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NUTRITIONAL STATUS AND SEXUAL DIMORPHISM IN THREE AMAZONIAN CABOCLO COMMUNITIES

ABSTRACT: Three Caboclo communities from Marajo Island (State of Pará, Brazil) were studied. Paricatuba is the most traditional one. Marajo-Açu is devoted to the extraction and commercialization of the fruit of açai. Praia Grande has adopted a mechanized agriculture, cattle raising and a cooperative religious organization. Three hundred and ten 0–30 year-old Caboclo males and females were measured. Each sample community was divided into three age stages: preadolescent (0–10 years old), youth (11–20 years old), and adult (21–30 years old). Body weight and height, mid upper-arm circumference, triceps skinfold, and bicondylar humerus width were measured. Body mass index, and upper-arm fat, muscle and bone proportions were calculated. In preadolescents, underweight and stunting frequencies were found to be greater in Paricatuba and Marajo-Açu than in Praia Grande. Few significations for wasting were found in all. Sex dimorphism for youths was present in the three communities, whose upper-arm fat proportion was greater in females than in males. Adult Praia Grande males had a greater upper-arm muscle proportion – and females a greater upper-arm fat proportion – than in the other two villages. In synthesis, the three communities underwent some kind of nutritional stress, but Praia Grande was in better conditions than Paricatuba and Marajo-Açu. This suggests an improvement in Praia Grande quality of life, presumably due to westernisation.

KEY WORDS: Growth – Underweight – Stunting – Wasting – Westernisation

INTRODUCTION

Caboclo is the term commonly used to describe the populations originated from the admixture of African, European (mostly Portuguese) and Native American ancestry in Brazil (Moran 1974, Parker 1985). Caboclo populations have inhabited Marajo Island, in the estuary of the Amazon River, for more than a century (Moran 1974, Murrieta *et al.* 1992). In other parts of the Amazonian estuary, Caboclo populations have been reported to show about 53% of European, 22% of Native American, and 25% of African ancestry in their gene pool (Salzano 1986).

Since the early 70s, Caboclo communities of Marajo Island have been experiencing different degrees of change: from the traditional slash-and-burn subsistence agriculture to the cash-based mechanized one. Although some authors assume that the so-called "traditional societies" show a visible deterioration of nutritional status and suffer from more diseases during the process of westernisation, the opposite view is also defended. Holmes (1985), in her analysis of westernisation on Amazonian communities, did not find any correlation between acculturation and the nutritional status of the populations of Rio Negro and Rio Orinoco (Venezuela). In a more recent study, Holmes (1993) showed weight and height values above the minimum recommended by the World Health Organization in four Indian communities and neighbouring criollo (South and Central America people from European parents) communities. Dricot and Dricot (1978), however, studying three Peruvian Machiguenga communities, observed a sensitive worsening of the adult male nutritional status in the most westernised place. Santos (1993) stressed that the acculturation process frequently aggravates the nutritional status of Indian groups. Pavan *et al.* (1997) found that the transition of Amazonian populations from a rural to an urban lifestyle might be accompanied by an increased risk of cardiovascular diseases. Nevertheless, Santos and Coimbra Jr. (1991), in a study undertaken among three Tupi-Mondê tribes of Rondonia and Mato Grosso (Brazil), noted a greater deficit in some anthropometric variables in the tribe less exposed to western habits.

In this paper, we report the anthropometrical results of three Amazonian Caboclo communities in different states of westernisation (for details see: Murrieta *et al.* 1999). The aim was: (a) to compare children's growth against international standards for evaluating prevalences of undernutrition; (b) to detect if sexual dimorphism is already present in youths; and (c) to evaluate if the differences in the nutritional status of adults are related to the differences in the three socio-economic systems.

MATERIAL AND METHODS

Population characteristics

The populations under study were located on the Southeast coast of Marajo Island, estuary of the Amazon, and settled near the mouth of Marajo-Açu river, along its margins, or along one of its tributaries (Igarape do Paricatuba), and along the beach called Praia Grande. The three localities belong to the district of Ponta de Pedras (approximately 10 22' 54"S, 48 50' 10"W), State of Pará, Brazil.

The studied area is a transitional region between the two dominant macroenvironments of Marajo Island: dense shady forest and grassland savannah, exhibiting ecotonal characteristics (Siqueira *et al.* 1995). The landscape where they are settled is a mosaic of primary and anthropic environments (mangroves, varzea forests, aningais and açaizais) (Murrieta *et al.* 1989). The climate is characterized by two different seasons: a rainy one (winter) from December to April, and a dry one (summer) from May to November.

The populations of Marajo-Açu and Igarape do Paricatuba are situated on the varzea, while the community of Praia Grande is settled on terra firme. The population of Paricatuba, with 144 residents during the investigation, relies strongly on native subsistence strategies. Its economy is based predominantly on slash-and-burn agriculture, associated to different extraction practices, notably of açai (*Euterpe deracia*). Families in Paricatuba grow mostly manioc, sugar cane, and bananas. The choice of crops is often dictated by the nature of the land where the gardens are situated, either terra firme or varzea. Most of the residents are small land owners, who also shrimp, fish, hunt, and gather for survival (Neves 1992, Siqueira *et al.* 1995). The food supply seems to be relatively constant along the year. The protein and calorie consumptions were calculated by one of us (RSSM) using households as unity of analysis (*Table 1*).

The population of Marajo-Açu, which is in an intermediate state of modernization, had 323 inhabitants by the time of the fieldwork, almost all meeiros. The residents had broadly abandoned agricultural subsistence practices in favour of the commercial extraction of açai, which is sold in nearby towns, mainly in Ponta de Pedras and Belém, the State capital. The açai extraction plays a vital role in the economic universe of Marajo-Açu and it is the key factor to understand the recent changes in the area. The harvest of açai takes place from late August or early September to January. Subsistence activities also include hunting, fishing and shrimping on a very irregular basis (Neves 1992). The caloric and protein intakes per household are the highest of three populations (*Table 1*).

TABLE 1. Percent consumption of proteins (g) and calories (kcal) in relation to FAO-WHO-UNU (1985) recommendations, and seasonal variation (Murrieta 1994).

	Rainy season	Dry season
Proteins		
Paricatuba	178.84	196.51
Marajo-Açu	381.54	295.03
Praia Grande	213.33	255.25
Calories		
Paricatuba	120.02	133.85
Marajo-Açu	212.67	166.35
Praia Grande	92.80	127.26

Praia Grande, with 111 residents by the time of the investigation, differs significantly from the other two communities. This responds to intense socio-economic changes during the past 20 years. A marked shift in Praia Grande subsistence activities took place when the community members decided, under strong influence of the Catholic Church, to abandon the "traditional" Caboclo life style and adopt a cooperative system of mechanized agriculture and cattle raising. Beans, rice, maize, and coconut are cultivated employing western techniques, and, until recently, cattle were bred intensively (Murrieta *et al.* 1992). Inhabitants of Praia Grande are completely integrated in the market economy and culture of the area. This includes access to electricity and processed food and other commercially produced (consumer) products. Murrieta (1994) showed that during the rainy season the caloric supply is slightly below than the mean Marajo-Açu consumption (*Table 1*). However, the same author noticed that Praia Grande shows the most diversified dietary repertoire (78 items against 59 for Marajo-Açu, and 56 for Paricatuba). Notably, Silva *et al.* (1995) showed that Praia Grande residents' blood pressure is significantly higher than that of Paricatuba ones.

Anthropometry

Body weight (bw) was measured with a beam scale (500 gm precision) in individuals wearing light clothing. Standing height (sh) was taken with a metal anthropometer (1 mm precision). Mid upper-arm circumference (MUAC) was taken with a metal tape measure (1 mm precision) at the midline of the left upper-arm. Bicondylar humerus width (hw) was taken with a sliding calliper (1 mm precision) at the distal end of the upper-arm. Triceps skinfold (ts) was taken on the dorsal surface of the upper-arm, at the same level as MUAC (Lange calliper, 0.1 mm precision). Three hundred and ten people of both sexes and from birth to 30 years of age were measured. One observer made all measurements (WAN) during the dry season. Body mass index (BMI) (Chumlea 1991, Cole 1991) was calculated as:

$BMI=bw/Sh^2$; where: bw=body weight (kg), and sh=standing height (m).

The mid upper-arm circumference (MUAC), the triceps skinfold (ts), and the bicondylar humerus width (hw) were employed to calculate the upper-arm width components as proportions of the mid upper-arm diameter (MUAD). Since MUAC approaches to a circumference, then:

$MUAD=MUAC/\pi$.

MUAD may be thought as composed by three length fractions. They are fat (fd), muscle (md), and bone (bd) diameters, all taken or estimated at the mid upper-arm region. We know that fd is acceptably equal to triceps skinfold, since mid upper-arm fat diameter is equal to the sum of half of the biceps skinfold value plus half of the triceps skinfold value. Bone diameter (bd) was deduced as bd=hw*k (cm); where the constant (k=0.381) was calculated dividing the humerus diaphysis by the bicondylar humerus width of fifty Caucasians, at different ages and sexes. The bones belonged to the Museo de La Plata and to the Centro Nacional Patagónico (Puerto Madryn, Argentina) (Dahinten and Pucciarelli, 2003). This constant presented 70% of reliability (r=0.84) in the linear regression; and a nonsignificant sex difference was obtained. The muscle diameter (md) was calculated by difference:

if MUAD=fd+md+bd, then md=MUAD–(fd+bd).

Every diameter calculated was affected by size (mainly due to body height variation) and/or scaling (mainly due to the different sized variables). Both undesirable effects were eliminated by transforming the diameters into proportions of the MUAD. Fat (fp), muscle (mp), and bone (bp) proportions were calculated as follows:

If fd+md+bd=MUAD, then:
fp=100*fd/MUAD
mp=100*md/MUAD
bp=100*bd/MUAD.

Each sample was divided into three sub samples: preadolescent (0–10 years old), youth (11–20 years old) and adult (21–30 years old). According to Gorstein (1989), comparisons against international standards are valid only up to ten years of age because variability due to sex and ethnicity in the adolescent growth spurt may distort the weight-height-age relationship. The 0–10 year-old children were compared against the international references given by the NCHS/WHO (WHO Working Group 1986, Gorstein 1989, Onís *et al.* 1993). Z-scores were calculated by subtracting the median of the reference to each individual value and dividing by the standard deviation of the reference. Z-scores were calculated for weight-for-age, height-for-age, and weight-for-height indices. The height-for-age index measures growth delays in stature (stunting) with respect to the reference for the same age and sex (WHO Working Group 1986, Gorstein 1989, Onís *et al.* 1993). The height-for-weight index measures the delay of weight gain – or the actual loss of weight – (wasting) with respect to the reference values for the same height. The weight-for-age index measures underweight. Some authors believe that the height-for-age index measures chronic undernutrition, and the weight-for-height one shows the presence of acute undernutrition. However, according to Waterlow (1972), the terms chronic and acute undernutrition are not recommended because they are not as descriptive as stunting, wasting, and underweight.

The cutoff point chosen here was –2SD. Underweight, stunting and wasting were considered present from –2SD under the median of the NCHS reference population for weight-for-age, height-for-age, and weight-for-height, respectively (Keller and Fillmore 1983, Gorstein 1989, Gernaat *et al.* 1996). The prevalences were calculated as the percentage of children below the cutoff value (Gorstein 1989, Onís *et al.* 1993).

One word about the constraints of this methodology should be said. Supposing that a population "A" presents 10% of children with –2SD and 5% with –3SD of stunting; this 15% of calculated prevalence will be equal to that of a population "B", presenting 5% of children with –2SD and 10% with –3SD of stunting. Both populations are, however, differently affected, since the risk at –3SD is greater than at –2SD. Considering the different degrees of risk usually solves this. It is possible to express information in one datum, multiplying the prevalence of each age stage, from –2SD, by the mean value of the respective SD range to obtain the Prevalence index (PrI):

$PrI= \sum[Pz*(-SD/2)]$; where: Pz= percent of children at each –SD at risk; and SD/2= the middle value of the range between the cutoff points.

In our example, population "A" would have a PrI of –42.5 (i.e.: 10*[–2.5]+5*[–3.5]) and population "B" one of –47.5 (i.e.: 5*[–2.5]+10*[–3.5]). The prevalence index measures actually the intensity of undernutrition and would replace the rough prevalence data.

Between-sex and between-place comparisons were standardized as Percent Differences between Means (PDM) according to the formula:

$PDM=100* (X_1-X_2)/X_1$.

For sexual dimorphism comparisons: X_1= mean value of a given variable for males; and X_2= mean value of the same variable for females. For example, a fp with PDM=–10.0 means that females were 10% greater than males with respect to this variable. For between-place comparisons, X_1= mean value of a given variable from a place (for example, Paricatuba males) and X_2= mean value of the same variable from another place (for example, Marajo-Açu males). A BMI with PDM= 5.0 means that, for males, Paricatuba was 5% greater than Marajo-Açu in body mass

TABLE 2. Sample sizes.

	Male	Female	Total
Paricatuba			
Preadolescent	21	25	46
Youth	13	14	27
Adult	10	5	15
Subtotal	44	44	88
Marajo-Açu			
Preadolescent	37	36	73
Youth	27	24	51
Adult	10	10	20
Subtotal	74	70	144
Praia Grande			
Preadolescent	22	15	37
Youth	18	8	26
Adult	5	10	15
Subtotal	45	33	78
Total	163	147	310

index (for details see: Oyhenart *et al*. 1998). In order to avoid the effect of the different age ranges between sex and place, the youth and adult data variables were adjusted by age expressed as Adj. sex, and Adj. place, respectively.

ANALYSIS

Sample sizes are described in *Table 2*. The normality of the frequency distributions for all anthropometric variables was tested by the one sample Kolmogorov-Smirnov (K-S) test. The variables that showed asymmetry were body weight for males in Praia Grande; triceps skinfold for females in Marajo-Açu; and body mass index in Marajo-Açu, and Paricatuba. Asymmetries were solved by the normal – log(n) – procedure. After the log(n) transformation, asymmetries were corrected with K-S=p>0.05.

TABLE 3. Mean (X) and standard deviation (SD) of the variables, indices, and proportions in males.

Variable	Paricatuba		Marajo-Açu		Praia Grande	
	X	SD	X	SD	X	SD
Preadolescent						
Body weight	15.41	5.24	15.61	5.93	17.98	5.04
Standing height	99.34	17.54	98.12	18.90	106.92	15.61
Body mass index	15.24	1.17	15.75	1.60	15.46	0.94
Triceps skinfold	0.69	0.14	0.73	0.16	0.71	0.17
Bicondylar width	4.10	0.64	4.22	0.62	4.66	0.56
Upper-arm circumference	15.34	1.46	15.80	1.49	16.20	1.39
Upper-arm fat proportion	14.27	3.04	14.60	3.66	13.85	3.34
Upper-arm muscle proportion	54.03	2.85	53.73	2.66	51.96	2.63
Upper-arm bone proportion	31.70	2.63	31.67	2.88	34.19	2.44
Youth						
Body weight	37.36	10.27	35.74	8.50	35.04	8.06
Standing height	141.92	13.42	141.90	11.28	140.43	10.86
Body mass index	18.18	2.17	17.49	1.92	17.51	1.70
Triceps skinfold	0.86	0.25	0.64	0.18	0.60	0.11
Bicondylar width	5.86	0.61	5.96	0.51	5.93	0.65
Upper-arm circumference	21.52	2.94	21.04	2.50	20.72	1.73
Upper-arm fat proportion	12.50	3.15	9.52	2.37	9.11	1.97
Upper-arm muscle proportion	54.88	3.11	56.57	3.24	56.79	2.57
Upper-arm bone proportion	32.63	2.13	33.92	2.66	34.10	2.30
Adult						
Body weight	58.86	4.20	58.80	10.57	58.45	5.80
Standing height	161.71	3.94	160.66	6.89	162.80	3.84
Body mass index	22.51	1.44	22.62	2.34	22.09	2.39
Triceps skinfold	0.58	0.11	0.52	0.12	0.67	0.30
Bicondylar width	6.79	0.30	6.77	0.52	6.89	0.28
Upper-arm circumference	27.96	1.47	28.08	3.45	27.79	2.42
Upper-arm fat proportion	6.55	1.17	5.83	1.15	7.56	2.94
Upper-arm muscle proportion	64.48	2.51	65.31	2.10	62.15	3.20
Upper-arm bone proportion	28.97	2.01	28.86	2.04	30.29	3.44

TABLE 4. Mean (X) and standard deviation (SD) of the variables, indices, and proportions in females.

Variable	**Paricatuba**		**Marajo-Açu**		**Praia Grande**	
	X	**SD**	**X**	**SD**	**X**	**SD**
Preadolescent						
Body weight	15.24	3.72	14.68	6.17	13.97	6.06
Standing height	98.89	13.46	96.89	20.41	93.54	22.77
Body mass index	15.48	1.25	14.87	1.43	15.25	1.76
Triceps skinfold	0.81	0.21	0.81	0.18	0.75	0.14
Bicondylar width	3.97	0.45	3.99	0.63	4.06	0.68
Upper-arm circumference	15.46	1.04	15.56	1.92	15.02	1.17
Upper-arm fat proportion	16.53	4.41	16.35	3.43	15.84	4.06
Upper-arm muscle proportion	52.92	3.83	53.21	3.26	52.11	3.84
Upper-arm bone proportion	30.55	2.48	30.44	2.64	32.05	3.60
Youth						
Body weight	36.37	9.23	39.74	13.14	38.26	9.90
Standing height	139.93	9.84	141.77	10.14	142.03	10.75
Body mass index	18.27	2.42	19.31	4.35	18.65	2.42
Triceps skinfold	1.21	0.41	1.95	0.47	1.09	0.42
Bicondylar width	5.32	0.39	5.39	0.51	5.55	0.25
Upper-arm circumference	21.84	2.79	22.40	4.21	21.71	2.81
Upper-arm fat proportion	17.13	4.50	17.15	3.91	15.45	4.46
Upper-arm muscle proportion	53.63	4.09	53.62	2.97	53.71	2.42
Upper-arm bone proportion	29.24	2.28	29.23	3.57	30.79	3.41
Adult						
Body weight	44.64	9.09	54.25	7.66	48.25	4.16
Standing height	149.40	6.79	151.43	6.81	153.85	6.47
Body mass index	19.94	3.47	23.61	2.50	20.45	2.16
Triceps skinfold	1.35	0.71	1.67	0.74	1.07	0.25
Bicondylar width	5.45	0.44	5.74	0.52	5.72	0.56
Upper-arm circumference	23.72	3.40	26.96	2.98	24.71	1.45
Upper-arm fat proportion	17.29	6.06	19.15	7.67	13.56	2.98
Upper-arm muscle proportion	55.09	3.53	55.37	7.01	58.80	2.90
Upper-arm bone proportion	27.62	2.86	25.48	2.37	27.64	3.31

For preadolescents, differences in the prevalences of underweight, stunting and wasting by sex and village (place) were ascertained by the t_p test, a variant of the t-test devoted to proportions when the N (sample size) values are known (see: Orden *et al.* 1999). For youths and adults, differences in anthropometric characteristics were evaluated by the multivariate (MANOVA) and the multifactor (ANOVA) analyses of variance. After the MANOVA results, the multifactor ANOVA was applied for each dependent variable, with age, sex, and place as factors. After ANOVA results, sex and place factors were tested as separate factors by F tests for effects, belonging to the ANOVA procedure. In the youth and adult comparisons, the variables were reduced to six. Since the mid upper-arm circumference (MUAC), the triceps skinfold (TS), and the bicondylar humerus width (hw) became redundant after employed to calculate the fat, muscle and bone proportions.

The statistical analysis was carried out with the SYSTAT 9 and SPSS 7.5 programs, at the CIGEBA (Universidad Nacional de La Plata, Argentina).

RESULTS

The mean and standard deviation values for the variables, indices, and proportions were shown in *Table 3* for males and *Table 4* for females.

Multivariate analysis

The MANOVA analysis was done with the raw-variables (indices not included). Wilks' Lambda (from λ=0.94 for the intercept, to λ=0.65 for the age factor) showed that age, sex, and place were significant factors for the sample as a whole. The same results were drawn from the Hotelling trace (from T=0.07 for the intercept to T=0.52 for the

TABLE 5. Multivariate analysis of variance (MANOVA) for testing factors and interactions.

Factor	Wilks Lambda		Hotelling "T"		Noncentrality parameter	
	Value	F**	Value	F**	Wilks	Hotelling
Intercept	0.94	3.13**	0.07	3.13**	18.77	18.77
Age	0.65	11.53**	0.52	12.40**	138.34	148.75
Sex	0.68	22.61**	0.47	22.61**	135.69	135.69
Place	0.78	6.55**	0.28	6.71**	78.56	80.57
Age*sex	0.80	5.61**	0.24	5.74**	67.29	68.91
Age*place	0.73	4.04**	0.35	4.18**	84.06	100.22
Sex*place	0.76	7.13**	0.31	7.47**	85.58	89.66
Age*sex*place	0.79	6.18**	0.27	6.51**	74.18	78.08

**p<0.01

age factor). The first (age*sex, age*place, sex*place) and second (age*sex*place) levels of interaction were also highly significant (*Table 5*).

Preadolescent comparison

Prevalences

The weight-for-age z-scores showed different degrees of underweight prevalence (SD<–2.0). In males, this was 29% in Paricatuba, 19% in Marajo-Açu, and 5% in Praia Grande. The remaining z-scores ranged from –1.9 to 1.9 SD. Underweight prevalences in females were 8% in Paricatuba, 20% in Marajo-Açu, and 7% in Praia Grande. The remaining z-scores ranged from –1.9 to 2.9 SD. The height-for-age z-scores showed greater levels of prevalence than the former index. In males, stunting prevalence was 52% in Paricatuba, 49% in Marajo-Açu and 23% in Praia Grande. The remaining z-scores ranged from –1.9 to 2.9. In females, prevalences were 40% in Paricatuba, 25% in Marajo-Açu, and 33% in Praia Grande. The remaining z-scores ranged between 1.9 and –1.9. The weight-for-height index showed lower percentages of low-anthropometry than the other indices. In males, wasting prevalence was 5% in Paricatuba, and 0% in Marajo-Açu and Praia Grande. The remaining z-scores

TABLE 6. Prevalence of low anthropometry, and tp comparisons.

	Village			tp-comparison		
	Paricatuba	Marajo-Açu	Praia Grande	Paricatuba – Marajo-Açu	Paricatuba – Praia Grande	Marajo-Açu – Praia Grande
Prevalence males						
Underweight	29.0	19.0	5.0	9.0 **	24.0 **	14.0 **
Stunting	52.0	49.0	23.0	3.0	49.0 **	26.0 **
Wasting	5.0	0.0	0.0	5.0	5.0	0.0
Females						
Underweight	8.0	20.0	7.0	–18.0	1.0	13.0
Stunting	40.0	25.0	33.0	15.0 *	7.0	–8.0
Wasting	0.0	5.0	0.0	–5.0	0.0	5.0
Prevalence index						
Males						
Underweight	76.0	47.0	12.0	29.0 **	64.0 **	35.0
Stunting	155.0	140.0	61.0	15.0 **	94.0 **	79.0
Wasting	12.0	0.0	0.0	12.0 **	12.0 **	0.0
Females						
Underweight	20.0	52.0	17.0	–32.0 **	3.0	35.0 **
Stunting	120.0	98.0	97.0	22.0	23.0	1.0
Wasting	0.0	14.0	0.0	–14.0 **	0.0	14.0

*p<0.05; **p<0.01

ranged between –1.9 and 2.9 SD. In females, Paricatuba and Praia Grande showed no prevalences of wasting, being 5% in Marajo-Açu. The remaining z-scores ranged from –1.9 to 2.9 SD (*Figure 1a–c*). Between-place statistics for underweight showed that, in males and females, Paricatuba and Marajo-Açu had greater prevalences than Praia Grande; Paricatuba being greater than Marajo-Açu, and the latter greater than Praia Grande. Stunting in males showed that Paricatuba and Marajo-Açu had greater prevalences than Praia Grande, the Paricatuba – Marajo-Açu comparison being non-significant. In females, Paricatuba showed a higher prevalence than Marajo-Açu, the remaining ones being non-significant. Non-significant differences were found for wasting in all comparisons (*Table 6*).

Prevalence indices

The weight-for-age in males was 76% in Paricatuba, 47% in Marajo-Açu, and 12% in Praia Grande; while in females it was 20%, 52%, and 17%, respectively. The prevalence index for height-for-age in males was 155% in Paricatuba, 140% in Marajo-Açu, and 61% in Praia Grande; while in females it was 120%, 98%, and 97%, respectively. The prevalence index for weight-for-height in males was 12% in Paricatuba, and 0% in Marajo-Açu and Praia Grande; while in females it was 0%, 14% and 0%, respectively (*Figure 1d–f*). The statistical comparison between places showed that, in males, underweight, stunting, and wasting were higher in Paricatuba than in Marajo-Açu and Praia Grande, underweight being greater in Marajo-Açu than in Praia Grande. In females, underweight and wasting were higher in Paricatuba than in Marajo-Açu, the remaining comparisons being non-significant (*Table 6*).

Youth comparison

The Multifactor ANOVA showed, in raw-data, a model of highly significant differences for all the measurements. After age range correction, between-sex significations were reduced to the fat proportion in females, being greater in Marajo-Açu (80%) and Praia Grande (70%) than in Paricatuba (39%). The remaining components were non-significant (*Table 7*; *Figure 2a–c*).

Adult comparison

The Multifactor ANOVA showed, in raw-data, a model of highly significant differences for all the measurements. After age range correction, the inter-village (place) significations were reduced to a greater proportion of muscle component in males (17%, and 30%, *Figure 3a–c*); and to a greater proportion of fat component in females (21% and 25%, *Figure 3d–f*) of Praia Grande village with respect to Paricatuba and Marajo-Açu ones (*Table 8*).

DISCUSSION AND CONCLUSIONS

The so-called "Latin American model" of malnutrition, i.e. a low prevalence of stunting and wasting, with predominance of the first over the second (Dufour 1992, Onís *et al.* 1993, Cesar *et al.* 1996, Cardoso *et al.* 2001, Orr *et al.* 2001, Oyhenart *et al.* 2003) was confirmed in the present research. In males, prevalences of underweight were significantly greater in Paricatuba than in the other two places, and in Marajo-Açu greater than in Praia Grande; while in females, between-place non-significant differences were detected. Stunting prevalences were greater in Paricatuba than in Marajo-Açu females, and in Paricatuba and Marajo-Açu greater than in Praia Grande males. The three communities showed a lower nutritional status than the international NCHS growth standards; however, undernutrition was moderate. This assumption is based on the significant prevalences found for underweight and stunting, and the feeble ones for wasting. Prevalence indices not only enlarged the differences, but also increased in about 40% the number of significations, and made the between-place differences clearer than with "raw-prevalences": underweight was in males, the same in both approaches, but stunting was greater in Paricatuba than in Marajo-Açu and Praia Grande. Wasting, which was non-significant with the raw-prevalences in both sexes, showed now higher prevalence indices in Paricatuba than in Marajo-Açu than in Praia Grande. This effect withdrew the present samples from the Latin American model of malnutrition, leading to the most affected community (Paricatuba) to approach

TABLE 7. Effect of place, age and sex in youths on anthropometrics.

Variable	F Mean Sq	F-test Adj. sex	Multifactor ANOVA Post-hoc LSD test Paricatuba	Marajo-Açu	Praia Grande
Body weight	2558.2	1.4	7.8	31.5	21.7
Standing height	5989.3	0.8	35.5	33.3	21.7
Body mass index	2633.9	1.9	6.2	14.1	8.1
Upper-arm fat proportion	9032.2	15.2 **	33.7 **	49.1 **	38.7 **
Upper-arm muscle proportion	1177.3	0.4	8.3	–5.6	–14.8
Upper-arm bone proportion	2082.4	1.4	–11.2	–20.6	–15.9

**p<0.01

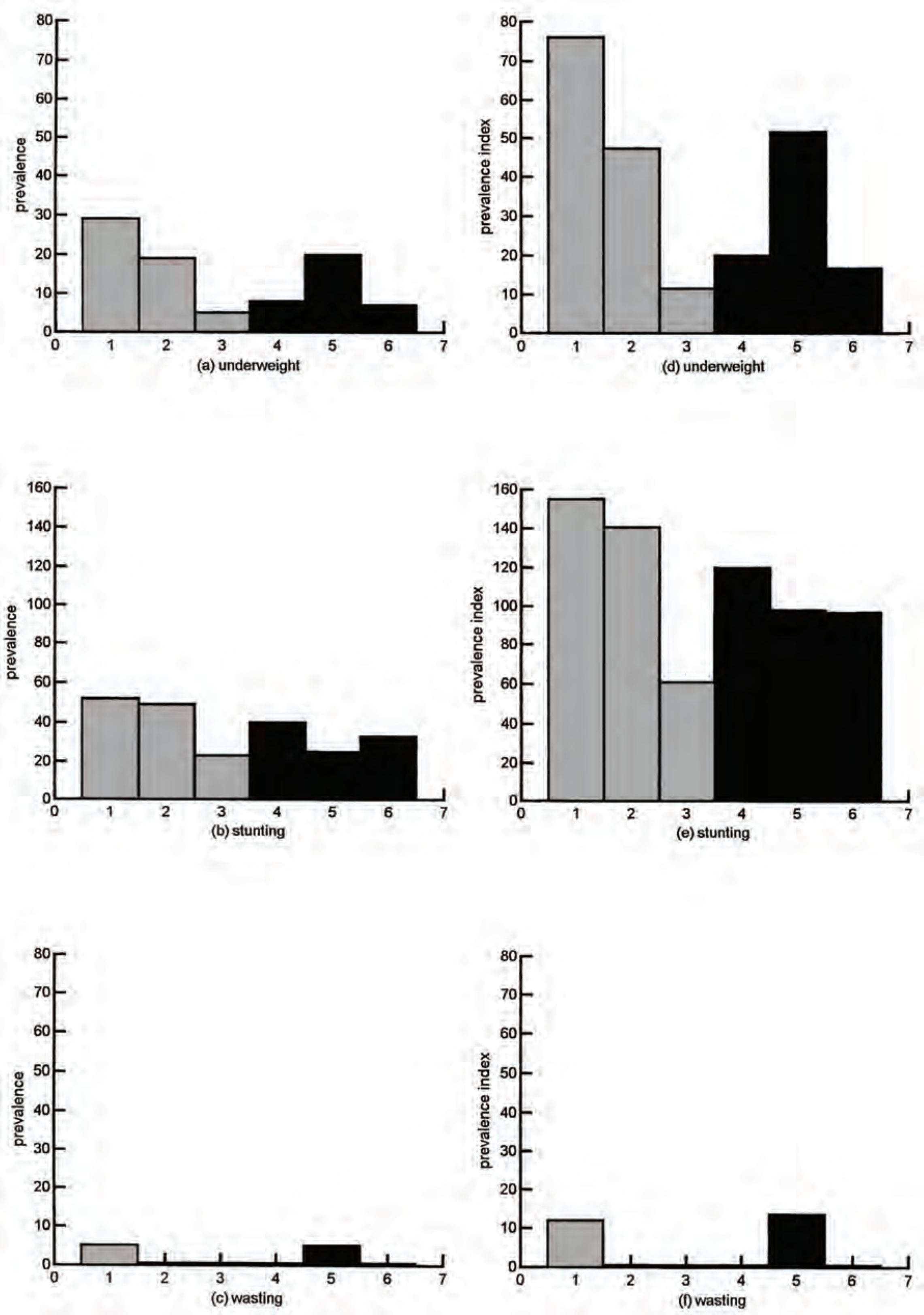
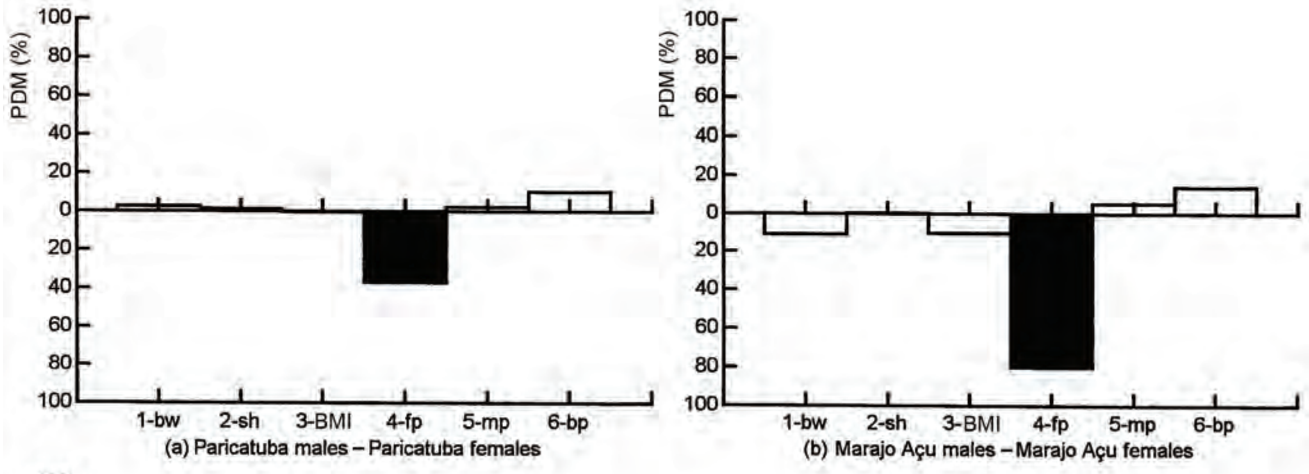


FIGURE 1. Preadolescent undernutrition prevalences (left graphs) and prevalence indices (right graphs) in Paricatuba (bars 1, 4), Marajo-Açu (bars 2, 5) and Praia Grande (bars 3, 6) for underweight, stunting, and wasting. Grey bars = males, black bars = females.



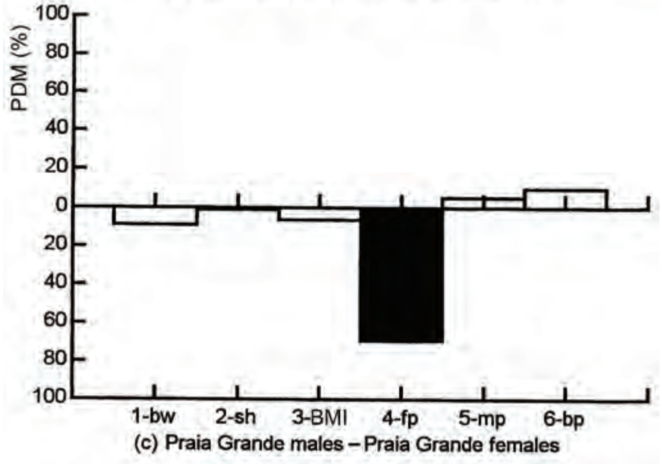


FIGURE 2. Between-sex PDM in youths from Paricatuba, Marajo-Açu, and Praia Grande. Above zero = males greater than females. Below zero = females greater than males. bw = body weight; sh = standing height; BMI = body mass index; fp = fat proportion; mp = muscle proportion; bp = bone proportion. black bars: p<0.01, white bars: n.s. (mid upper-arm circumference, bicondylar humerus width, and triceps skinfold were omitted to avoid redundancy).

to African populations like the Nchelengue children of Zambia, whose prevalences were 30% of underweight, 69% of stunting, and 4% of wasting (Gernaat *et al.* 1996). Marajo-Açu was in an intermediate position, and Praia Grande was the least affected. Many Amazonian children are small compared with the international reference (Santos 1993). The Gaviao, Suruí, Zoró, Xinguan, Xavante, and Kayapó communities are small in stature, and lower in body weight when compared with the reference values, but close to the 50th percentile in weight-for-height (Niswander *et al.* 1967, Eveleth *et al.* 1974, Black *et al.* 1977, Coimbra Jr., Santos 1991, Santos, Coimbra Jr. 1991). Rees *et al.* (1987) found 8% of stunting and 1% of wasting in three (two urban and one rural) communities of the state of Ceara (Northeastern Brazil). Fagundes-Neto *et al.* (1981) found 4.2% of underweight and 2.9% of stunting in the Alto Xingu; while Morais *et al.* (1990) reported, for the same region, prevalence mean of 6.3% for underweight. Studies made on the Tupi-Monde revealed, however, 55.4% of stunting and 0.8% of wasting (Santos, Coimbra Jr. 1991).

Monteiro *et al.* (1993), based on the results of the Pesquisa Nacional de Saúde e Nutriçâo (PNSN), carried out in 1989, reported mean values of undernutrition prevalence (<–2SD) of 10.6% and 12.8% in the North and Northeast of Brazil, respectively. These values were the highest of Brazil, well above the mean of the country (7.1%), but lower than the 20% of stunting and 4% of wasting reported by Onís *et al.* (1993) for the same country. Onís's data are in accordance with the prevalence of wasting found here for Paricatuba males and Marajo-Açu females. Prevalences of stunting were, however, well above the average, since the limits ranged from 23% to 52%. No references for underweight prevalence were found, but the variation range found that here (5% to 29%) agreed with the variation of the other two indices.

Only upper-arm fat proportion was, in this study, sexually dimorphic between the youths from the three villages, being in all cases greater in females than in males. The greatest dimorphism degree was seen in Marajo-Açu, followed in decreasing order by Praia Grande and Paricatuba (*Figure 2*). To similar conclusions arrived Torres *et al.* (2002) studying a small Tehuelche population from Patagonia (Argentina). They found that skinfolds and fat area were greater in females than in males. According to Tanner (1962), sex dimorphism may be inhibited when a nutritional deficiency acts on a population. This happens because males grow less than females, although both sexes were evenly affected by undernutrition. Apart from fat, the rest of the variables were non-dimorphic at all, implying that stress was present in the three communities.

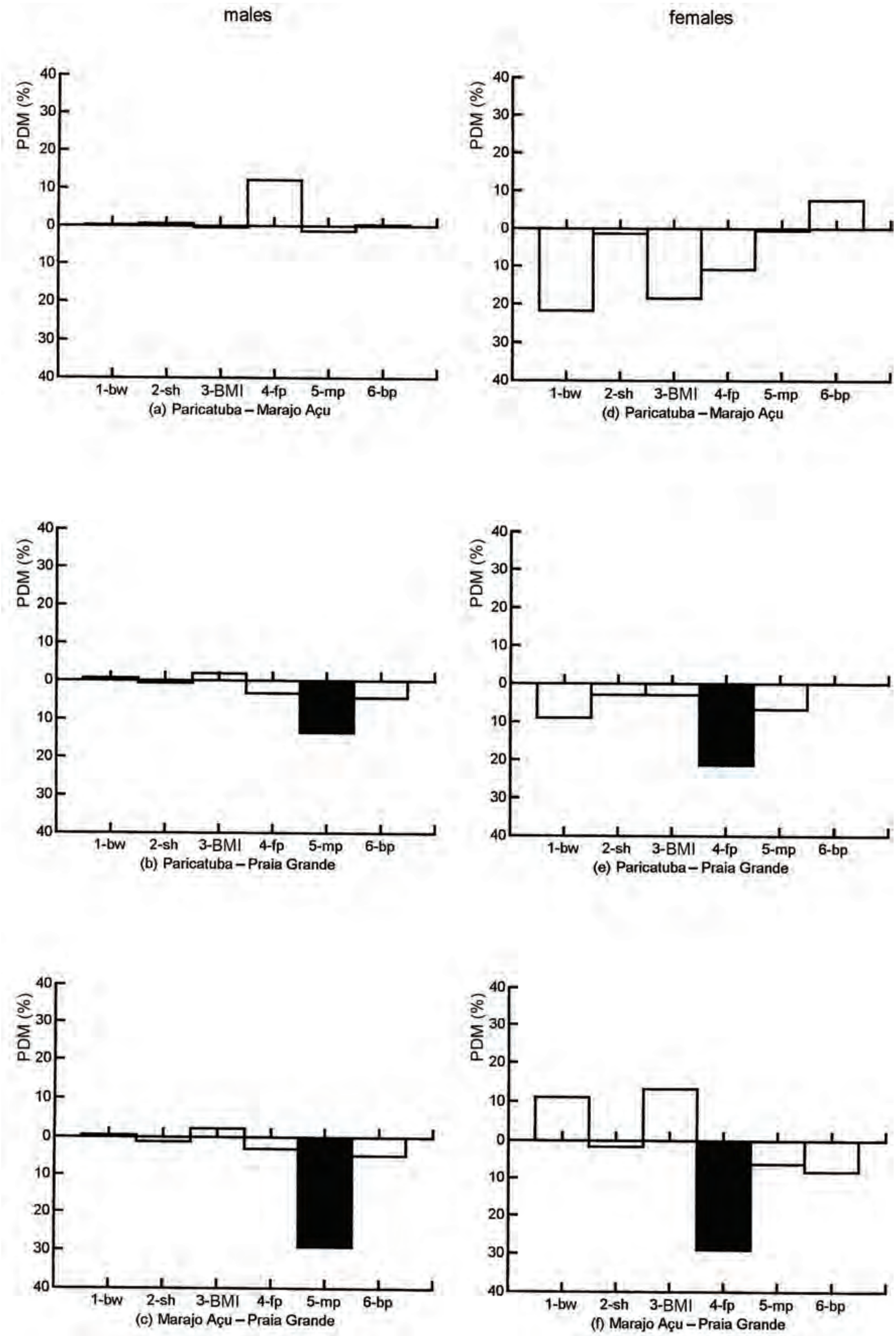


FIGURE 3. Adult male (left graphs) and female (right graphs) between-place PDM comparisons. Above zero = first place greater than the second. Below zero = second place greater than the first. bw = body weight; sh = standing height; BMI = body mass index; fp = fat proportion; mp = muscle proportion; bp = bone proportion. Black bars: p<0.01, white bars: n.s. (mid upper-arm circumference, bicondylar humerus width, and triceps skinfold were omitted to avoid redundancy).

TABLE 8. Effect of place, age and sex in adults on anthropometrics.

Variable	Mean sq	F-test Adj. place		Paricatuba – Marajo-Açu	Paricatuba – Praia Grande	Marajo-Açu – Praia Grande
Body weight	1967.9	2.1	Males	7.8	–15.9	–23.8
			Females	28.2	13.4	–14.7
Standing height	3227.8	0.8	Males	23.1	–36.1	–59.2
			Females	–0.1	19.8	19.9
Body mass index	191.7	1.4	Males	3.9	–6.8	–10.8
			Females	10.7	2.8	–7.8
Upper-arm fat proportion	3393.6	11.4 **	Males	–1.7	1.3	2.9
			Females	3.8	–13.6**	–17.4**
Upper-arm muscle proportion	1865.5	3.1 **	Males	14.5	–22.5 **	–37.1 **
			Females	–0.3	16.6	16.9
Upper-arm bone proportion	886.9	0.8	Males	5.1	–2.8	–7.8
			Females	–7.5	1.6	9.1

**p<0.01

Adult inter-village comparisons showed that in males, the upper-arm muscle proportion was more developed in Praia Grande than in Paricatuba and in Marajo-Açu, the last two being non-differentiated (*Figure 3a–c*). Praia Grande females showed greater upper-arm fat proportion than Paricatuba and Marajo-Açu, the last two being non-differentiated (*Figure 3d–f*). The behaviour of the mid upper-arm components was in accordance with Bogin and Sullivan (1986). A proportionally inverse growth rate between muscle on the one hand, and fat tissues on the other hand, was found: while muscle grew more in males, fat grew more in females, and bone content remained stable. This behaviour kept the upper-arm circumference non-differentiated in both sexes (Guimarey *et al.* 1993, Pucciarelli *et al.* 1993).

The significant inter-village differences in fat and muscle contents, together with the low undernutrition prevalences found in Praia Grande, showed that this village was, in general terms, less stressed than Paricatuba and Marajo-Açu. The nutritional status found for Praia Grande people is intriguing because, according to Murrieta, they showed the lowest level of protein and calorie intakes of the three communities (Murrieta 1994, Murrieta *et al.* 1999). Two hypotheses can explain this fact. The first one is that diet breadth is as important as the amount of food intake for physical growth and development. Praia Grande exhibits the most diversified dietary repertoire of the three communities. The second one is that the process of cooperative organization provides better sanitation conditions for the community. This could be the case of Praia Grande. Although sharing the same medical assistance with the other two groups, it is the only community that has tap watering, septic tanks, and receives training on basic personal hygiene procedures. Similar results were reported in highlands by Meer *et al.* (1993), who found that inter-place and Aymara-Quechua differences in children's physical growth are associated with the microclimate, place economy, sociodemographic factors, and differences in the land system. These factors may play an important role in the higher nutritional status of the people of Praia Grande. To a similar conclusion arrived Melcher and Neves (1994) after comparing the local profiles of human growth and development against the standards proposed by Frisancho (1990).

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