of Portel or with traveling boat merchants (*regatão*). Through this trade they acquired industrialized food products such as sugar, coffee, cooking oil, and salt, and non-food items such as soap and motor oil. Some males were working wage-labor jobs created by the scientific field station operated by the Goeldi Museum [Estação Científica Ferreira Penna (ECFPn)] and in small-scale timber extraction. In general, ECFPn work was not as physically demanding as timber extraction, and included activities such as grounds keeping, laundry, cooking, and serving as motor boat drivers or field guides and assistants for visiting researchers. Timber extraction jobs included activities such as clearing forests, cutting trees, and operating equipment.

Fig. 1. Map of the field site. Image taken from Piperata 2007.
In 2009, the local population still cultivated manioc and fished, hunted, and collected some of the food they consumed. However, they were actively involved in and dependent upon the regional market economy to a greater extent than in 2002. Participation in the market and wage labor had increased, as had the repertoire of industrialized food products that were obtained regularly from Portel or the *regatão*. As in 2002, males in some households were employed in wage-labor jobs by the ECFPn and small-scale timber extraction operations. However, in 2009 the majority of households were receiving cash from the *Bolsa Família* program, which did not exist in 2002. This cash income, as well as sale of *farinha* and *açaí*, further increased their involvement in and dependence on the market economy.

**Study Design**

The data reported were collected as part of a longitudinal study of diet change in Ribeirinha women in 2002 and 2009. In both time periods, female heads of households living in seven rural communities located within 30 miles (2 hours by speedboat) of the *Ferreira Penna* Research Station in the *Caxiuana* National Forest were invited to participate in the study. In 2002, data were collected over a 22-month period when the researcher (Barbara Piperata) lived in the seven rural communities. A total of 23 women participated; 18 women, aged 17-37, are included in this analysis. In 2009, data were obtained over a 10-week period between April and July. A researcher visited each household for approximately 5 hours per day, observing mealtimes, food preparation, and processing. Fifty-four women participated in the study; 52 women, aged 20-66, were included in the final analysis.
Data Collection

In both 2002 and 2009, quantitative and qualitative data on dietary intake were collected over three consecutive days with each woman, using the weighed inventory method (Gibson, 1990). Everything the woman ate was weighed, recipes for all prepared foods were documented, and all ingredients weighed. Any unconsumed portions were subtracted from daily intake. A Hanson 500-gram rotating dial dietetic scale was used to weigh all foods and ingredients in 2002; a Hanson 1,000-gram rotating dial dietetic scale was used in 2009; measurements were rounded to the nearest gram in both time periods. In 2002, the researcher remained in continuous contact with the woman throughout the day, minimizing the potential for underreporting or failure to report intake. As a researcher was not in the household for the entire day in 2009, interviews were used to reconstruct the ingredients, recipes, and weights in cases when food was prepared or consumed without a researcher present. In both 2002 and 2009 formal and informal interviews were conducted with adult men and women. Participant observation was used to gather ethnographic and economic information, such as employment and, in 2009, receipt of cash from *Bolsa Família*.

In 2002, food composition tables (FAO food composition table for Latin American Foods; Franco, 2003) and nutritional analysis software (NutriBase 5) were used to calculate the energy and macronutrient composition of all foods consumed. In 2009 nutritional information on individual food items was obtained from Brazilian and US food composition databases in the following order of preference: Tabela Brasileira de Composição de Alimentos (2006), Tabela de Composição de Alimentos da Amazônia (1998), Franco (2003), Tabela Brasileira de Composição de Alimentos (2008), and
NutriBase 8 Professional Nutrition and Fitness Software, Professional Edition. In both time periods, total daily energy (kcal), carbohydrate (g), protein (g) and fat (g), intakes were calculated for each woman for each day nutritional analysis software (NutriBase 8).

In 2002, data collection methods were approved by the Human Research Committee at University of Colorado, Boulder (HRC #1001.2), the Comite de Ética at the Universidade de São Paulo, Brazil, and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brasilia, Brazil. In 2009, data collections methods were approved by the Human Research Committee at the Ohio State University Institutional Review Board at The Ohio State University (IRB # 2009B0056) and the Comite de Ética at the Universidade de São Paulo, Brazil.

**Data Analysis**

I hypothesized that, compared to 2002, women in 2009 will show 1) increased intake of energy, 2) increased intake of all macronutrients, with fat showing the greatest increase, 3) increased consumption of oil, animal products, and refined carbohydrates, 4) decreased consumption of fruits and vegetables, and 5) increased reliance on purchased foods. Lastly, 6) households receiving Bolsa Família benefits will show these changes to a greater degree.

To test the first and second hypotheses, descriptive statistics were calculated for energy and macronutrient intakes from 2002 to 2009. Independent sample Student’s t-tests were used to identify differences between means over time. Paired t-tests were used to identify differences between means of the sub-sample of women who participated in both the 2002 and 2009 study periods. This longitudinal component of the study allowed
me to test change over time more precisely by comparing dietary change in the same individuals.

In order to test the third and fourth hypotheses, energy and macronutrient contributions to women’s diets of all food items (including ingredients of prepared dishes) were calculated. Food items were then grouped into sixteen categories: açaí, manioc products, fruits and vegetables other than açaí and manioc, broths, eggs, fish, baked goods, beans, coffee, pasta, oil and margarine, local meat, purchased meat, milk, rice, and other purchased foods. For the purposes of testing the third and fourth hypotheses, soybean oil and margarine were included under the category of “oil.” All locally-hunted game meats (including paca, agouti, coati, alligator, turtle, sloth, monkey, and wild deer and pig) and all purchased meats (including a dried, salted, fatty beef product referred to as charque, a bologna-like pork and beef product referred to as Mortadella, and tinned beef) but not fish were included in the category “animal products.” Sugar, flour, and all baked goods (salty and sweet) were grouped as “refined carbohydrates.” Manioc and açaí were initially calculated separately from other fruits and vegetables due to their significance in the local diet, but all fruits and vegetables were counted together to assess the validity of the second hypothesis. An “other” category included purchased foods – tinned sardines in oil, popcorn, candy, soy protein, cornmeal, sweet carbonated beverages, and industrial hot chocolate mix – that were rarely seen in the diet. Energy and macronutrient contributions of these food categories were calculated and analyzed as a ratio of total energy and macronutrient intake to identify major contributors of energy, carbohydrates, protein, and fat.
To test the fifth hypothesis, the energy and macronutrient contribution of all foods and recipe ingredients consumed, using the method described above, were calculated and coded “local” or “purchased” based on their source. All foods obtained locally through hunting, foraging, or agricultural efforts, without the exchange of money, goods, or labor, were considered local. Foods that were purchased in town, from the *regatão*, or neighbors, including industrial foods (sugar, oil, powdered milk, etc.) and locally manufactured foods sold for cash (locally baked breads, and in the case of some households, *farinha*) were considered purchased. The energy and macronutrient contributions of these local and purchased food categories were analyzed as a ratio of total energy and macronutrient intake. Independent sample t-tests were used to identify differences in the contribution of purchased and local foods in 2002 and 2009. Paired sample t-tests were used to compare differences across time between the contributions of these foods to diets of the sub-sample of women who participated in both time periods.

To test the sixth hypothesis, independent sample t-tests were used to identify differences between the energy and macronutrient intakes in 2009 of women in *Bolsa Família* beneficiary household and those who did not receive benefits. Wage-earning households were not separated from non-wage-earning households because they were few, and many still qualified for the *Bolsa Família* benefit. A larger sample would be needed to meaningfully compare households while accounting for both variables. SPSS 18 was used for all statistical analyses.
RESULTS

In 2002, average daily energy intake was 1805 ± 463 kcal, obtained from 330 ± 81.9 g carbohydrate (73%), 47.6 g protein (11%) and 32.9 g fat (16%) (Table 1). In 2009, energy intake was 1335 ± 428 kcal – 232.1 ± 79.5 g carbohydrate (70%), 41.9 ± 15.2 g protein (13%), and 26.4 ± 13.7 g fat (17%). Mean energy (1805.2 ± 462.6 kcal in 2002 to 1335.3 ± 427.9 kcal in 2009; t=3.93; p < .01) and carbohydrate (330 ± 81.9 g to 232.1 ± 79.5 g; t=4.47; p < 0.01) intakes and mean percent energy obtained from carbohydrates (73.4 ± 4.2% to 69.5 ± 9.2%; t=2.38; p = 0.02) were significantly lower in 2009 than in 2002. Mean percent energy obtained from protein was significantly higher (10.8 ± 2.4% to 12.9 ± 4%; t=-2.62; p = 0.01).

Women who participated in both time periods also showed a significant decrease in energy (1692.9 ± 347.2 kcal in 2002 to 1326.9 ± 361.3 kcal in 2009; t=2.19; p = 0.05) and carbohydrate (314.6 ± 69.2 g in 2002 to 230.3 ± 69.6 g in 2009; t=2.64; p = 0.02) intake over time (Table 2). Energy obtained from carbohydrates significantly decreased (74.3 ± 3.8 g in 2002 to 69 ± 8.7 g in 2009; t=2.16; p = 0.05) while energy from proteins significantly increased (11.5 ± 2.6 g in 2002 to 14.6 ± 5.4 g in 2009; t=-2.25; p = 0.05). No significant differences were recorded in fat or protein intake or in energy from fat.
### TABLE 1. Daily energy, macronutrient intakes of women in 2002 (n=18) and 2009 (n=52)

<table>
<thead>
<tr>
<th></th>
<th>2002 Mean ± SD</th>
<th>2009 Mean ± SD</th>
<th>t-test, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>1805.2 ± 462.6</td>
<td>1335.3 ± 427.9</td>
<td>t = 3.93; p = 0.00</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>330.0 ± 81.9g</td>
<td>232.1 ± 79.5g</td>
<td>t = 4.47; p = 0.00</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>47.6 ± 12.5g</td>
<td>41.9 ± 15.2g</td>
<td>t = 1.43; p = 0.16</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>32.9 ± 14.9g</td>
<td>26.4 ± 13.7g</td>
<td>t = 1.71; p = 0.09</td>
</tr>
<tr>
<td>Energy (kcal) from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>73.4 ± 4.2%</td>
<td>69.5 ± 9.2%</td>
<td>t = 2.38; p = 0.02</td>
</tr>
<tr>
<td>Energy (kcal) from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>10.8 ± 2.4%</td>
<td>12.9 ± 4.0%</td>
<td>t = -2.62; p = 0.01</td>
</tr>
<tr>
<td>Energy (kcal) from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>15.9 ± 4.3%</td>
<td>17.5 ± 7.8%</td>
<td>t = -0.83; p = 0.41</td>
</tr>
</tbody>
</table>

### TABLE 2. Daily energy, macronutrient intake of women participating in 2002 and 2009 (n=12)

<table>
<thead>
<tr>
<th></th>
<th>2002 Mean ± SD</th>
<th>2009 Mean ± SD</th>
<th>t-test, time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>1692.9 ± 347.2</td>
<td>1326.9 ± 361.3</td>
<td>t = 2.19; p = .05</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>314.6 ± 69.2</td>
<td>230.3 ± 69.6</td>
<td>t = 2.64; p = .02</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>47.7 ± 11.7</td>
<td>46.6 ± 16.4</td>
<td>t = 0.21; p = .84</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>26.7 ± 7.9</td>
<td>24.1 ± 10.5</td>
<td>t = 0.64; p = .54</td>
</tr>
<tr>
<td>Energy (kcal) from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>74.3 ± 3.8</td>
<td>69.0 ± 8.7</td>
<td>t = 2.16; p = .05</td>
</tr>
<tr>
<td>Energy (kcal) from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td>11.5 ± 2.6</td>
<td>14.6 ± 5.4</td>
<td>t = -2.25; p = .05</td>
</tr>
<tr>
<td>Energy (kcal) from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fat</td>
<td>14.0 ± 3.7</td>
<td>16.2 ± 5.0</td>
<td>t = 1.25; p = .24</td>
</tr>
</tbody>
</table>

### TABLE 3. Comparison of source (local vs. purchased) of energy and macronutrient intake of women in 2002 (n = 18) and 2009 (n = 52)

<table>
<thead>
<tr>
<th></th>
<th>2002 Mean ± SD</th>
<th>2009 Mean ± SD</th>
<th>t-test, p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1475.2 ± 396.0</td>
<td>683.1 ± 463.9</td>
<td>t = 6.47; p &lt; .01</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>283.9 ± 78.8</td>
<td>128.5 ± 97.3</td>
<td>t = 6.11; p &lt; .01</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>37.6 ± 13.0</td>
<td>24.2 ± 17.1</td>
<td>t = 3.03; p &lt; .01</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>20.5 ± 8.6</td>
<td>7.8 ± 8.7</td>
<td>t = 5.38; p &lt; .01</td>
</tr>
<tr>
<td>Purchased Sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>345.8 ± 295.1</td>
<td>667.0 ± 480.1</td>
<td>t = -3.34; p &lt; .01</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>50.0 ± 43.3</td>
<td>106.0 ± 92.2</td>
<td>t = -3.42; p &lt; .01</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>10.7 ± 9.7</td>
<td>17.9 ± 15.7</td>
<td>t = -2.29; p = .03</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>11.7 ± 11.1</td>
<td>18.9 ± 14.6</td>
<td>t = -1.90; p = .06</td>
</tr>
<tr>
<td>Contribution of Local foods (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>79.8 ± 15.3</td>
<td>52.1 ± 30.6</td>
<td>t = 4.99; p &lt; .01</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>83.7 ± 12.7</td>
<td>55.2 ± 34.4</td>
<td>t = 5.07; p &lt; .01</td>
</tr>
<tr>
<td>Protein</td>
<td>75.6 ± 21.9</td>
<td>58.4 ± 35.2</td>
<td>t = 2.42; p = .02</td>
</tr>
<tr>
<td>Fat</td>
<td>65.0 ± 26.6</td>
<td>34.3 ± 31.1</td>
<td>t = 3.73; p &lt; .01</td>
</tr>
<tr>
<td>Contribution of Purchased foods (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>20.2 ± 15.3</td>
<td>47.9 ± 30.6</td>
<td>t = -4.99; p &lt; .01</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>16.3 ± 12.7</td>
<td>44.8 ± 34.4</td>
<td>t = -3.43; p &lt; .01</td>
</tr>
<tr>
<td>Protein</td>
<td>24.5 ± 21.9</td>
<td>41.6 ± 35.2</td>
<td>t = -2.41; p = .02</td>
</tr>
<tr>
<td>Fat</td>
<td>35.0 ± 26.6</td>
<td>65.7 ± 31.1</td>
<td>t = -3.73; p &lt; .01</td>
</tr>
</tbody>
</table>
Significant decreases were observed over time in energy (1475.2 ± 396 kcal in 2002 to 683.1 ± 463.9 kcal in 2009; t=6.47; p < 0.01), carbohydrate (283.9 ± 78.8g to 128.5 ± 97.3g; t=6.11; p < 0.01), protein (37.6 ± 13g to 24.2 ± 17.1g; t=3.03; p < 0.01), and fat (20.5 ± 8.6g to 7.8 ± 8.7g; t=5.38; p < 0.01) from locally obtained food sources (Table 3). Significant increases over time were observed in energy (345.8 ± 295.1 kcal to 667 ± 480.1 kcal; t=-3.34; p < 0.01), carbohydrate (50 ± 43.3g to 106 ± 92.2g; t=-3.42; p < 0.01), and protein (10.7 ± 9.7 to 17.9 ± 15.7g; t=-2.29; p = 0.03) from purchased food sources. The decrease in fat and protein intake, increase in percent energy obtained from fat, and the increase in fat from purchased sources were not statistically significant.

For the longitudinal group a significant decrease over time was observed in energy (1409.1 ± 432.1 kcal in 2002 to 798 ± 476.3 kcal in 2009; t=3.14; p < 0.01), fat (18.6 ± 9g to 9.8 ± 8.8g; t=2.83; p = 0.02), and carbohydrate (269.2 ± 84g to 145.3

### TABLE 4. Comparison of source (local vs. purchased) of energy and macronutrient intake of women participating in 2002 and 2009 (n = 12)

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2009</th>
<th>Paired sample t-test, time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td>t-value</td>
</tr>
<tr>
<td>Local Sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>1409.1 ± 432.1</td>
<td>798.0 ± 476.3</td>
<td>3.14; p &lt; .01</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>269.2 ± 84.0</td>
<td>145.3 ± 103.1</td>
<td>2.98; p = .01</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>39.7 ± 13.5</td>
<td>31.7 ± 19.8</td>
<td>1.40; p = .19</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>18.6 ± 9.0</td>
<td>9.8 ± 8.8</td>
<td>2.83; p = .02</td>
</tr>
<tr>
<td>Purchased Sources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>283.8 ± 272.0</td>
<td>528.8 ± 388.3</td>
<td>-2.04; p = .07</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>45.3 ± 44.0</td>
<td>85.0 ± 73.5</td>
<td>-1.74; p = .11</td>
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<tr>
<td>Protein (g)</td>
<td>8.0 ± 8.6</td>
<td>14.9 ± 12.3</td>
<td>-1.84; p = .09</td>
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<tr>
<td>Fat (g)</td>
<td>8.2 ± 7.7</td>
<td>14.3 ± 9.5</td>
<td>-1.99; p = .07</td>
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<tr>
<td>Contribution of Local foods (%)</td>
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<td></td>
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</tr>
<tr>
<td>Energy</td>
<td>80.1 ± 17.8</td>
<td>59.2 ± 29.5</td>
<td>2.23; p = .05</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>83.1 ± 14.8</td>
<td>59.4 ± 35.5</td>
<td>2.13; p = .06</td>
</tr>
<tr>
<td>Protein</td>
<td>78.8 ± 22.8</td>
<td>66.9 ± 32.8</td>
<td>1.19; p = .26</td>
</tr>
<tr>
<td>Fat</td>
<td>65.8 ± 30.5</td>
<td>43.3 ± 33.6</td>
<td>2.15; p = .06</td>
</tr>
<tr>
<td>Contribution of Purchased foods (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>19.9 ± 17.8</td>
<td>40.8 ± 29.8</td>
<td>-2.23; p = .05</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>16.9 ± 14.8</td>
<td>40.6 ± 35.5</td>
<td>-2.13; p = .06</td>
</tr>
<tr>
<td>Protein</td>
<td>21.3 ± 22.7</td>
<td>33.1 ± 32.8</td>
<td>-1.18; p = .26</td>
</tr>
<tr>
<td>Fat</td>
<td>34.2 ± 30.5</td>
<td>56.7 ± 33.6</td>
<td>-2.15; p = .06</td>
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</table>
±103.1g; t=2.98; p = 0.01) intake obtained from local food sources (Table 4). There was a
significant decrease over time in percent energy obtained from local foods (80.1 ± 17.8%
to 59.2 ± 29.5%; t=2.23; p = 0.05) and a significant increase in percent energy obtained
from purchased foods (19.9 ± 17.8 to 40.8 ± 29.8; t=-2.23; p = 0.05). There were no
statistically significant changes in mean protein obtained locally, in energy and
macronutrients obtained from purchased foods, or in percent fat, carbohydrate, or protein
obtained locally or from purchased sources.

In 2002, local manioc-based products were the main source of energy (48.8%),
followed by local fruit including açai (19.6%) and fish (6.8%), purchased beans (5.2%)
and rice (4.2%), and local game meats (3.4%) (Table 5). In 2009, manioc was purchased
by some households but remained the main source of energy (46.9%), however the
contribution of fruit (5.9%) and fish (5.4%) decreased, and beans (8.1%), rice (6.9%),

<table>
<thead>
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<tbody>
<tr>
<td><strong>2002 Energy (kcal)</strong></td>
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<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Manioc 48.8</td>
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<tr>
<td>Fruit 19.6</td>
</tr>
<tr>
<td>Fish 6.8</td>
</tr>
<tr>
<td>Beans 5.2</td>
</tr>
<tr>
<td>Rice 4.2</td>
</tr>
<tr>
<td>Game meat 3.4</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td>TOTAL 88%</td>
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<tbody>
<tr>
<td><strong>2002 Carbohydrates</strong></td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Manioc 64.9</td>
</tr>
<tr>
<td>Fruit 18.6</td>
</tr>
<tr>
<td>Rice 4.3</td>
</tr>
<tr>
<td>Sugared Coffee 4.2</td>
</tr>
<tr>
<td>Beans 4.2</td>
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<tr>
<td>TOTAL 96.3%</td>
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</table>
baked goods such as bread and crackers (6.2%), sugared coffee (4.5%), and oil and margarine (4.2%) became key sources of energy.

In 2002, the main sources of carbohydrates were manioc products (64.9%), followed by fruit (18.6%), rice (4.3%), sugared coffee (4.2%), and beans (4.2%) (Table 6). In 2009, manioc remained the major source of carbohydrates (65.3% - exceeding its 2002 value) and the contribution of fruit (5.4%) decreased while purchased foods – rice (7.5%), sugared coffee (6.3%), baked goods 6.3%), and beans (5.9%) – provided a large proportion of carbohydrates.

In 2002 the main source of protein was fish (40.4%), followed by game (16.6%) and purchased meat (3.6%), beans (11.4%), fruit (9.1%), manioc (7.5%), and rice (3.1%) (Table 7). In 2009, fish remained the major source of protein (31.4%) though its contribution was reduced. The contributions of local (19.5%) and purchased meat

<table>
<thead>
<tr>
<th>2002 Protein</th>
<th>2009 Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>40.4</td>
</tr>
<tr>
<td>Game meat</td>
<td>16.6</td>
</tr>
<tr>
<td>Beans</td>
<td>11.4</td>
</tr>
<tr>
<td>Fruit</td>
<td>9.1</td>
</tr>
<tr>
<td>Manioc</td>
<td>7.5</td>
</tr>
<tr>
<td>Purchased meat</td>
<td>3.6</td>
</tr>
<tr>
<td>Rice</td>
<td>3.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>89.7%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2002 Fat</th>
<th>2009 Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>30.7</td>
</tr>
<tr>
<td>Margarine, Oil</td>
<td>16.2</td>
</tr>
<tr>
<td>Fish</td>
<td>13.1</td>
</tr>
<tr>
<td>Game meat</td>
<td>9.4</td>
</tr>
<tr>
<td>Beans</td>
<td>6.3</td>
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<tr>
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<td>5.3</td>
</tr>
<tr>
<td>Baked Goods</td>
<td>3.9</td>
</tr>
<tr>
<td>Rice</td>
<td>5.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>85 %</td>
</tr>
</tbody>
</table>
(10.7%) and beans (15.1%) increased, while that of manioc (6.2%) decreased. Baked goods supplied 5.1% of dietary protein in 2009.

In 2002, the main source of fat was fruit (30.7%), followed by oil and margarine (16.2%), fish (13.1%), local (9.4%) and purchased meat (5.3%), beans (6.3%), and baked goods (3.9%) (Table 8). In 2009, oil and margarine supplied the bulk of dietary fat (23.9%), followed by beans (12.3%), purchased (11.6%) and local meat (8.1%), fruit (11%), fish (7.4%), baked goods (7%), and rice (5.6%).

Decreases in the energy contribution of all local foods except game meat, and increases in the contribution of all purchased foods were documented (Table 9).

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\begin{array}{|c|c|c|c|}
\hline
\text{Energy contributions of specific foods/food groups, 2002 and 2009} & \text{Energy} & \text{Energy} & \text{2002 - 2009} \\
& 2002 & 2009 & \\
\hline
\text{Açai} & 16.2\% & 4.9\% & \text{Decrease} \\
\text{Caldo} & 0.6\% & 0.4\% & \text{Decrease} \\
\text{Egg} & 0.6\% & 0.4\% & \text{Decrease} \\
\text{Fish} & 6.8\% & 5.4\% & \text{Decrease} \\
\text{Fruit/Veg} & 3.4\% & 1.0\% & \text{Decrease} \\
\text{All Manioc} & 48.8\% & 46.9\% & \text{Decrease} \\
\text{Baked Goods} & 2.5\% & 6.2\% & \text{Increase} \\
\text{Beans} & 5.2\% & 8.1\% & \text{Increase} \\
\text{Coffee} & 3.2\% & 4.5\% & \text{Increase} \\
\text{Farinha} & 46.1\% & 41.5\% & \text{Decrease} \\
\text{Pasta} & 0.1\% & 1.5\% & \text{Increase} \\
\text{Margarine, Oil} & 2.7\% & 4.2\% & \text{Increase} \\
\text{Meat, Local} & 3.4\% & 4.0\% & \text{Increase} \\
\text{Meat, Purchased} & 1.3\% & 3.4\% & \text{Increase} \\
\text{Milk} & 0.1\% & 0.8\% & \text{Increase} \\
\text{Rice} & 4.2\% & 6.9\% & \text{Increase} \\
\text{Sweets} & 0.7\% & 0.8\% & \text{Increase} \\
\text{Other, Purchased} & 0.0\% & 0.5\% & \text{Increase} \\
\hline
\end{array}
\]
DISCUSSION

Although the nutrition transition is better documented in urban settings, there are indications that it is rapidly occurring both in urban and rural settings worldwide (Popkin, 2003). There are also indications that the nutrition transition is occurring in rural Ribeirinho populations in the Brazilian Amazon (Murrieta et al., 1999, 2008; Piperata, 2007; Silva et al., 2006), however literature specifically addressing the nutrition transition in these populations is limited. The present study adds to the sparse dialogue on dietary change among Ribeirinhos by posing the questions: what dietary changes occurred in this population with the economic changes observed from 2002 to 2009? Are observed changes indicative of a nutrition transition? The hypotheses addressed here are that dietary intake is 1) higher in energy and 2) higher in all macronutrients, with fat showing the greatest increase, 3) higher in consumption of oil, animal products, and refined carbohydrates, 4) lower in consumption of fruits and vegetables, and 5) more reliant on purchased foods. The sixth hypothesis is that households receiving Bolsa Família benefits will show these changes to a greater degree. The present study is also the only one of which the author is aware that compares the same population before and after the introduction of a conditional cash transfer program, a major driver of economic change. Because this population has been largely ignored in Amazonian academic literature, holistic anthropological studies of dietary and subsistence change among Ribeirinhos is necessary to understand the effects of globalization and market integration on this
demographically and economically significant population. This paper contributes to this vital dialogue.

**Energy and Macronutrient Intake: Hypotheses 1 and 2**

If this population were experiencing a nutrition transition over the last decade, their energy and macronutrient intakes would increase between 2002 and 2009. However, intakes of energy and all macronutrients were lower in 2009; energy and carbohydrate intakes decreased significantly. Instead of transitioning to a diet characterized by excess or better access to energy and macronutrients, which would be expected with a nutrition transition, these women appear to be getting significantly less energy than they were in 2002. The decrease of average energy intake from 1805 kcal in 2002 to 1335 kcal in 2009 provides the best indication that the changes seen here are not those predicted by the pattern of the nutrition transition. A similar trend of reduced food security was reported in western Kenya as an outcome of agricultural intensification (due to population pressure, a point on which this case differs from that of the Amazon) and increased integration into the market economy and wage labor (Conelly and Chaiken, 2000).

Percent energy obtained from carbohydrates decreased significantly. The decrease of almost 100g of carbohydrates per woman per day accounted for over four fifths of the 470 kcal decrease in mean energy intake. As manioc, usually in the form of farinha, accounted for 49% of the carbohydrate intake in 2002 and 47% in 2009, a key factor in the decrease of carbohydrate consumption may be the transition from locally grown and processed to purchased farinha. Purchased farinha, while still a large part of the diet, was not consumed as freely as a family’s own harvest, and this could account for a large part of the decrease in farinha (and thus carbohydrate) intake. Variation in sampling may also
account for some of the change: *farinha* intake may have been underestimated in 2009 due to the fact that a researcher was not in the houses over the course of the entire day, as was the case in 2002. This may explain some of the apparent decrease in the consumption of *farinha* and thus carbohydrates.

Low estimates of recalled *farinha* portions or failure to report consumption of one or two handfuls of *farinha* could have caused carbohydrates to be underreported by about 30 – 60g which amounts to around 120 - 230kcal. Low carbohydrate intake caused protein to appear more significant in the diet in 2009: percent energy obtained from protein was significantly higher than in 2002 although total protein intake was lower. This is a reflection of lower carbohydrate intake on diet composition; with the decrease in carbohydrates in the diet, protein is supplying a proportionally greater part of the net energy, although protein intake has decreased.

The greater standard deviation of protein intake in 2009 suggests greater daily and inter-individual variation, and may indicate a greater degree of insecurity in the form of unpredictable or inadequate availability of protein (FAO, 2003; Radimer et al., 1992). The contribution of local fish to protein intake decreased by about 25% between 2002 and 2009. Meats, especially salted, preserved meat purchased in town or from the *regatão* replaced fish with a less reliable, purchased source of protein. The *regatão* and markets in town are not sources that can be counted on day to day as most households can only afford to travel to town once a month and the *regatão* does not keep a schedule. The Food and Agriculture Organization (FAO) defines food insecurity as “not having adequate physical, social or economic access to food for an active and healthy life” (2003). Other definitions include uncertainty or worry over food, or having access to food of inadequate
quality or quantity (Radimer et al., 1992.) Reports are mixed on how food insecurity affects nutritional status (Jones and Frongillo, 2007; Kaiser et al., 2004). However, recorded dietary intakes, observed unreliability of the regatão, and reported difficulties in making a trip to town, all suggest a link between food insecurity and low dietary intakes.

*Oil, Animal Products, and Refined Carbohydrates vs. Fruits and Vegetables:

**Hypotheses 3 and 4**

A population undergoing a nutrition transition would be expected to increase its consumption of oil, animal products, and refined carbohydrates, while decreasing consumption of fruits and vegetables. Here, the proportion of energy supplied by oil, animal products, and refined carbohydrates almost doubled, lending some support to the nutrition transition hypothesis. However, the increase in actual intake by weight of these three types of food is small, and, paired with lower total energy and macronutrient intakes, fails to support the third hypothesis. Fruits and vegetables decreased in the diet, both in actual intake and in proportion of total energy they supply, supporting the fourth hypothesis. The addition or increase of other foods in the diet did not fully compensate for the loss of energy from fruits and vegetables. This trend has been linked with nutrition transition and food insecurity. In one example, food insecurity has been linked with lower consumption of fruits and vegetables in Trinidad and Tobago (Gulliford et al., 2003).

*Local vs. Purchased Foods: Hypothesis 5*

Proposing that this population is undergoing a nutrition transition, I hypothesized that their reliance on purchased foods increased from 2002 to 2009. A trend quickly emerges in analysis of the energy and macronutrient contributions of specific foods and foods groups to the diet: dietary contributions of local foods have decreased, while those
of purchased foods have increased. The only local food to increase its overall energy contribution to the diet from 2002 to 2009 was game meat; however, the increase was not significant. By 2009 women were much more dependent on purchased foods for energy and all macronutrients than they had been in 2002. Another, earlier study in one of the communities assessed in this study reported a similar trend, with 19% of energy coming from purchased sources in a 24-hour recall assessment of household diet (Murrieta et al., 2008). Another study of rural river communities in Amazonas State reported 31% of food items as purchased (Leme da Silva and Begossi, 2007).

In 2009, close to half of women’s energy, carbohydrate, and protein intake came from purchased sources, along with two thirds of their fat intake. The pattern was similar but not as clear for women in the longitudinal test group, perhaps due to smaller sample size. The shift from a diet based predominantly on local food to one reliant on both local and purchased food is clear, underscoring the increased participation in the market economy and availability of funds to purchase food. The energy contribution of all local foods, with the exception of game meat, decreased in 2009, while the contribution of all purchased foods increased, again demonstrating the shift toward processed, industrialized foods. The higher standard deviations in 2009 for energy and macronutrient intake from local and purchased sources likely reflect a greater range of strategies, such as substituting less desirable food items and trading in food with family and neighbors, employed by women for meeting their caloric requirements.

Manioc continued to contribute a large part of energy and carbohydrate in the diet, despite its transition to a purchased food for some households. A few households no longer maintained manioc gardens, mostly due to the loss of their adult males in
traditional subsistence activities. These men now invested their time and labor in wage labor or collecting forest products for sale or trade in the market economy. The role of women in subsistence, particularly relating to the processing of manioc and açai, had also changed in 2009. With increased prevalence of food processing technologies, such as machines to extract açai juice, and reliance on purchased foods, the amount of physical activity women contribute to subsistence activities has decreased.

Perhaps the biggest change in dietary composition was the source of dietary fat. Oil and margarine replaced local fruit (primarily açai) as the main contributors of fat in 2009. Purchased, often fatty, meats had also increased their contribution to the diet. While the dietary contribution of açai decreased, this could be a function of seasonality – açai was not in season in some communities during the 2009 round of data collection, a situation that did not arise in 2002 as data were collected over a longer time.

**Effect of Bolsa Família: Hypothesis 6**

Lastly, I hypothesized that households receiving the Bolsa Família benefit will show a greater degree of changes associated with the nutrition transition. While t-tests did not indicate any statistically significant differences in diet with receipt of Bolsa Família funds as a grouping variable in 2009, this should not be taken to mean that receipt of cash from the Bolsa Família program does not have an impact on dietary intake. All receiving households reported spending at least some part of their benefit on food, and the present study shows that this population has transitioned toward a diet based significantly more on purchased foods than in 2002. In 2009 beans, rice, oils, sugar, and preserved meats provided a large portion of total energy and macronutrient intakes. Although some households had access to wage labor and all had limited access to the market economy,
the majority of those without salary-earning members were classified as extremely poor, and the addition of the **Bolsa Família** cash transfer represented a large part if not all of their actual income. As a result of the addition of **Bolsa Família** funds to household income in 2009, families spent more on industrialized food than they could or did in 2002, when the program was not yet in place. In the case of the seven communities studied, a major confounding factor to identifying the dietary impact of cash transfers was the broad spectrum of subsistence and income strategies utilized by the local population. These included wage labor, part-time paid labor, part-time labor for which individuals are paid with goods or services, varying participation in the market through the sale of forest products such as *açaí* and *farinha*, and varying levels of reliance on natural resources. Testing for the impact of these diverse strategies would require a larger sample and thorough documentation of all work performed, the money or goods earned through these activities, and what they bring to the household through trade or purchase. Interviews revealed that households had differential access to forest resources, depending on variables such as investment in manioc gardens and proximity to fruit-bearing trees (some families had encouraged the growth of *açaí* trees near their houses, increasing yields and in some cases extending the fruit-bearing season). For each household, availability of natural resources, existing household capital (gardens, manioc and *açaí* processing technology), presence of wage labor or market participation opportunities, and social support all mediated the potential impact on diet of any single source of income by presenting or limiting opportunities to obtain food (Leme da Silva and Begossi, 2007; Murrieta et al., 1999; Piperata, 2007; Silva et al., 2006).
**Women’s Strategies and Adaptations**

A potential explanation for how these women were coping with the low intakes recorded in this study, beyond the possibility of underreporting of *farinha* intakes, is that these women practiced a “binge” pattern of eating by greatly increasing their intakes when food is available. Studies have shown an association between food insecurity and disordered binge-like eating of preferred or missed foods, brought on by an emotional response to voluntary or involuntary food restriction (Kendall et al., 1996). Energy intakes as low as 200-300 kcal per day were observed in a few instances. In 2002 women also reported eating small amounts or skipping meals altogether when food was scarce, to ensure that their children ate (Piperata, 2007), a practice also reported by studies outside the Amazon (Radimer et al., 1992). “Binges” are likely to follow successful hunting or fishing trips which, lacking means for preservation, must, after being shared within the social support network, be consumed within a few days, temporarily alleviating mothers’ worries of overeating at the expense of their children. A trip to town or the arrival of the *regatão*, when calorie-dense foods and beverages are briefly abundant in the household, may also trigger “binge” eating. Decreased intakes in 2009 may reflect this practice set against a background of increased food insecurity. Although it was not directly observed during data collection, the completed analysis of dietary intakes of children compared to their mothers will likely contribute to our understanding and interpretation of these women’s low reported intakes. If the data show that on food-scarce days women’s portions are abnormally small while the portions of children do not decrease as dramatically, and on days when food is abundant women’s portions increase more dramatically than expected, this would be compelling evidence of women decreasing
their intake when food is scarce to provide for their children, and making up for this loss by increasing their intake when food is available.

Another explanation may lie in these women’s metabolic efficiency. The “thrifty genotype” has been suggested as having been selected for during the cycles of feast and famine in early human foragers. Feast and famine cycles would have favored individuals with this “thrifty” metabolism, which was highly efficient at storing fat during times of plenty (Neel 1962, 1999). These women may have inherited a “thrifty genotype” from indigenous ancestors, for whom seasonal variation in quantity and quality of food has been well-documented (Coimbra et al., 2005; Dufour, 1994; Flowers, 1983; Murrieta and Dufour, 2004; Murrieta et al., 1999, 2008). This genotype may provide these women with an improved ability to store fat from “binges” during times when food is abundant. The “thrifty genotype” hypothesis is not completely understood at this point (Waterland and Michaels, 2007), and its effects, if any, on the Ribeirinhos are difficult to predict. With further research, this hypothesis may help explain how these women tolerate low energy and macronutrient intakes by offering a mechanism for increased metabolic efficiency.

Further research is necessary to address the question of how – including but not limited to investigator error, women’s strategies such as binge eating and substituting less desirable foods or reducing activity levels when food is scarce, or physiological factors such as especially efficient metabolism – these women are maintaining their nutritional status despite the low intakes reported here.
CONCLUSIONS

This population demonstrated a partial shift away from traditional subsistence, toward reliance on income and industrialized foods. However, opportunities for wage labor and market participation were limited. Opportunities to purchase food, even when resources to do so are available, were also limited, and unpredictable. The shift was premature in that social and economic infrastructure does not yet exist in the rural Amazon to support consistent wage labor and subsistence based on purchased foods. The very rural location of the communities and historic marginalization of the people creates problem of access at all steps of the process toward industrializing their subsistence.

Presently, with few wage-earning opportunities, the Bolsa Família program was the only reliable income for many households. With reliance on purchased foods increasing, if Bolsa Família benefits are to be withdrawn the nutritional situation of the population would be dire. Most households would experience a drastic decrease in income, and many would be left completely without access to money. Those who no longer maintained manioc gardens in favor of purchasing farinha with Bolsa Família benefits and other income would have to borrow or purchase farinha on dwindling funds until their own gardens could be established, a process which can take a year. The shift from subsistence based on local foods to an emphasis on purchased food is creating a generation that is not as adept at traditional subsistence activities. As wage labor opportunities are scarce, the population is more reliant on government funds than when
the program began. This projection lends some validity to the fear that the _Bolsa Família_ program is not breaking the cycle of poverty, and is instead creating a population reliant on the government for subsistence.

In order for a nutrition transition to occur in this population, either a reliable source of wage labor must be introduced, along with reliable opportunities to purchase food, or the population must move to these opportunities in urban areas. For many households, the present lifestyle is only sustainable while _Bolsa Família_ benefits last and the occasional opportunity for extraction work brings in cash or goods. Should these sources of income fail, the _Ribeirinhos_ may return to subsistence based on local foods or move to nearby towns and cities – places where the infrastructure exists to support an industrialized lifestyle. Although more individuals, and in some cases families, are moving from rural to urban areas than vice versa, there does not seem to be a marked migration.

This population has moved in the direction of a nutrition transition by transitioning toward a Western diet and lifestyle. But it now finds itself in the precarious situation of being unable to participate in a sufficiently permanent and reliable way in the market economy to be able to subsist on those earnings. The combined effect of scarce opportunities for securing income and unreliable opportunities to purchase food leave them in a position of high food insecurity. This conclusion draws additional support from the results of economic and food security interviews conducted in the communities 2009.
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