Original Research Article

Nutritional Vulnerability in Mbyá-Guaraní Adolescents and Adults from Misiones, Argentina

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Objectives: The aim of this study was to evaluate the nutritional status and body composition in Mbyá-Guaraní adolescents and adults from three communities in the Province of Misiones, in northern Argentina.

Methods: Anthropometric parameters were analyzed in 45 individuals (aged 14–60). Data were transformed to z-scores using NHANES I and II.

Results: Ninety-three percent of the sample showed some kind of malnutrition (undernutrition and/or excess of weight). Stunting and overweight reached the highest prevalences (85.0 and 10.0%, respectively). The most Mbyá people were found to have low arm muscle and fat areas. They also tended to have shorter than normal lower limbs. Centralized obesity was evident in both sexes and in all the age intervals.

Conclusions: Extreme poverty, together with changes in life habits and diet composition, resulted in decrease of body size and changes in body proportions and composition. Although these changes could be considered as an adaptive response to the chronic exposure of these populations to adverse environmental conditions, they would favor the co-occurrence of malnutrition and overweight in a single scenario, and consequently increase the risk of infectious and nontransmissible diseases. Am. J. Hum. Biol. 23:592–600, 2011.

In the last decade, mainly because of globalization and economic growth, as well as urbanization and modernization, various countries have been undergoing important demographic, epidemiological, and nutritional transitions (Groeneveld et al., 2007; Popkin and Gordon-Larsen, 2004; Popkin, 2011). Indigenous people around the world are not escaping this trend. A range of health outcomes in Indigenous communities relate to their social environment, especially for people living in reserves or in close contact with urban populations and are linked to acculturation. Indigenous communities more integrated into mainstream society are more vulnerable to so-called modern diseases and diseases of poverty. This vulnerability can be linked to disease exposures and poor living conditions (Montenegro and Stephen, 2006).

Many Latin American countries, such as Mexico, Guatemala, Bolivia, Peru, Ecuador, and Brazil, have large indigenous populations. These groups are generally the poorest and least formally educated, as well as the most growth-retarded or stunted (Cardoso et al., 2001; Pajuelo et al., 2003; Rivera et al., 2003; Tanner et al., 2009). Recent studies emphasize that in these populations, malnutrition affects more than a quarter of the children under 5 years (Leite et al., 2006; Santos and Coimbra, 2003). Poverty is also associated with precarious conditions of sanitation and housing, as well as less coverage and quality of health care, which result in the deterioration of the nutritional condition of aboriginal children. Chronic diseases are becoming increasingly more frequent in these populations, which are characterized by the coexistence of an epidemic pattern comprising nutrient deficiency and infecto-contagious diseases (Cardoso et al., 2001; Huamán-Espino and Valladares, 2006; Muniz-Junqueira and Oliveira Queiróz, 2002).

Among the problems of nutrition, obesity has become a focus of interest for public health worldwide (WHO, 1998). In developed countries, obesity has reached epidemic proportions and, together with undernutrition and infectious diseases, constitutes a challenge in the health and quality of life of children (Gotthelf and Jubany, 2005). Different authors have argued that excessive weight during childhood promotes development of coronary heart disease, hypertension, diabetes mellitus Type 2, certain types of cancer, and other diseases in adults (Núñez-Rivas et al., 2003; Pajuelo et al., 2003). According to Drewnowski (2009) obesity and Type II diabetes mellitus follow a socioeconomic gradient and the highest percentages have been observed in populations with low economic resources and educational levels.

Again, this situation is also being reported for indigenous communities, particularly in Latin America that have experienced, at various degrees and paces, a process of westernization. This process is characterized by a shift in subsistence practices (from agriculture or foraging to wage labor and market economy) and an escalation of urbanization and secularization (Valeggia et al., 2010). Gugelmin and Ventura Santos (2001) observed in two Xavánte indigenous communities from Mato Grosso with similar habitat, cultural practices, and social organization, that the differences in the intensity of physical activity combined with the incorporation of social patterns, political, and economic established by the Brazilian

Grant sponsor: Universidad Nacional de La Plata; Grant sponsor: ANPCyT; Grant number: PICT 01541; Grant sponsor: CONICET; Grant number: PIP 02197.

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Received 15 December 2010; Revision received 8 February 2011; Accepted 8 March 2011

DOI 10.1002/ajhb.21175

Published online 16 June 2011 in Wiley Online Library (wileyonlinelibrary.com).

society, were also determinants of overweight and/or obesity in these populations. In Argentina, Orden and Oyhenart (2006) and Valeggia et al. (2010) provided evidence of a striking increase in obesity rates in aborigines as a part of the process of nutritional transition. Thus, the etiology of obesity in these populations can be interpreted as the result of the combination of genetic and environmental factors. Among the latter, those related to lifestyle factors, especially quality of nutrition and physical activity, have been most studied (Pedraza, 2009).

It is interesting to note that, despite increasing overweight and obesity rates, undernutrition is still observed in some Native American populations (Eisenmann et al., 2003; Story et al., 1999) as well as in other populations of developing countries (Cesani et al., 2007; Orden et al., 2005; Oyhenart et al., 2008; Pais and Fernandez de Carrera, 2009). In this sense, the nutrition transition refers to changes in diet composition from traditional diets that are primarily derived from plant-based food sources low in fat and high in fiber, to more "Western" diets that are high energy dense and low in fiber, typically begins with urban populations and those in higher social economic strata (Food and Agriculture Organization, 2006; Popkin, 2003). Moreover, increased intakes of animal source foods and edible oils have been documented differentially in urban and rural areas. Therefore, nutrition transition is a major driving force behind the double burden of malnutrition (Mendez et al., 2004).

The consequences of malnutrition during childhood can be dire. Bogin et al. (2007) reported that humans growing-up in adverse biocultural environments, including undernutrition, exposure to infection, economic oppression/poverty among other, may be stunted, have asymmetric body proportions, be wasted, be overweight, and be at greater risk for disease. These situation was observed in previous work carried out among Mbyá-Guaraní (Navone et al., 2006; Oyhenart et al., 2003) as well as the study recently published by Zonta et al. (2010), in children from 2 to 13 years old inhabitant in three communities (Takuapí, Ka'a cupe and El Pocito).

On the basis of these results, which indicated that these populations were subjected to extreme poverty conditions with severe growth stunting and parasitic infections affecting about half of them, we believe necessary to advance in the human biology knowledge on aboriginal populations and to analyze nutritional status and body composition and proportion of Mbyá-Guaraní from 14 to 60 years old belonging to Mbyá communities of Misiones, Argentina.

METHODS

Study population

The province of Misiones is located in northeastern Argentina bordering with Brazil, Paraguay, and the Argentine province of Corrientes. Misiones belongs to the District of the Mixed Rainforest of the Paranaense Phytogeographical Province and has subtropical weather without a dry season. The relief is strongly undulated with hills and the soils are deep, sandy, and muddy with thick texture that prevents evaporation (Cabrera, 1971).

The Mbyá-Guaraní ethnic group, one of the indigenous communities inhabiting this region, belongs to the Tupí Guaraní linguistic family. This group has been characterized by its wide mobility, occurring from historical times up to the present in small enclaves. Populations set out from settlements in Paraguay and reached Argentina during the mid-19th century. Their settlements currently extend over northern Argentina, southern Brazil, and have recently reached Uruguay (Martinez et al., 2004).

The Mbyá population in Argentina is smaller than that settled in Brazil and Paraguay. According to official sources, Misiones province contains 54 communities with about 4,000 individuals distributed along national and provincial roads (Encuesta Complementaria de Pueblos Indígenas 2004–2005). This study included the communities from Takuapí (Ruiz de Montoya Municipality) with 38 families (162 inhabitants), Ka'a cupe (Garuhapé Municipality) with 17 families (65 inhabitants), and El Pocito (Capioví Municipality) with 41 families (170 inhabitants), all of them located within the Department Libertador General San Martín, Misiones province (see Fig. 1).

The original forest of Misiones province comprised about 2,700,000 hectares, which represented almost the totality of its territory. Colonization of this region from different areas and with varying purposes and exploitation strategies, such as wood extraction (white cedar, lapacho, pines, guatambu, among others), added to the population increase, and the expansion of lands used for farming, has progressively restricted and modified this ecosystem, altering its characteristics and consequently those territories occupied by Mbyá ethnic groups. Even so, the Paranaense forest is a biome of great biological diversity, and one of the most threatened natural systems in South America (Crivos et al., 2007).

The subsistence of these ethnic groups is primarily linked to the forest. It is in this ecosystem, characterized by its rich biodiversity, where they perform their subsistence activities developed through time. These include cultivation using slash and burn techniques in combination with hunting, fishing, and gathering being the main cultures corn, sweet potato, manioc, fruit, and citric plants, among others. Wood, bark, tree fibers, leaves, roots, and fruits are also collected to be used in different activities, therapeutic, hand-making, building of weapons and houses, and fish poisoning, (Remorini, 2008). Recently, a 1250 m^2 dam was built in The Pocito with state funds, with the purpose of establishing a fish breeding facility and a community garden to improve the food safety of this population. Meat from hunting, which was an abundant resource some decades ago, has currently a scarce presence on the people diet, oriented mainly to horticultural products, wild fruits, and industrial food (Remorini, 2008).

Families, mainly men and boys, engage in two activities as employment alternatives: temporary small jobs in *yerba mate* and tobacco plantations, and production of craftwork; both activities are poorly remunerated (Martinez et al., 2004; Zonta, 2010).

The Cacique or Pai is the group leader. The family heads, gathered in council, attempt to solve the problems of the community. Group members speak their own language (Mbyá), as well as Paraguayan guaraní or Spanish (trilingual). The preservation of their culture, the "mbyá system," is fundamentally carried out by the women, while their interactions with the world of "whites" take place through the men (who speak Spanish). In the privacy of their community, they preserve their own religious and mythical ideas (Remorini, 2008).

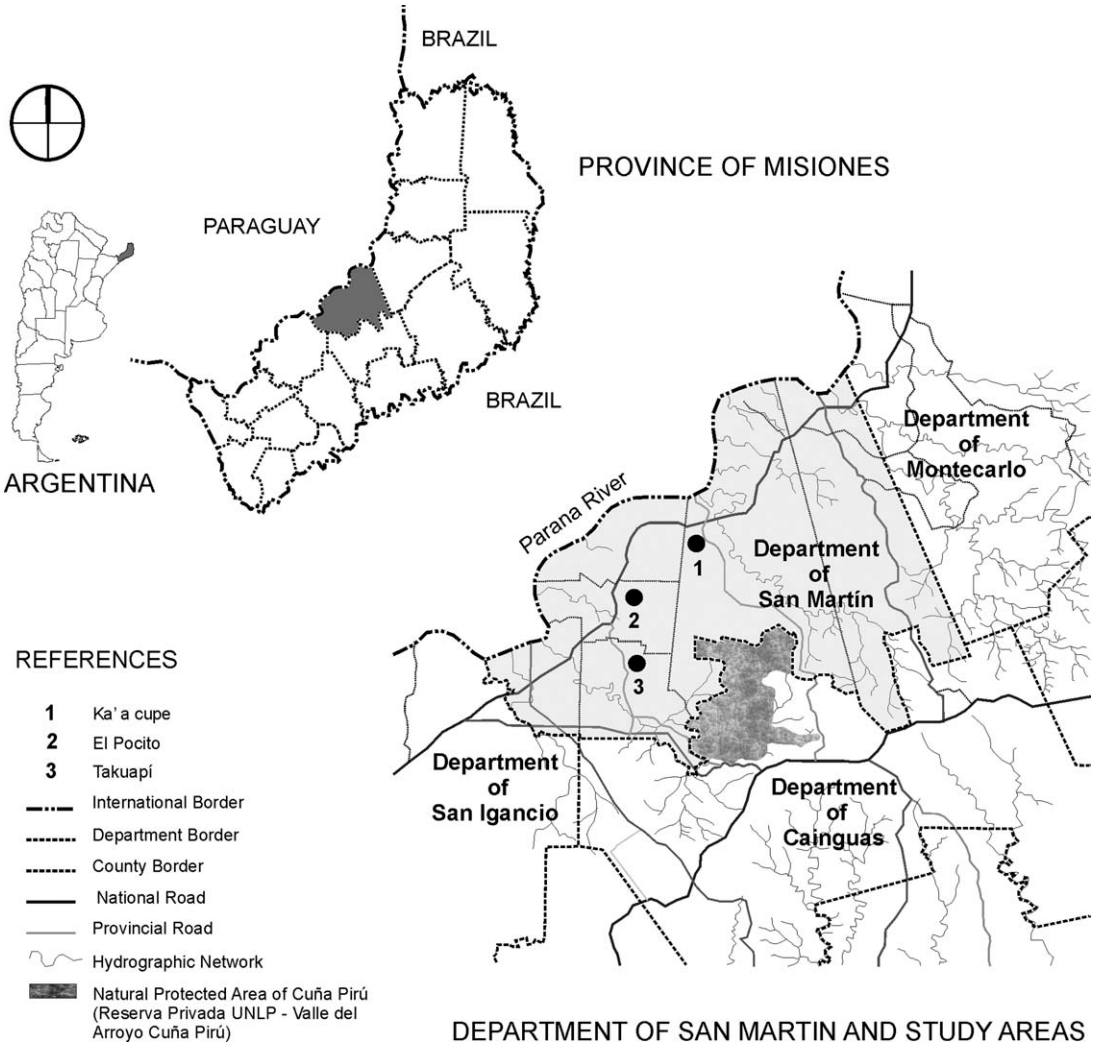


Fig. 1. Area of distribution of Mbyá communities in Misiones, Argentina.

A bilingual school functions in each community; beyond their educational function, the classrooms are usually used for religious meetings and recreational activities held in the afternoon and evening. For the last few years, these communities have had access to electricity and satellite television. First-aid medical stations are staffed by a sanitary agent who is a member of the community. The agent's tasks include distribution of certain medicines under the supervision of a physician, registration, and distribution of powdered milk for toddlers and children, weighing, and general health monitoring of children and women. Occasionally, a physician visits the community for general health examinations, diagnosis, and distribution of medicines. Villagers usually go to the nearest health centers for complex medical care. On many occasions, community members use natural resources for therapeutic treatment (Crivos et al., 2002; Huber et al., 2005; Pochettino et al., 2003).

Members of these communities live in precarious constructions made out of wood and/or masonry, less frequently with a dirt or cement floor. Defecation takes place outdoors, on open ground, whereas drinking water is supplied by either the Cuña Pirú o Capioví brooks or subterranean water wells. These water sources are different distant from the house (between 30 and 400 m), and consequently water is usually kept in containers for several days (Zonta, 2010).

Anthropometry and data analysis

A cross-sectional anthropometrical study was made in 45 individuals (13 males and 32 females) aged from 14 to 60 years old. Because of the small sample size per age within and between sexes, individuals were assigned to age intervals (14, 0–19, 9; 20, 0–29, 9, 30, 0–59, 9 years old). The sample selection was non-probabilistic and was largely determined by voluntary participation in the study. Children participated in the anthropometric study only after the parents or legal guardian gave written consent. No cases of chronic diseases or pathological conditions were present among the individuals surveyed. Research protocols followed the principles outlined in the Helsinki Declaration, and its subsequent modifications as

TABLE 1. Means (M) and standard deviations (SD) for age intervals and sex

		W (kg)		*H* (cm)		UAC (cm)		TS (mm)		SS (mm)		BMI		UMA (cm^2)		UFA (cm^2)		SHR		IST	
Age intervals	*N*	M	SD	M	SD	M	SD	M	SD	M	SD	M	DE	M	DE	M	DE	M	DE	M	DE
Males																					
14.0–19.9	6	50.7	2.1	152.6	2.3	24.8	1.2	10.8	6.1	14.8	5.1	21.8	1.2	36.5	6.6	12.3	6.8	52.5	1.3	1.6	0.6
20.0–29.9	2	50.4	2.2	153.9	2.6	25.6	1.7	8.0	5.7	10.5	4.9	21.3	1.7	42.4	0.3	9.9	7.2	53.3	0.8	1.5	0.4
30.0–59.9	5	55.9	4.1	156.3	6.8	25.4	1.7	8.0	3.2	14.8	3.8	23.0	2.1	42.0	5.7	9.7	4.0	52.3	1.8	2.1	0.8
Females																					
14.0–19.9	12	48.0	5.8	145.3	4.3	24.3	2.4	21.7	6.0	24.4	10.8	22.7	2.1	24.6	3.9	23.0	7.8	52.9	1.1	1.1	0.4
20.0–29.9	12	48.9	6.7	146.5	3.7	25.3	3.0	22.1	7.4	28.2	13.7	22.7	2.9	26.8	3.1	24.6	10.1	53.4	0.9	1.3	0.4
30.0–59.9	8	51.1	8.1	146.1	3.1	25.9	4.3	20.0	8.2	29.8	12.1	23.9	3.7	31.0	7.2	23.7	13.2	52.2	1.7	1.6	0.6

W, body weight; *H*, height; UAC, upper-arm circumference; TS, tricipital skinfold; SS, subscapular skinfold; BMI, body mass index; UMA, upper-arm muscle area; UFA, upper-arm fat area; SHR, sitting-height ratio; IST, index subscapular tricipital.

well as those dictated by Argentine National Law N° 25.326 on the privacy of personal data.

The age of each person was recorded from their national identity card. Measurements were taken at the local school from September 2005 to May, 2007 by one of the authors (M.L.Z.). The survey procedure followed standard protocols (Lohman et al., 1988). Body weight (*W*) in kilograms was measured on a lever scale (accuracy 100 g) with subjects lightly clothed; height (*H*) in centimeters was recorded with a movable vertical anthropometer (accuracy 1 mm). Body mass index (BMI) was calculated as weight (kg) divided by $(\text{height})^2$ (m^2).

Upper arm circumference (UAC) was measured in centimeters using a flexible steel tape (accuracy 1 mm). Triceps skinfold (TS) (posterior upper arm, halfway between elbow and acromion) and subscapular skinfolds (SS) (1 cm below lower tip of scapula) were measured in millimeters, using a Lange caliper (accuracy 1 mm).

The upper arm fat area (UFA) and upper arm muscle area (UMA) were calculated using the following formulas (Frisancho, 2008):

$$\text{TUA} = \{(\text{UAC}^2)/(4 * \pi)\}$$

$$\text{UFA} = (\text{TUA} - \text{UMA})$$

$$\text{UMA} = \{\text{UAC} - (\text{TS} * \pi)\}^2/(4 * \pi)$$

Finally, to assess body proportion sitting-height ratio (SHR) SHR = 100*(height-sitting height) was used.

The scale and skinfold caliper were calibrated before each measurement session. Measurement precision was assessed through technical error of measurement (TEM), calculated as the square root of the sum of squared differences between two repeated measurements in 15 subjects, divided by 2 times the number of subjects measured. Calculated TEM values were lower than the maximum acceptable TEM values reported by Ulijaszek and Kerr (1999).

All data were transformed into z-scores by means of the NHANES I and NHANES II references (Frisancho, 1990). Z-scores values lower than −2 SD for weight-for-age, height-for-age, and weight-for-height parameters were used to determine the prevalence of underweight, stunting, and wasting, respectively (Gorstein et al., 1994). Mean z-scores were calculated for each age interval and sex.

Individuals with BMI values at or above the sex-specific 85th percentile were considered overweight, and those with a BMI at or above the 95th percentile were considered obese. The subscapular/tricipital index (STI), which measures the body fat distribution pattern, was calculated as tricipital divided by subscapular skinfolds (Deurenberg et al., 1990). An STI value higher than 1 was considered indicative of central fat distribution (CFD), and a STI value below than 1 as an indicator of peripheral fat distribution (PFD) (Martinez et al., 1993).

We compared prevalence rates by means of chi-square statistical analysis employing Yates' correction (at a significance level of $P < 0.05$); and when the number of observations was fewer than 5, Fisher's test was used. These statistical analyses were performed using the SPSS 15.0 package.

RESULTS

Anthropometric analysis

Table 1 shows means and standard deviations for measures (*W*, *H*, UAC, TS, and SS) and also calculated variables (BMI, UMA, UFA, SHR, and IST) by sex and age intervals.

For both males and females, the mean z-scores for weight lay below the reference (WAZ = −0.65–−1.76). Height z-scores were also negative (HAZ = −2.53–−3.29). In contrast, z values for body-mass index (BMI) were mostly positive except in males more than 20 years old (BMI = −0.62–−0.67; see Fig. 2). The population z-scores hemi-distribution of frequency moved to the left of the reference. Height was diminished in the 50% of the individuals, followed by body weight, 41.1%, and BMI, 3.3%, (Fig. 3a).

Upper arm circumference (UAC) and upper arm muscle area (UMA) showed, in both sexes, negative z-scores throughout all age intervals. However, z values for subscapular skinfolds (SS) lay above the reference except in males more than 20 years old (SS = −0.13–−0.21). Finally, tricipital skinfold (TS), upper arm fat area (UAFA), and sitting-height ratio (SHR), had z-scores were similar or below the reference (see Fig. 2). The population z-scores hemi-distribution of frequency was also at the left of the reference. Upper arm circumference was diminished in the 30.0% of the individuals, followed by muscle area, 27.8%, and the fat area, 7.8%, (Fig. 3b).

Ninety-three percent of the total analyzed population showed some kind of malnutrition (undernutrition and/or excess of weight). Stunting and overweight reached the greatest prevalences (85.0% and 10.0%, respectively). The prevalence of underweight was 2.5%, and wasting and obesity were not observed (Table 2). The analysis by age

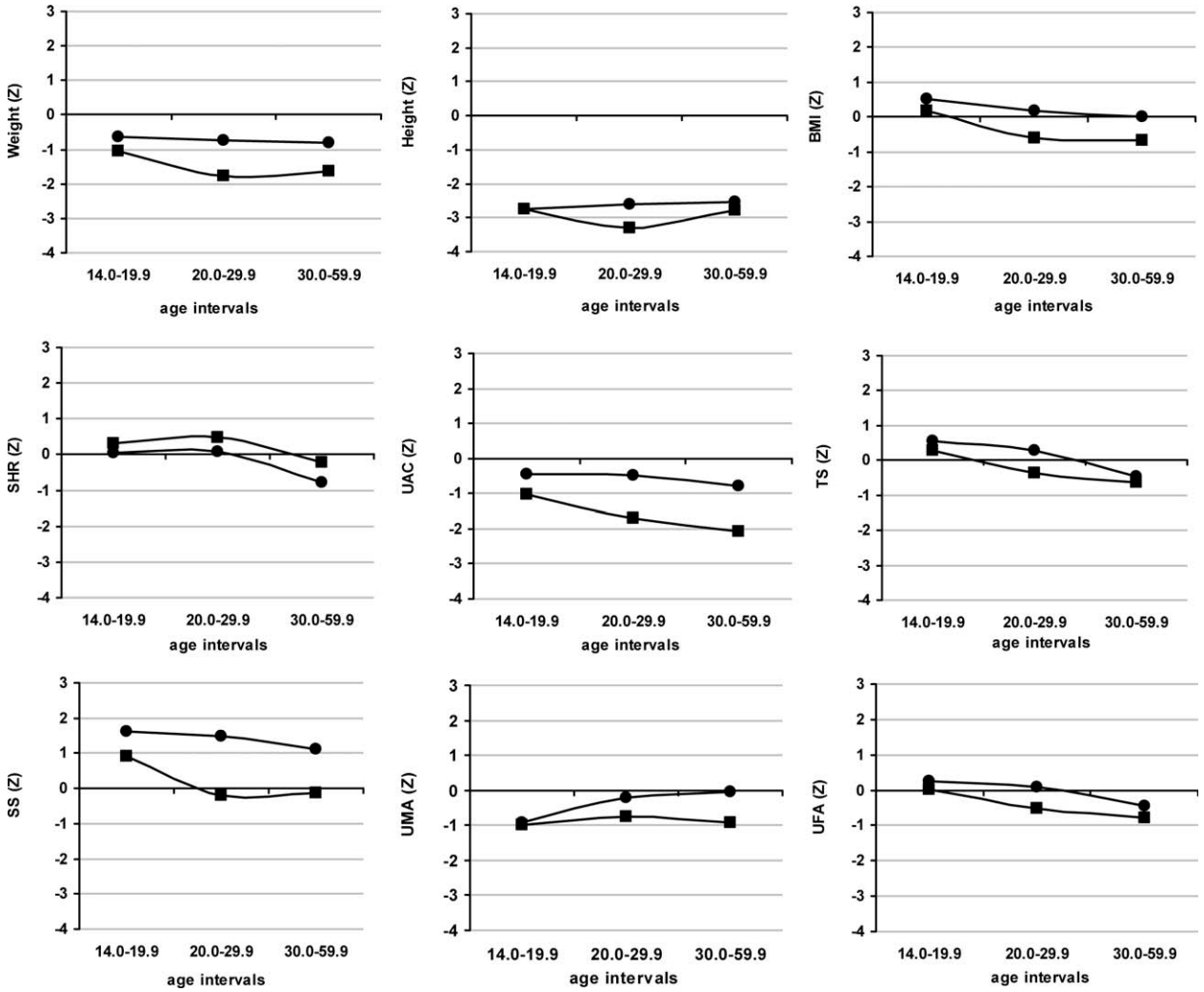


Fig. 2. Mean z-scores and standard deviations by age intervals in males (squares) and females (circles).

indicated that stunting was present in all the age intervals and was greater in the second interval and underweight in 30.0–59.9 age interval (7.7%). However, overweight was greater in the first interval (Table 2).

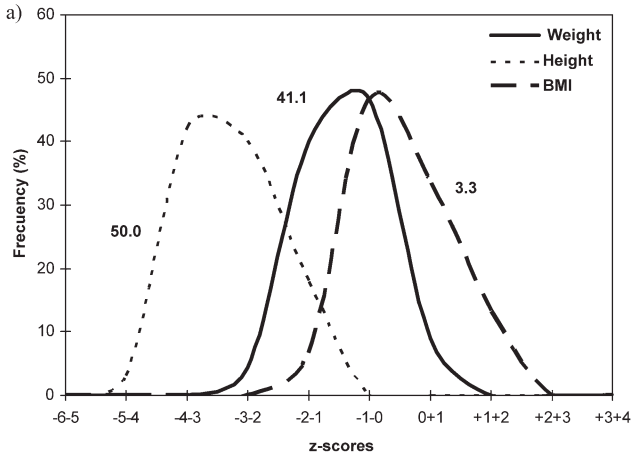
The pattern of adiposity distribution indicated that centralized obesity was evident in both sexes in all the age intervals (see Fig. 4).

DISCUSSION

Height increases in absence of external forces, in contrast, it decreases in adverse circumstances (Komlos and Baur, 2004). The latter was evident in the Mbyá populations from Takuapí, Ka'a cupe and El Pocito, given that about half of the individuals presented decreased height. Also, 40% of the population had lower body weight. Males and females were shorter and lighter with respect to the reference, in agreement with previous observations made in other Mbyá communities that inhabit Misiones (Orden and Oyhenart, 2006; Oyhenart et al., 2003). Nevertheless, the males showed greater reduction of weight and height.

Parasitic infections will contribute to lineal growth retardation (Gorstein et al., 1994). In this sense, previous studies in Mbyá communities have indicated a high prevalence of parasitic infections, capable of producing stunting (Navone et al., 2006; Zonta et al., 2010). These authors observed the presence of protozoans (*G. lamblia y B. hominis*) and helminths (Ancylostomídeos*, S. stercoralis, A. lumbricoides, T. trichiura*) associated with factors socio-environmental and cultural that they to characterize to these communities. Also, several studies found a negative correlation between intestinal parasitic infections and anthropometrics measurements of physical growth and nutritional status (Casapía et al., 2006; Nematian et al., 2004; Wilson et al., 1999).

The modification in height and weight was reflected in the high prevalence of stunting compared with that of underweight (85 and 2.5%, respectively). Nevertheless, the latter was observed only in individuals older than 30 years old indicating the high vulnerability at adulthood. In all cases, the prevalences were greater than those reported for other Mbyá-Guaraní communities from Brazil (Pícoli et al., 2006)



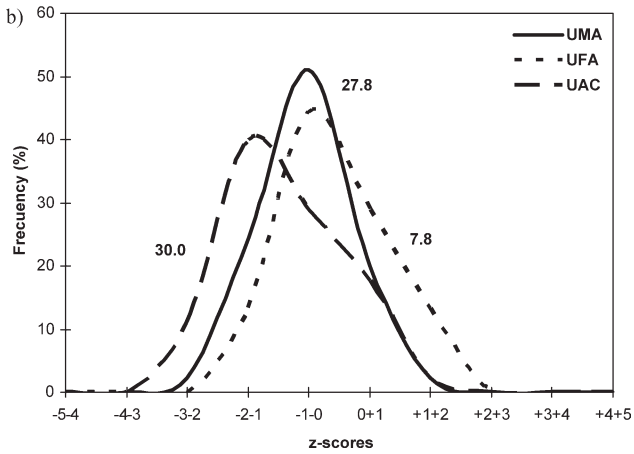


Fig. 3. Z-scores distributions (a) weight, height, and BMI, b) upper arm muscle area (UMA), upper arm fat area (UFA), and upper arm circumference (UAC).

TABLE 2. Prevalence (%) of indicators nutritional status by age intervals in Mbyá aborigines

Age intervals	Underweight	Stunting	Wasting	Overweight	Obesity
14.0–19.9	0.0	83.3	0.0	22.2	0.0
20.0–29.9	0.0	85.7	0.0	0.0	0.0
30.0–59.9	7.7	76.9	0.0	7.7	0.0
Total average	2.5	85.0	0.0	10.0	0.0

and Argentina (Orden and Oyhenart, 2006; Oyhenart et al., 2003).

Prevalence of stunting were also greater than those reported for most of the areas of Argentina, inhabited by nonaborigines populations, which had the poorest socio-economical conditions (Bolzán et al., 2005; Orden et al., 2005; Oyhenart et al., 2007, 2008). A study performed by Habicht et al. (1974) reported that differences in growth of preschool children associated with social class, are many times those which can be attributed to ethnic factors alone. In agreement, Bustos et al. (2001) demonstrated that in case of the population Mapuche, it was the poverty and not the ancestry the one that was cause lineal growth retardation. The high prevalences of stunting in the Mbyá

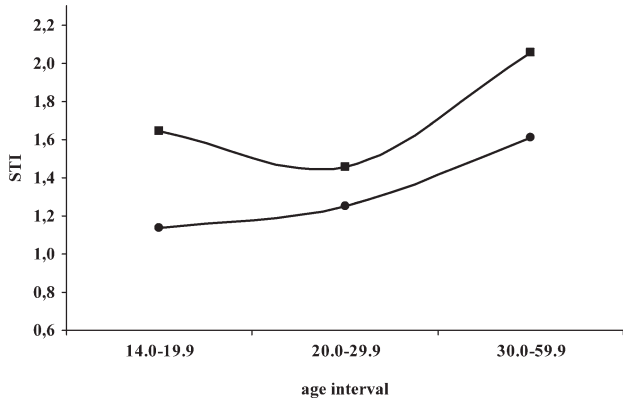


Fig. 4. Curves of subscapular/tricipital index (STI) in males (squares) and females (circles).

population seem to be a common condition in populations of South America (Bustos et al., 2001; Foster et al., 2005; Piperata, 2007).

The study of body size and shape also allows better understanding of the socio-economical condition that these populations go through (Varela-Silva and Bogin, 2003). As an example, the sitting height ratio is considered to be as sensitive, and perhaps even more sensitive, than stature as a measure of environmental quality (Bogin et al., 2001, 2002; Frisancho et al., 2001; Smith et al., 2003). These body modifications were accompanied with a relatively longer trunk. Thus, the low height of the population probably resulted from shortening of the lower limbs as a consequence of the changes in body composition and proportions seen previously in Mbyá children aged 1–14 years old inhabiting the same communities (Zonta et al., 2010). According with Bogin and Varela Silva (2010), a special feature of the human pattern is that between birth and puberty the legs grow relatively faster than other post-cranial body segments.

Several investigators looked at maintenance of traditional culture and suggest that this is a protective factor, especially for problems related to nutrition and moves from a nomadic to a sedentary urban life (Hollenberg 1997; Santos, 1993). In this sense, the lifestyle and, especially, the economy of the Mbya-Guaraní, have been modified over time because of the interactions with other American ethnic groups and with Europeans during the long process of conquest and colonization. The colonization of the forest in the province of Misiones was based on different kinds of economic activities (i.e., industrial-type cultivation and the exploitation of timber trees), and has gradually reduced and modified the features of this habitat affecting the territory and culture of the native communities. Consequently, the Mbya characterized by their large-scale migrations, that nowadays would be considered transnational, exhibit at present a sedentary tendency, while simultaneously searching through the socio-environment for conditions that make the development of their traditional activities possible. So, the Mbyá population investing less time in traditional activities and moving about less in search of resources, which in turn has been worsened in recent years by the addition of economic and/or alimentary assistance plans provided by the local government (Crivos et al., 2007). Therefore, the high

prevalence of stunting and the presence of overweight that were found in the Mbyá may be related to observe lifestyle, feeding habits, and consumption.

Obesity is a new phenomenon in the evolutionary history of man (Ulijaszek and Lofink, 2006). In the last 60 years the social, economic, and technological changes have modified lifestyles all over the world. According to Uauy et al. (2001) and Kuhnlein et al. (2004) westernization of indigenous diets tends to imply reduced consumption of foods accessed through fishing, hunting, herding, gathering, or own production (like fish, meat, fruits, berries, tubers, etc.), and increased reliance on a purchased diet consisting of pre-processed foods and drinks, high in refined carbohydrates, and saturated fat. The Mbyá population does not have sufficient cash income for buying these types of industrial food; nevertheless, their diet was higher in calories and may not be sufficiently in protein or in key micronutrients. Nutritional interviews and direct observational studies provided us detailed qualitative information on the diet of these populations. The Mbya diet includes high use of fat, oil, and carbohydrates. Reviro, manioc, and chipá were common meals eaten by children and adults every day. Meat is currently scarce in people's diet, which mainly includes horticultural products and wild fruits (Remorini, 2008). The influence of the diet and in the lifestyle was evident too in the analysis of body shape. The Mbyá population presented low arm circumference and muscle area indicating possible acute protein malnutrition and an adipose tissue distribution pattern, which indicated centralized adiposity manifested in both sexes. This adiposity pattern is frequently associated with lipid disorders (dyslipidemia and hypertriglyceridemia) and hypertension, and may make individuals more susceptible to cardiovascular diseases. Cardoso et al. (2001) and Tavares et al. (2003) have observed that the progressive change in the patterns of nutrition and physical activity of aboriginal populations has led to increase of those indexes and risk of this type of diseases.

Finally, although the values, especially for overweight and obesity, were lower than those reported by Orden and Oyhenart (2006) for other Mbyá-Guaraní communities of Misiones or by Zonta (2010) for children of the same communities this problem issue, cannot be dismissed. Literature on early developmental programming describes how nutritional deprivation during the fetal period and early childhood leads to adaptations that may result in obesity during later life (Lanigan and Singhal, 2009). This may partly explain the co-occurrence of stunting in early childhood with overweight (Kimani-Murage et al., 2010). Insufficient diets and diseases are the immediate negative determinants of malnutrition, together with alimentary insecurity, insufficient education, lack of medical assistance, deficient sanitary, and bad hygiene conditions are also another underlying causes (UNICEF 1990; Jonsson 1995). Nevertheless, the main basic determinant is poverty, which along with the changes in lifestyle and diet composition, results in reduced size and altered body composition and proportions. Although the latter could be considered as an adaptive response to the adverse environmental conditions that these populations are chronically exposed to, they would favor the coexistence of malnutrition and overweight in a single scenario and consequently, the risk of infectious and nontransmissible diseases. According to Bogin et al. (2007) under adverse conditions, trade-offs result in reduced survival, poor growth, constraints on physical activity, and poor reproductive outcomes. Models of human development may need to be refined to accommodate a greater range of the biological and cultural sources of adversity as well as their independent and interactive influences.

CONCLUSIONS

The poverty rooted in the socio-cultural transition that these populations pass out, represents the fundamental cause that favors, in Mbyá adolescent and adults of the Takuapí, Ka'a cupe, and El Pocito communities, severe growth stunting, and presence of overweight. Relatively short legs, low arm muscle area, and centralized adiposity; indicate the quality of the environment and the plasticity of the human body in relationship to stressing factors.

LITERATURE CITED

Bogin B, Kapell M, Varela Silva MI, Orden AB, Smith PK, Loucky J. 2001. How genetic are human body proportions? In: Dasgupta P, Hauspie R, editors. Perspectives in human growth, development and maturation. Dordrecht, The Netherlands: Kluwer. p 205–221.

Bogin B, Smith P, Orden AB, Varela Silva MI, Loucky J. 2002. Rapid change in height and body proportions of Maya American children. Am J Hum Biol 14:753–761.

Bogin B, Varela Silva MI, Rios L. 2007. Life history trade-offs in human growth: adaptation or pathology? Am J Hum Biol 19:631–642.

Bogin B, Varela-Silva MI. 2010. Leg length, body proportion, and health: a review with a note on beauty review. Int J Environ Res Public Health 7:1047–1075.

Bolzán A, Mercer R, Ruiz V, Brawerman J, Marx J, Adrogué G, Carioli N, Cordero C. 2005. Evaluación nutricional antropométrica de la niñez pobre del norte Argentino: proyecto encuNa. Arch Argent Pediatr 103:545–555.

Bustos P, Amigo H, Muñoz SR, Martorell R. 2001. Growth in indigenous and nonindigenous chilean schoolchildren from 3 poverty strata. Am J Public Health 91:1645–1649.

Cabrera AL. 1971. Fitogeografía de la República Argentina. Boletín de la Sociedad Argentina de Botánica 14:1–42.

Cardoso A, Mattos I, Koifman R. 2001. Prevalence of risk factors for cardiovascular disease in the Guaraní-Mbyá population of the State of Rio de Janeiro. Cad Saúde Pública 17:345–354.

Casapía M, Joseph SA, Núñez C, Rahme E, Gyorkos TW. 2006. Parasite risk factors for stunting in grade 5 students in a community of extreme poverty in Peru. Int J Parasitol 36:741–747.

Cesani MF, Zonta ML, Castro L, Torres MF, Forte LM, Orden AB, Quintero FA, Luis MA, Sicre ML, Navone GT, Gamboa MI, Oyhenart EE. 2007. Estado nutricional y parasitosis intestinales en niños residentes en zonas urbana, periurbana y rural del partido de Brandsen (Buenos Aires, Argentina). Rev Arg Antropol Biol 9:105–121.

Crivos M, Martinez MR, Navone G, Pochettino ML, Arenas P, Digiani C, Teves L, Remorini C, Sy A, Illkov C, Delorenzi N. 2002. Un enfoque etnogáfico- biológico en el estudio de las enteroparasitosis en comunidades Mbyá-Guaraníes (Misiones, Argentina). Sztuka Leczenia 8:199–213.

Crivos M, Martínez MR, Pochettino ML, Remorini C, Sy A, Teves L. 2007. Pathways as "signatures in landscape": towards an ethnography of mobility among the Mbya-Guaraní (Northeastern Argentina). J Ethnobiol Ethnomed 3:1–12.

Deurenberg P, Pieters JJ, Hautvast JG. 1990. The assessment of the body fat percentage by skinfold thickness measurements in childhood and young adolescence. Br J Nutr 63:293–303.

Drewnowski A. 2009. Obesity, diets, and social inequalities. Nutr Rev 67:36–39.

Eisenmann JC, Arnall DA, Kanuho V, McArel H. 2003. Growth status and obesity of Hopi children. Am J Hum Biol 15:741–745.

Encuesta Complementaria de Pueblos Indígenas (ECPI). 2004–2005. Complementaria del censo de Población y Vivienda 2001. INDEC. Ministerio de Economía y Producción de la Nación.

Food and Agriculture Organization (FAO) of the United Nations. 2006. The double burden of malnutrition. Case studies from six developing countries: FAO Food Nutr Pap 84:1–334.

Foster Z, Byron E, Reyes-García V, Huanca T, Vadez V, Apaza L, Pérez E, Tanner S, Gutierrez Y, Sandstrom B, Yakhedts A, Osborn C, Godoy RA, Leonard WR. 2005. Physical growth and nutritional status of Tsimane'

Amerindian children of lowland Bolivia. Am J Phys Anthropol 126:343–351.
Frisancho R. 1990. Anthropometric standards for the assessment of growth and nutritional standards. Ann Arbor: University of Michigan Press.
Frisancho AR. 2008. Anthropometric standards: an interactive nutritional reference of body size and body composition for children and adults. Ann Arbor, MI: University of Michigan Press.
Frisancho A, Guilding N, Tanner S. 2001. Growth of Leg length is reflected in socioeconomic differences. Acta Med Auxol 33:47–50.
Gorstein J, Sullivan K, Yip R, de Onís M, Trowbridge F, Fajans P, Clugston G. 1994. Issues in the assessment of nutritional status using anthropometry. Bull WHO 72:273–283.
Gotthelf SJ, Jubany LL. 2005. Comparación de tablas de referencia en el diagnóstico antropométrico de niños y adolescentes obesos. Arch Argent Pediatr 103:129–134.
Groeneveld IF, Solomons NW, Doak CM. 2007. Nutritional status of urban schoolchildren of high and low socioeconomic status in Quetzaltenango, Guatemala. Rev Panam Salud Pública 22:169–177.
Gugelmin SA, Ventura Santos R. 2001. Ecología humana e antropometría nutricional de adultos Xavánte, Mato Grosso, Brasil. Cad Saúde Pública 17:313–322.
Habicht JP, Martorell R, Yarbrough C, Malina R, Klein R. 1974. Height and weight standards for preschool children: how relevant are ethnic differences in growth potential? Lancet 1:611–614.
Hollenberg NK, Martinez G, McCullough M, Meinking T, Vicaria-Clement M. 1997. Aging, acculturation, salt intake, and hypertension in the Kuna of Panama. Hypertension 29:171–176.
Huamán-Espino L, Valladares CE. 2006. Estado nutricional y características del consumo alimentario de la población aguaruna. Amazonas, Perú 2004. Rev Peru Med Exp Salud Publica 23:12–21.
Huber AA, Mampaey M, Gamboa MI, Zonta ML, Navone G. 2005. Fitoterapia Mbyá-Guaraní en el control de las parasitosis intestinales. Una experiencia piloto en tres aldeas de Misiones, Argentina. Parasitol Latinoam 60:276.
Jonsson U. 1995. Towards an improved strategy for nutrition surveillance. Food Nutr Bull 16:102–111.
Kimani-Murage EW, Kahn K, Pettifor JM, Tollman SM, Dunger DB, Gómez-Olivé XF, Norris SA. 2010. The prevalence of stunting, overweight and obesity, and metabolic disease risk in rural South African children. BMC Public Health 10:158.
Komlos J, Baur M. 2004. From the tallest to (one of) the fattest: the enigmatic fate of the American population in the 20th Century. Econ Hum Biol 2:57–74.
Kuhnlein HV, Receveur O, Soueida R, Egeland GM. 2004. Arctic indigenous peoples experience the nutrition transition with changing dietary patterns and obesity. J Nutr 134:1447–1453.
Lanigan J, Singhal A. 2009. Early nutrition and long-term health: a practical approach. Proc Nutr Soc 68:422–429.
Leite MS, Santos RV, Gugelmin SA, Coimbra ACE Jr. 2006. Physical growth and nutritional profile of the Xavánte indigenous population in Sangradouro-Volta Grande, Mato Grosso, Brazil. Cad Saúde Pública 22:265–276.
Lohman TG, Roche AF, Martorell R. 1988. Anthropometric standardization reference manual. Illinois: Human Kinetics Books.
Martínez MR, Crivos M, Teves L. 2004. Owners, Intruders and Intermediaries: the claim for lands within the Mbya-Guaraní community (Valley of Cuñapirú, Misiones, Argentina). In: Engerman SL, Metzer J, editors. Land rights, ethno-nationality, and sovereignty in history. London: Routledge. p 347–357.
Martinez E, Devesa M, Bacallao J, Amador M. 1993. Índice subescapular/tricipital: valores percentilares en niños y adolescentes cubanos. Arch Latinoam Nutr 43:199–203.
Mendez M, Du SF, Popkin B. 2004. Urbanization, income and the nutrition transition in China: a case study. FAO. Globalization of food systems in developing countries: impact on food security and nutrition FAO Food and Nutrition Paper No. 83. Rome. p 169–194.
Montenegro RA, Stephen C. 2006. Indigenous health in Latin America and the Caribbean. Lancet 367:1859–1869.
Muniz-Junqueira MA, Oliveira Queiróz EF. 2002. Relationship between protein-energy malnutrition, vitamin A and parasotoses in children living in Brasilia. Revista da Sociedade Brasileira de Medicina Tropical 35:133–141.
Navone GT, Gamboa MI, Oyhenart EE, Orden AB. 2006. Parasitosis intestinales en poblaciones Mbyá-Guaraní de la Provincia de Misiones. Aspectos epidemiológicos y nutricionales. Cad Saúde Pública 22:1089–1100.
Nematian J, Nematian E, Gholamrezanezhad A, Ali Azgari A. 2004. Prevalence of intestinal parasitic infections and their relation with socio-economic factors and hygienic habits in Tehran primary school students. Acta Trópica 92:179–186.
Núñez-Rivas HP, Monge-Rojas R, León H, Roselló M. 2003. Prevalence of overweight and obesity among Costa Rican elementary school children. Rev Panam Salud Públ 13:24–32.
Orden AB, Oyhenart EE. 2006. Prevalence of overweight and obesity among Guaraní-Mbyá from Misiones, Argentina. Am J Hum Biol 18:590–599.
Orden AB, Torres MF, Luis MA, Cesani MF, Quintero FA, Oyhenart EE. 2005. Evaluación del estado nutricional en escolares de bajos recursos socioeconómicos en el contexto de la transición nutricional. Arch Argent Pediatr 103:205–211.
Oyhenart EE, Dahinten SL, Alba JA, Alfaro EL, Bejarano IF, Cabrera GE, Cesani MF, Dipierri JE, Forte LM, Lomaglio DB, Luis MA, Luna ME, Marrodán MD, Moreno Romero S, Orden AB, Quintero FA, Sicre ML, Torres MF, Verón JA, Zavatti JR. 2008. Estado nutricional infanto juvenil en Argentina: variación regional. Rev Arg Antropol Biol 10:1–62.
Oyhenart EE, Techenski MF, Orden BA. 2003. Nutritional status in two Mbyá-Guaraní communities from Misiones (Argentina). HOMO 54: 170–179.
Oyhenart EE, Torres MF, Quintero F, Luis MA, Cesani MF, Zucchi M, Orden AB. 2007. Estado nutricional y composición corporal de niños pobres residentes en barrios periféricos de La Plata (Argentina). Rev Panam Salud Públ 22:194–201.
Pais AB, Fernandez de Carrera E. 2009. Necessidades básicas insatisfeitas, desnutrição infantil e risco de doenças na vida. Rev Paul Pediatr 27:127–132.
Pajuelo J, Rocca J, Gamarra M. 2003. Obesidad infantil: sus características antropométricas y bioquímicas. Ann Fac Med 64:21–26.
Pedraza DF. 2009. Obesidad y Pobreza: marco conceptual para su análisis en Latinoamérica. Saúde Soc 18:103–117.
Pícoli RP, Carandina L, Ribas DLB. 2006. Saúde materno-infantil e nutrição de rianças Kaiowá e Guaraní, Área Indígena de Caarapó, Mato Grosso do Sul, Brasil. Cad Saúde Pública 22:223–227.
Piperata BA. 2007. Nutritional status of Ribeirinhos in Brazil and the nutrition transition. Am J Phys Anthropol 33:868–878.
Pochettino ML, Martinez MR, Arenas PM, Crivos M, Navone G, Digiani C, Teves L, Remorini C, Sy A, Illkow C, Delorenzi N. 2003. Fitoterapia Mbyá: análisis y evaluación del tratamiento de las parasitosis. Delpinoa 45:301–310.
Popkin B. 2003. The Nutrition Transition in the Developing World. Dev Policy Rev 21:581–597.
Popkin BM. 2011. Contemporary nutritional transition: determinants of diet and its impact on body composition. Proc Nutr Soc 70:82–91.
Popkin BM, Gordon-Larsen P. 2004. The nutrition transition: worldwide obesity dynamics and their determinants. Int J Obes 28:S2–S9.
Remorini C. 2008. Aporte a la caracterización etnográfica de los procesos de salud-enfermedad en las primeras etapas del ciclo vital, en comunidades Mbyá-Guaraní de Misiones, República Argentina. Tesis Doctoral N°: 0960. Universidad Nacional de La Plata.
Rivera JA, Monterrubio EA, González-Cossío T, García-Feregrino R, García-Guerra A, Sepúlveda-Amor J. 2003. Nutritional status of indigenous children younger than five years of age in Mexico: results of a national probabilistic survey. Salud Pública Méx 45: 466–476.
Santos RV. 1993. Physical growth and nutritional status of Brazilian Indian populations. Cad Saude Publica 9:46–57.
Santos RV, Coimbra JrCEA. 2003. Cenarios e tendencias da saúde e da epidemiología dos povos indígenas no Brasil. In: Coimbra CEA Jr., Santos RV, Escobar AL, editors. Epidemiología e saúde dos povos indígenas no Brasil. Río de Janeiro: Editora Fiocruz/Abrasco. p 13–47.
Smith PK, Bogin B, Varela-Silva MI, Loucky J. 2003. Economic and anthropological assessments of the health of children in Maya immigrant families in the US. Econ Hum Biol 1:145–160.
Story M, Evans M, Fabsitz RR, Clay TE, Holy Rock B, Broussard B. 1999. The epidemic of obesity in American Indian communities and the need for childhood obesity prevention programs. Am J Clin Nutr 69: 747–754.
Tanner S, Leonard WR, McDade TW, Reyes-García V, Godoy R, Huanca T. 2009. Influence of heminth infections on childhood nutricional status in Lowland Bolivia. Am J Hum Biol 21:651–656.
Tavares EF, Vieira-Filho JPB, Andriolo A, Sañudo A, Gimeno SGA, Franco LJ. 2003. Metabolic profile and cardiovascular risk patterns of an Indian tribe living in the Amazon region of Brazil. Hum Biol 75: 31–46.
Uauy R, Albala C, Kain J. 2001. Obesity trends in Latin America: transiting from under- to overweight. J Nutr 131:893–899.
Ulijaszek SJ, Kerr DA. 1999. Anthropometric measurement error and the assessment of nutritional status. Br J Nutr 82:165.
Ulijaszek SJ, Lofink K. 2006. Obesity in biocultural perspective. Ann Rev Anthropol 35:337–360.

UNICEF (United Nations International Children's Emergency Fund). 1990. Strategy for improved nutrition of children and women in developing countries. New York: UNICEF.

Valeggia CR, Burke KM, Fernandez-Duque E. 2010. Nutritional status and socioeconomic change among Toba and Wichí populations of the Argentinean Chaco. Econ Hum Biol 8:100–110.

Varela-Silva MI, Bogin B. 2003. Growth as a measure of socioeconomic inequalities and poor living conditions among Portuguese, Cape Verdean-Portuguese, and Cape Verdean children, between 1993 and 2001. Lusophone Africa: Intersections between the Social Sciences. Cornell University. p 1–17.

WHO (World Health Organization). 1998. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation on Obesity, Geneva, World Health Organization (WHO).

Wilson WM, Dufour DL, Staten LK, Barac-Nieto M, Reina JC y GB Spurr. 1999. Gastrointestinal parasitic infection, anthropometrics, nutritional status, and physical work capacity in Colombian boys. Am J Hum Biol 11:763–771.

Zonta ML. 2010. Crecimiento, estado nutricional y enteroparasitosis en poblaciones aborígenes y cosmopolitas: los Mbyá guaraní en el Valle del arroyo Cuña Pirú y poblaciones aledañas (Misiones). Tesis Doctoral. Universidad Nacional de La Plata. Disponible en http://sedici.unlp.edu.ar/search/request.php?id_document=ARG-UNLP-TPG-0000000598.

Zonta ML, Oyhenart EE, Navone GT. 2010 Nutritional status, body composition, and intestinal parasitism among the Mbyá-Guaraní communities of Misiones, Argentina. Am J Hum Biol 22: 193–200.