

Ecological Niche Theory: Non-traditional Urban and Rural Human Populations

Ana Paula Branco do Nascimento^{1,2}, Maurício Lamano Ferreira^{1,3} and
Sílvia Maria Guerra Molina²

¹*Universidade Nove de Julho, São Paulo, SP, Brasil, Av. Adolfo Pinto, 109, Barra Funda, 01156-050, E-mail: apbnasci@yahoo.com.br*

²*Escola Superior de Agricultura Luiz de Queiroz (ESALQ-USP), Piracicaba, SP, Brasil, Av. Pádua Dias, 11, CP 9, 13418-900.*

³*Centro de Energia Nuclear na Agricultura (CENA-USP), Piracicaba, SP, Brasil, Av. Centenário, 303, CP 96, 13416-000.*

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ABSTRACT Statistical samples from urban and rural non-traditional populations at Piracicaba, SP, Brazil, are studied in terms of human ecological fitness to his own environment. Ecological fitness was measured by Body Mass Index (BMI) with a demographic approach. Niche amplitude was estimated by Levins index. An economic classification was also elaborated. The highest level income families include rare food items and relative narrowing of food niche. Both populations use the same five food items more frequently: rice, beans, meat, bread, and coffee. According to BMI, these foods are not adequate: overweight and obesity mean that both populations are not ecologically fitted to their environment. The three joint approaches (ecological, economical and population nutritional status) have shown to be adequate for human ecological studies on modern ways of life. They also made it clear that economical factors are inconclusive for food choices.

INTRODUCTION

In 2007, about half of world human population was already living in urban environments (RNU 2007). Most of them and an expressive part of rural population were living non-traditional ways of life. The current way of life of humans causes more impact over the environment and, also, allows the proliferation of specific diseases, affecting human life, interfering in fitness, such as overweight and obesity, which nowadays characterize a global epidemic event (WHO 2000, 2009). Human ecology, both as science and as study program (Begossi 1993), cannot avoid facing this context. It is necessary to propose and to test multi-disciplinary scientific approaches, in order to study these complexes aspects in current Human Ecology.

Food choices and food intake are the most important interactions between population and its environment. The success of these interactions is very important for ecological fitness of a particular population. For non-traditional population, perhaps, economical factors can be the strongest ecological influences on food

choices (Begossi et al. 2002). In this paper, ecological human fitness and ecological food niche were employed associated to an economic classification, in order to perform a human-ecological study of urban and of rural populations, both presenting modern ways of life.

The ecological niche concept, as proposed by Hutchinson (1957), expresses the relationship of an individual or a population to all aspects of its environment. Among several aspects, food selectivity analyses shows itself as a niche dimension measure. This concept was applied first to human population by Hardesty (1972). Studies on the relationship between human population and environmental resources have employed niche concept (Adams 2002; Hanazaki and Begossi 2004; Cavallini and Nordin 2005; Silva and Begossi 2009). However, studies approaching niche concept applied to human urban populations are not found. Laland et al. (2007), employ "niche construction" concept, similar dimensions to Hardesty's concept, which was applied to urban environments. According to these authors, the "niche construction" is a result from relationships between the organism and its environment, which comprehends its metabolism, activities, and choices. They include learning and culture in studying ecological niche on human populations. Shenegyan and Zhiheng

Corresponding author:
Sílvia Maria Guerra Molina,
Telephone: +55 (19) 34294125, +55(19) 34336016,
E-mail: smgmolin@esalq.usp.br

(2007) employ niche concept referring to urban niche, and classify the urban environment as: natural, economical, and social categories.

According to Hardesty (1972), ecological niche comprehends all conditions necessary for an organism to exist. Considering the ecological niche, it can analyze each one of all interactions. For example: trophic or food niche (food relationship, such as: species preferred and availability), spatial niche (climatic, chemical and geographical factors a specie needs to survive), and behavior niche (way in which specie interact with others, such as: foraging, activity period among others).

Human population diet was studied in this paper because it encompasses and integrates several aspects of natural resources use. Food choices or food niches can bring important information on relationship between people and their socio-cultural and biological environment (Adams 2002). Using this concept, it can evaluate the degree of food resource dependencies, as well as, personal, family or seasonal variations on population diet, in specific social and local group. The adoption of this concept also allows verifying different relationships between diet and cultural, social, and economic factors. Studies on diet can, also, encompass nutritional and anthropometrical aspects as well as direct application on the life quality and general health conditions, in specific population (Hanazaki and Begossi 2004). The population nutritional status is an indicator of environmental fitness. It is an indicator of the individual and population capacities to adapt themselves to environment (Morán 1994; Morán and Ostrom 2009). In other words, malnutrition status reflects on ecological lacking, signaling that the population is not well succeed when living at this environment (Kormondy and Brown 2002).

Begossi and Richerson (1993) analyzed animal origin consumption among the "caiçaras" at Búzios Islands (Brazil), matching the family food niche amplitude with food availability and family income. In this analysis, measurement diversities were used to estimate food niche amplitude in particular population (Hanazaki and Begossi 2004). The difference among human groups into the same dimension niche amplitude (for example, food) can be an indicator of their specific relationship patterns within different environments.

Niche theory can be helpful in understanding food choices (Hanazaki and Begossi 2004).

According to this theory, an individual will prefer and choose a specific kind of food, despite the existence of others, always that it is abundant and available enough. The preferred food will be chosen if efforts to get it are counterbalanced by its nutritional and energetic value. In other words, when this preferred food is lacking, the animals forage for other low energetic foods, and so, their food niche is extended. For human beings, also, in face of high availability of many kinds of food, it is expected that they tend to narrow their niche and choose, among all those available, their preferred ones. For traditional human population, food choice is done according to maximization of nutritional and energetic return model (Setz 1989; Kormondy and Brown 2002). This is not what happens to people socialized in modern occidental cultures (Gigante et al. 1997; Fonseca et al. 1998; Rosado and Monteiro 2001; Pettinger et al. 2005; Contento et al. 2006). For modern occidental cultures of human beings, niche-narrowing is not necessarily attended by maximization of diet quality, in terms of energetic and nutritional return. Currently, high occurrence of overweight and obesity people in all age groups and all economic classes are reported for several countries (Moreira and Padrão 2006; Contento et al. 2006; Jiang et al. 2006), including Brazil, the country where this study was done (Felippe 2003; Campos et al. 2006; Gigante et al. 2006; Neves et al. 2006; Nascimento 2008). For non-traditional populations, economic issues are considered to be very relevant for food choices and for determining their general ecological relationships (Begossi 1993). Nowadays, most human beings are living in cities and a great part of them are adopting (or intending to reach) the modern occidental ways of life, with monetary relationships. When a particular population lives in an urban environment, the resources are obtained not directly from nature, and the relationships became more economic than ecological ones (Begossi 2004). In this context, family income highly determines food resource acquisitions.

Modern ways of life exert high stress over environment and quality of human life. The concept of fitness is useful for scientific study approach on this. As a rule, this concept is understood as a process, or as a result of a process, in which the number of descendants of one specie or population increases or, in the case of non-adaptation, it is reduced (Kormondy and Brown

2002). But, for human kind, the number of individuals is not enough for showing adaptability; reached quality of life is also very important. The nutritional status is relevant and adequate indicator, in this sense, because food intake is the main way by which the organisms relate themselves to environment. Fitness concept is employed as an indicator of human nutritional status (Nascimento et al. 2005).

Both facts that most human populations already live in cities and that they use monetary economy are very important for developing a converging approach for studying ecological aspects of their life. In order to study Ecology of non-traditional human populations, economic and ecological aspects were considered to be an integrated approach. Searching for adequate proceedings, with this aim and in this context, niche amplitude was estimated for each economic class¹ of rural and for urban population. Ecological niche concept allows us understand human population relationship with food resources in Piracicaba, SP, including economic factors as related to the use of them. Nutritional status for each economic class was also evaluated, in order to study fitness on both urban and rural populations. In this context, the objective of this study was to investigate the food diversity index by economical class in rural and urban population of Piracicaba, and also relate these food choices to the nutritional status of these populations.

METHODOLOGY

Study Area

The present study was accomplished in Piracicaba, SP, just near to São Paulo State and Brazil's most developed and highly industrialized region. This county has about 366,442 inhabitants (IPPLAP 2006).

Sample and Data Collection

A previous study (Nascimento et al. 2005), with pre-school children, has shown high prevalence of overweight and obesity. Mothers are responsible for their children's nutritional habits (Netto and Saito 2002; Santos et al. 2004; Rossi et al. 2008). Therefore, for better understanding human food choices, in this work, we have studied mothers of pre-school children on public institution in Piracicaba, SP. Total sample

universe was constituted by 137 urban mothers and 51 rural mothers. A Statistical sample was planned (Bolfarine and Bussab 2005) to obtain a representative sample for this paper. Present research considers two groups (rural and urban), allowing statistic comparisons between them.

Semi-structured 15 to 20 minutes interviews were performed with a sample of pre-school children mothers from rural and another from urban areas. Food items were listed by them, in a 24-hours recall.

Data Analysis

Niche analysis was measured in terms of diversity of items frequency on each meal. Diversity is indicated by the number of different consumed items and it reflects higher niche amplitude (a most generalist diet) in comparison with lower consumed item diversity (a narrower niche or a low generalist diet). We verify that almost all foods were acquired at Piracicaba, SP, from urban supermarkets, which offer all kind of foods, all over the year, what became unnecessary the seasonal concerning on data recollection.

Levins diversity index (Krebs 1999; as discussed by Begossi 2006) is:

$$B = 1 / [\sum p_j^2]^{-1}$$

B = food niche amplitude

p_j = proportion of an item of X variable presents in organism's life

For standardization of niche measurements (from 0 to 1), Hubert formula was applied (Krebs, 1999):

$$B_A = (B - 1) / (n - 1)$$

B_A = food niche standardized amplitude

B = food niche amplitude

n = consumed food items total number

Levins index emphasizes consumed items. Food diversity index was estimated for each area (rural or urban), according to different economic class living in these areas. The economic classes were defined by the Brazil Economic Classification Criteria, based on National Research Enterprise Association criteria (ANEP 2006). They emphasize people purchase capacity, and do not aim classifying people as social classes. A score system is employed considering: household-electric equipments ownership, head of family instruction degree, among others items.

Differences of food niche amplitudes among

the rural and urban populations studied were calculated through the items present in the diet, as reported by the 24-hour recall method. Families were classified from A to E classes, respectively from higher to lower income. Number of mothers classified in A and E classes were low. Therefore, A and B, as well as, D and E classes were respectively put together, for niche amplitude estimative purposes. At first, diversity estimative was performed for food items consumed in urban area and also in rural area; it was also performed in terms of economic classes in each area (A/B, C, and D/E). Later on, food items were grouped according to their main nutrients sources, as suggested by the adapted food pyramid to Brazilian population (Phillips et al. 1996). They are: group 1- breads, cereals, roots and tubercles (breads, flours, pastas, cakes, cookies, morning cereals, rice, corn, amylaceous, and tubercles); group 2- vegetables (all vegetables, except those already mentioned in the first group); group 3- fruits (citrics and non-citrics); group 4- meats (bovine, swine, birds, fish, egg, and viscera); group 5- milk (dairy products as milk, cheeses and yoghurts); group 6- leguminous (beans, soy, pea, pick pea, broad bean, peanut); group 7- oils and fats (margarine, butter, oil); and group 8- sugars and candies (candies, honey, and sugars) (Phillips et al. 1996).

Anthropometric Evaluation

Body mass index (BMI) was estimated by using weight (kg) and length (m). This index was adopted for nutritional status classification of the studied mothers:

$$\text{BMI} = \text{weight} / (\text{length})^2$$

Reference patterns adopted are the cut-points proposed by World Health Organization (WHO 1995; WHO 2009). Values less than 18.5 kg/m² mean underweight; values between 18.5 kg/m² and 24.9 kg/m² are considered as normal; values between 25.0 and 29.9 kg/m² mean overweight; and values equal or more than 30.0 kg/m² mean obesity. Population is considered fitted when their nutritional status proportions are in accordance to these cut-points.

RESULTS AND DISCUSSION

According to consumed food items, Levins amplitude index for urban population was BA = 0.20 and for rural population was BA = 0.27. This

index shows high similarities between both population niche amplitudes. Levins index, however, presents strong differences, where rural population was approximately one- third higher. This indicates that rural population has its diet more concentrated on more abundant food items. In spite of large spectrum of consumed food by both populations, these very similar values occurrence can be explained by the diet of both populations being constituted mainly by only five food items (rice, beans, bread, coffee, and meats). These items were consumed by 43.5% of urban, and 45.3% of rural population, at least once a day. Cavallini and Nordi (2005) also found narrowed niche amplitude in family farmers who had showed high dependency on few food items. They are rice and bean not produced by these families, but bought in supermarkets.

According to optimal foraging theory, the higher food abundance led to a narrower food niche. When resource shortage occurs, niche must expand, and few appreciated items (due their low nutritional and energetic return) are included in the diet. When resources are abundant, niche will be narrowed, because preferred items are easier to be found (Setz 1989; Hanazaki 2001). Therefore, in the present work, it was found that food behavior of both populations, urban and rural, includes similar places to acquire food items, which is the urban centre. The resultant similar niche amplitude was not expected according to niche theory. Nowadays, there is great food availability in urban environments, easily accessed by rural and urban populations. Against expect behavior, according to optimal foraging theory, food choice does not occur according to energetic and nutritional return. As shown by Kahn and Wansink (2004), available food varieties access by both populations, reduces frequency of different consumed products. Human population maintains the basis of its diet and varies on other items.

In a second analysis, we intend to verify food diversity by economic class. As shown in table 1, within urban population, 19% of the interviewed mothers belong to the A/B class; 49.5% to C class, and 31.5% to D/E class. Within rural population, 27.5% of the interviewed mothers belong to the A/B class, 37.2% to the C class, and 35.3% to the D/E class. The expected should be the highest proportion of mothers belonging to C and D/E classes. Firstly, people from these classes are numerically dominant in this county. And secondly, it studied preschool

children families whose children were in a public institution, which is expected to be frequented by lower economic classes. But in this study was found that expressive contingent from higher classes is recurring to public system of education.

As observed from table 1, the diversity of food items of rural and urban populations shows large differences when referring to economic classes. There is lowering of food resources diversity from class A to class D/E.

Table 1: Urban and rural population Niche Amplitude Index by familiar economic class

<i>Economic class</i>	<i>Urban population</i>			<i>Rural population</i>		
	<i>N</i>	<i>%</i>	<i>B_A</i>	<i>N</i>	<i>%</i>	<i>B_A</i>
A/B	26	(19.0)	0.34	13	(27.5)	0.44
C	68	(49.5)	0.22	19	(37.2)	0.34
D/E	43	(31.5)	0.23	18	(35.3)	0.27
Total	137			51		

Among the human populations, the incoming can be very important as an estimative of resources availability or capacity to acquire them. For current human population, economic before ecological aspects, can be better determinants of food choices (Begossi 2004). Therefore, ecological theory suggests indirectly that families with higher per capita income should have the narrowest niches, since they should tend to be more specialized consumers of more appreciated items (Begossi and Richerson 1993). According to optimal diet concept, richest families should consume food items, which, in any environmental condition, offer the best nutritional and energetic return for any species, considering the necessary effort to acquire them (Pyke et al. 1977). The probability of any item introduction in a diet does not depend on its own abundance, but mainly on the abundance of other items. Human beings, as omnivorous animals, must search for an adequate proportion for different groups in the food pyramid (Phillips 1999). In this present work, this was not found. Collected data show A/B class with slight higher food diversity and amplitude, both to urban and to rural population. This suggests that A/B class has access and can consume higher variety of food resources. On the other side, amplitude values were lower for all strata. Levins standardized index varies only from 0 to 1. These data show that, in spite of these populations do consume high variability of food items, their diets are concentrated on only just a few of them.

Amplitude measurements estimated after grouping food items by eight categories, according to food pyramid (see methodology), are shown in table 2. The estimative method of niche amplitude shows close values for all economic classes of urban population. Levins index shows that, even classifying and considering as food items only eight sources of the main nutrients, all the studied people are concentrating their food choices (and intake) on about 50% of them.

Table 2: Urban and rural population Niche Amplitude Index by economic class and grouped food items

<i>Economic class</i>	<i>Urban population</i>			<i>Rural population</i>		
	<i>N</i>	<i>%</i>	<i>BA</i>	<i>N</i>	<i>%</i>	<i>BA</i>
A/B	26	(19.0)	0.58	13	(27.5)	0.56
C	68	(49.5)	0.57	19	(37.2)	0.55
D/E	43	(31.5)	0.59	18	(35.3)	0.47
Total	137			51		

As commented in Methodology, the measurements of niche amplitude employed in this work have peculiar characteristics. The Levins (BA) formula attributes more weight to used resources abundance (Krebs 1999). According to this index, the values are much lower for rural areas. This fact indicates that more frequent food items have more consuming concentration in rural than in urban area.

Niche narrowing (narrower the lower income) is observed in the Figure 1. It does not reflect higher energetic and nutritional return for low favored economic classes. These classes do not show themselves more adapted, when indicated by nutritional point or view, instead when used niche narrowing. Excess of weight is found in 28.4% of D/E economic class in rural area (17.6% overweight and 11.8 % obesity). In urban areas, C class presents larger number of weight excess occurrences (24.4%; 13% overweight and 11.4% 7obesity). These high occurrences of weight excess in all classes reflect lack of nutritional scientific orientations for both populations, time lacking for fixing healthier foods, or bad economic conditions (for D/E classes) to acquire any good food. More profound studies on factors of human population food choices are necessary. Their choices are not done in order to maximize nutritional and energetic return. The number of overweighed and obese people, in urban and rural populations, is indicating that they are not fitting to their environments. These

populations are constituted by preschool children mothers, what may expect that these feed patterns tend continuing in future generations.

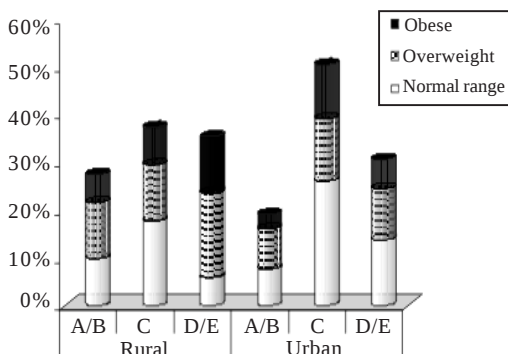


Fig. 1. Mothers nutritional classification: Eutrophic, overweight, and obesity by economic class

FINAL CONSIDERATIONS

The use of an economic classification associated to food niche studies and the BMI, considered as ecological fitness index, were studied in this paper. The approaches to this study (population nutritional status, ecological and economic index) show to be adequate for Human Ecology studies in the context of modern way of life. It was observed that lower income population have narrower food niches than the other studied classes. And also, that, except in the D/E rural class, food items diversity is very similar in all others, in spite of income differences. It was evidenced that economic factor is not a decisive aspect on food choices. This methodology also rendered that for modern human populations' ways of life, in rural and urban areas, niche narrowing on better food items does not occur. In spite of high or low income, modern human population has not reached ecological fitness. Lack of information or time to prepare or acquire good meals may cause it. Therefore, there is slightly better fitness in the highest income classes, which are indicating some differences in diet quality. On the other side, the trend to niche narrowing in low economic class was associated to higher weight excess. Data suggest nutritional inadequacy on food choices. Highest incomes could allow selection of preferred foods and subsequently a niche narrowing. In spite of economic differences, families of all economic classes, both from rural and urban areas, living into modern patterns, have

the same foods as basis for their meals. Five of the most consumed food items are the same to all economic classes from both areas. Therefore, the studied index allowed identifying a higher niche narrowing on rare food items in urban, than in rural area.

Probably, more ample niches could be an advantage for high diet quality, because this variability, which could allow more interest for meals and high nutritional equilibrium. A/B class of urban population may be reaching a nutritional and energetic return more adequate than all the others. In fact, A/B economic class showed lower prevalence of weight excess, both for urban and rural populations, than others groups. Human population is constituted by omnivorous beings. For their modern lifestyle, food item diversity seems to be an important factor for diet quality. As higher the economic class is, better will be the diets, because they could have access to more different food items. The more adequate BMI's, as ecological fitness index is suggesting these results. It is necessary to consider human necessity of variability in its diets, both as nutritional and as psychological needs. For this purpose, more detailed studies on food niche for human population modern ways of life studies are necessary, such the research presented in this paper.

It might be concluded that food choices and intakes of preschool children mothers are bad. They are rendering malnutritional status with higher prevalence of overweight and obesity than expected for healthy human populations. As long as mothers are builders of new generations' diet patterns, mistaken food choices and intakes are expected for future and consequent lacking of fitness for human population.

Co-ordering the uses of approaches on population nutritional status, ecological and economic proved to be adequate for Human Ecology studies on modern ways of life context.

NOTE

1. Nacional Association of Research Companies - ANEP. Brazil Economic Clasification Criteria. Available in <http://www.anep.org> Data based on Levantamento Sócio Econômico - 2000 - IBOPE [accessed in June, 07, 2005].

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