Original Research Article

Socio-Environmental Variables Associated with Malnutrition and Intestinal Parasitoses in the Child Population of Misiones, Argentina

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Objectives: The aim was to analyze the socio-environmental variables associated with malnutrition and intestinal parasitoses in children from Aristóbulo del Valle, Province of Misiones (Argentina).

Methods: A cross-sectional study was performed in 2,291 schoolchildren (age, 4–14 years). Body weight and height were measured and body mass index was calculated. NHANES III reference was used to estimate the nutritional status—underweight, stunting, wasting, overweight, and obesity. The parasitological analysis was performed by fecal and anal brush samples. The socio-environmental variables were surveyed using a semi-structured questionnaire. These variables were processed by categorical principal component analysis (cat-PCA).

Results: The two first axes defined four subgroups of schoolchildren: three of these were associated with urban characteristics (high, middle, and periurban), whereas the remaining subgroup was considered rural. Stunting and parasitic infections occurred mainly in the periurban group, that is the group of higher socio-environmental vulnerability. On the other hand, the highest prevalence of overweight and obesity and the lowest parasitism was observed in the high urban group.

Conclusions: The similarity between rural and middle urban groups in stunting prevalence reveals that cities are not healthier than rural environments. On the contrary, the fact that the rural group presents the lowest prevalence of overweight reaffirms that poverty and malnutrition are progressively moving from rural to urban areas, and that rural children have still more diverse and healthy diets favored by the consumption of homemade products (i.e., orchards, animal husbandry, etc.), placing them at an earlier stage of the nutrition transition. Am. J. Hum. Biol. 26:609–616, 2014.

Most Latin American countries have undergone a considerable increase of urbanization in recent years owing to the deterioration of life quality in rural areas and the decreasing demand for field labor, and thus giving rise to a countryside-to-city migration (Pérez, 2003). This new scenario has brought about a series of changes in diet, health, and patterns of work and physical activity, among others (Ebrahim et al., 2010; Masterson Creber et al., 2010; Popkin, 2002). In particular, Argentina has shown an accelerated process of urbanization in comparison with the other Latin American countries (UNICEF, 2012; Velázquez, 2004). The demographic growth of urban areas resulted in a transitional urban–rural interface. This interface, known as periurban or urban periphery, represents a space defined by its lack of definition: it is neither the country side nor the city side (Barsky, 2005; Entrena Durán, 2004). In Argentina, during the last 30 years, multiple neighborhoods have been consolidated in the periphery of cities; they are characterized by partial or total lack of sanitary services, low education, and income levels, the presence of precarious housing, and high levels of critical crowding. Consequently, urban deterioration and increasing poverty aggravated health problems affecting mainly the infantile–juvenile sector (Cesani et al., 2007; Garraza et al., 2011; Oyhenart et al., 2007; 2013).

Some authors, namely Dufour and Piperata (2004), have discussed the arbitrary definition of the "rural" and "urban" categories, and the tendency to analyze these categories separately. In this sense, Oyhenart et al. (2008) reported that these categories of urban and rural populations are not uniformly different or the urban ones are internally homogeneous. The negative effects of environment on nutritional status in children are not restricted only to poor periurban and rural areas though these two regions are still poor environments for human growth.

In this context, intestinal parasitoses constitute a serious public health problem and are considered an indicator of poverty; these parasitoses are the most difficult to control owing to the different means of transmission of causal agents among the population (Juárez and Rajal, 2013; Korkes et al., 2009). Parasitic diseases occur mainly in children, especially in schoolchildren who present greater rates of infection owing to soil-transmitted helminths—geohelminths (WHO, 2005). In addition, these infectious agents may affect the nutritional condition and intellectual capacity of the children infected by them, and also cause malabsorption and intolerance to sugars and vitamins (Crompton, 2000; Moffat, 2003; Quihui-Cota et al., 2004; Rai et al., 2002; Stephenson et al., 2000).

These infections are more prevalent and endemic in developing countries, being significant markers of sanitary and ecological conditions of their hosts' environment (Thompson, 2001). In Argentina, several studies have

Contract grant sponsors: UNLP 11/N552, ANPCyT PICT 01541, CONICET PIP 02197.

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Received 15 January 2014; Revision received 3 May 2014; Accepted 20 May 2014

DOI: 10.1002/ajhb.22570
Published online 9 June 2014 in Wiley Online Library (wileyonlinelibrary.com).

Fig. 1. Geographical location of Aristóbulo del Valle in Misiones, Argentina.

demonstrated that the prevalence of enteroparasites is heterogeneous, with considerable variation in their distribution (i.e., 28–96%) (Gamboa et al., 2011; Navone et al., 2006; Soriano et al., 2005; Taranto et al., 2003; Zonta et al., 2010, 2013). In addition, soil contamination by human and/or animal feces may represent a potential environmental sanitary risk (Alves Lima et al., 2007; Tiyo et al., 2008).

The previous studies that have been carried out in Aristóbulo del Valle (Misiones), without discrimination of residence type (urban, periurban, or rural), allowed establishing that in the cosmopolitan population, 80% of children were infected by enteroparasites. *Blastocystis hominis*, *Enterobius vermicularis*, and *Giardia lamblia* were the most prevalent and pathogenic species (Zonta, 2011; Zonta et al., 2011a,b). In addition, these studies showed that 22% of the children showed malnutrition; being overweight was more prevalent than under nutrition. Based on these results, we became interested in performing an in-depth analysis of the nutritional status and the distribution of parasitoses, applying a categorical principal component analysis (cat-PCA) model.

The aim of this article is to analyze the socio-environmental variables associated with malnutrition and intestinal parasitoses in children from Aristóbulo del Valle, Province of Misiones (Argentina).

METHODS

Study area

The town of Aristóbulo del Valle (27°08′ S, 54°54′ W) in the Cainguás Department is located in the center of the Province of Misiones in the morphological district known as "central longitudinal strip or *Sierras Centrales*" (Fig. 1).

The history of the town began with its foundation as a colony in 1921, on the basis of a second colonization process that involved families from diverse areas of the province, Brazil, and Paraguay. Taking into consideration the total population (inhabitants, 20,683), this town is ranked as number 12 in the province (CNPyV, 2001). According to the 2004–2005 census, the urban population included 13,171 inhabitants with an average family size of 4.15 inhabitants, whereas no equivalent census data exist for the population located in the rural areas (Plan Estratégico de la ciudad de Aristóbulo del Valle, 2006).

The main activities of the inhabitants involve gathering of agricultural products, especially tobacco and tung oil, as well as tourism and trade at a smaller scale. A large proportion of the *colonos* (tenant farmers) who live in the rural zone work on small-scale farming. The crops are used for personal consumption and in some cases are also traded in the local fairs. Since the middle of 1951, the production of tea has become an interesting alternative activity for this population (Pochettino et al., 2002).

The weather is subtropical without a marked dry season, warm, with substantial temperature, and rainfall changes owing to variations in altitude, and therefore giving it a marked continental character. The average annual temperature is 21.1°C and precipitations range from 1,600 to 2,000 mm.

Sample

A cross-sectional study was performed in 2,291 children (49.7% boys and 50.3% girls), aged from 4 to 14 years, attending schools of Aristóbulo del Valle, Province of Misiones. Data were collected from 16 public educational institutions (kindergarten and elementary schools), representing 53.3% of the total schools of the district. The sample selection was nonprobabilistic and was largely determined by voluntary participation in the study. Children participated in the anthropometric study only after the respective 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 well as those dictated by Argentine National Law N°25.326 on the privacy of personal data.

Socio-environmental analysis

We used a structured questionnaire filled out by the parents to evaluate several socio-environmental characteristics, and to measure housing variables with information regarding structural and physical amenities. These characteristics provided information about indoor and outdoor housing conditions.

We asked about: building materials (type of materials used in their construction: low-quality prefab, fired-brick masonry, makeshift materials, and so forth); dirt floor in at least one room of the house; source of drinking water (piped water system, protected well, rain-tank storage, or unprotected well [natural source], and public faucet); wastewater disposal (open-air defecation, sewage system, septic tanks [cesspool], or latrines); solid waste disposal (open-air pits, incineration, nonsanitary burial, or public waste collection and removal system), and overcrowding (more than three persons per room).

Lodging status. Among the socioeconomic status variables, we considered the mode of lodging or housing-tenure status (house owner, lease holder, or free lodging).

Parental characteristics. These comprised education level and work. The former was evaluated in terms of

formal education level (unschooled, primary, secondary, tertiary, and university). The latter was divided into five categories: employed (formal worker), unskilled worker (unqualified worker who performs mostly temporary jobs), informal worker (without work contract), autonomous worker (freelance jobs), and unemployed (father) or housewife (mother).

Health insurance. Whether medical insurance was paid by the employer or by the person (fee-for-service health insurance plans); measured as the presence or absence.

Public assistance. Referring to national or local programs (from governmental agencies, NGOs, or other entities) that benefit poor families by supplementing their food budget (nutritional support) and/or by providing cash relief to the heads of households (monetary support); measured by the presence or absence.

Farming practices. Additional activities possibly contributing to household income, such as animal husbandry, orchard; measured by the presence or absence.

Other aspects. Contact with animals: dogs, cats, farm animals; measured by the presence or absence.

Anthropometric analysis

The anthropometric study was carried out by following standardized protocols (Lohman et al., 1988).

The following variables were recorded: age: obtained from identification cards or from school records; body weight (*W*) (kg): measured on a digital scale (accuracy, 100 g) with the subjects lightly dressed (subtracting the weight of clothes); height (*H*) (cm): using a portable vertical anthropometer (accuracy, 1 mm). Body mass index (BMI) was calculated as weight (kg) divided by squared height (m^2).

To estimate nutritional status, the NHANES III reference was used. The cut-off value was 5th percentile to determine low weight-for-age (underweight), low height-for-age (stunting), and low weight-for-height (wasting). Individuals were classified as overweight or obese when their BMI was in the 85–95th percentile or above the 95th percentile, respectively (Frisancho, 2008).

Parasitological analysis

Informational workshops were carried out at the public schools of the area with the aim of interacting with parents, tutors, and school authorities. The use of a workshop methodology enabled the interchange among participants of knowledge and an understanding of the biology and transmission modes of the most frequent parasitoses within the area.

The life cycles of the most common parasites were analyzed and the participants observed representative specimens under a stereoscopic and a light microscope. Then, parasitological tests were offered to be performed on the children belonging to the participating families. Each consenting family was provided with two vials for each child containing 10% v/v of aqueous formaldehyde for simple serial deposits of fecal material and anal swabs. The coproparasitological samples were processed using the techniques of concentration by sedimentation (Ritchie) and by flotation (Willis) (Becerril Flores and Romero Cabello, 2004), whereas the formaldehyde from anal-swab samples was sedimented by centrifugation for 3 min at 1,600*g*. The samples were observed under a light microscope at magnifications of 100 and 400× to screen for parasitic forms (eggs, cysts, oocysts, and larvae). We used both temporary (Lugol) and permanent (Ziehl–Neelsen) staining when necessary. Total prevalences of infection and individual parasite species were calculated (Bush et al., 1997). Percentages of mono, bi, and polyparasitism (more than three species) were determined.

Data analysis

The prevalence of each indicator of nutritional status and of parasitic infections was calculated in the whole sample.

The cat-PCA was employed for the analysis of the socio-environmental variables. It simultaneously quantifies categorical variables while reducing the dimensionality of the data variables. The objective is to reduce an original set of variables to a smaller uncorrelated component that represents most of the information found in the original variable set. Also, it is the most useful technique when a large number of variables hinder effective interpretation of relationships. Therefore, a small number of components are interpreted instead of a large number of variables. The cat-PCA analysis allows the implementation of the standard analysis of principal components in any mixture of nominal, ordinal, and numerical variables.

We used the results of cat-PCA to define the groups of observations, compared socio-environmental variables among groups, and then tested the differences using chi-square test (χ^2) (Oyhenart et al., 2008).

The prevalence of parasitic infections in the children grouped according to their nutritional status was analyzed by means of a generalized linear model with "link" logit. However, such analysis could not be applied to underweight and wasting cases owing to the low frequency in the population ($N = 3$). The analysis was limited to stunting. When there were significant differences between groups regarding the probability of parasite or stunting occurrence, we performed χ^2 tests at a significance level of $P < 0.05$.

All the statistical procedures were carried out using the SPSS 15.0 statistical program.

RESULTS

The first two dimensions of the cat-PCA summarized 30.19% of the total variance with Cronbach's Alpha values of 0.84 and 0.66 for the first and second axis, respectively.

Table 1 lists the eigenvectors for these first two dimensions. The variables that contributed most to the analysis were as follows: mother and father education, wastewater disposal, health insurance, animal husbandry, and some physical amenities. Nutritional support, lodging status, and dirt floor had the lowest eigenvectors.

From the order established by the mean values of the two first principal components, we defined four subgroups of schoolchildren who coincided with the four corners obtained from cat-PCA. Figure 2 shows the magnitude and orientation of the eigenvectors and Figure 3 shows the centroids of multiple nominal variables.

Group I (dimension 1 positive, dimension 2 positive): families that lived mostly in brick/masonry houses, with access to public services. Regarding education level, most parents had completed primary and secondary school, and in some cases also higher levels (tertiary and university).

TABLE 1. Eigenvectors from cat-PCA of socio-environmental variables

Variable	Abbreviation	Dimension 1	Dimension 2
Mother's education	ME	0.661	0.319
Father's education	FE	0.624	0.273
Wastewater disposal	WD	0.676	0.236
Health insurance	HI	0.143	0.407
Piped water system	PWS	0.789	−0.123
Solid waste disposal	SWD	0.759	−0.158
Monetary support	MS	0.089	−0.165
Animal husbandry	AH	−0.535	0.344
Contact with farm animals	CFA	−0.527	0.484
Unprotected well (natural source)	UW	−0.465	0.184
Contact with cats	CC	−0.432	0.264
Protected well	PW	−0.362	0.480
Orchard	O	−0.337	0.379
Contact with dogs	CD	−0.282	0.421
Rain-tank storage	RTS	−0.260	0.228
Overcrowding	OC	−0.393	−0.440
Public faucet	PF	−0.193	−0.462
Dirt floor	DT	−0.115	−0.039
Lodging status	LS	−0.086	−0.099
Nutritional support	NS	−0.068	−0.313

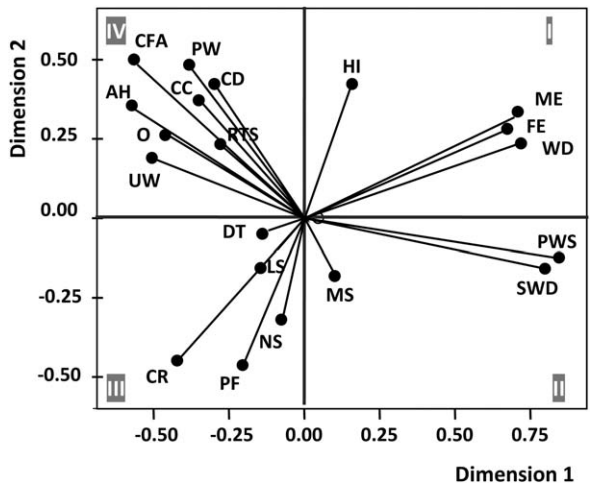

Fig. 2. Eigenvectors corresponding to socio-environmental characteristics. Group I (top right), Group II (lower right), Group III (lower left), and Group IV (top left). Building materials (BM), father's, and mother's work (FW, MW) were excluded because they are multiple nominal variables (nonlinear).

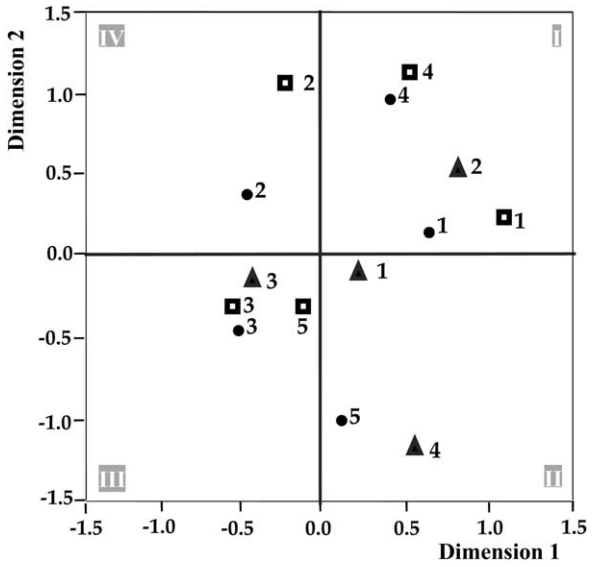

Fig. 3. Centroids of multiple nominal variables. References: ▲ Building materials: 1 (prefab); 2 (fired-brick masonry); 3 (makeshift materials); and 4 (other). ● Father's work: 1 (formal worker); 2 (unskilled worker); 3 (informal worker); 4 (autonomous worker); and 5 (unemployed). ◘ Mother's work: 1 (formal worker); 2 (unskilled worker); 3 (informal worker); 4 (autonomous worker); and 5 (housewife).

Most were employees or worked autonomously, and had health insurance.

Group II (dimension 1 positive, dimension 2 negative): families that inhabited houses made of wood and metal sheet, or in some cases prefabricated homes, with access to public services such as piped water system, solid waste collection, and removal system. The parents had mostly completed the primary education level. As regards work conditions, in most cases father was an employee or, to a lesser extent, did temporary small jobs, whereas mother was mainly housewife, and to a lesser extent, formal worker. Some of these families received some type of monetary support from government plans.

Group III (dimension 1 negative, dimension 2 negative): families that occupied mostly wood and metal sheet houses, with dirt floor in at least some room and overcrowding in many cases. Water for consumption was obtained from a public faucet. They used latrines for wastewater disposal, and incinerated solid domestic wastes. The parents had started the primary school level, but many of them had withdrawn. The most frequent parents' employment was informal work (father) and housewife (mother). In many cases, they received nutritional support from the municipality or from the schools that their children attended.

Group IV (dimension 1 negative, dimension 2 positive): families that occupied mostly houses made of wood and sheet metal. Water for consumption was obtained by protected or unprotected well; they used latrines for wastewater disposal, and incinerated their solid domestic wastes. Parents had completed the primary school level, they worked as temporary workers, or were autonomous or other type of laborers, and mothers were housewives. Many of the families practiced horticulture, had contact with animals, and bred some animals for their own personal consumption.

Table 2 lists the frequency of each socio-environmental variable by group (expressed as percentage). All the differences were statistically significant.

The prevalence analysis of nutritional indicators in the total population showed the highest values for overweight (10.4%), stunting (6.5%), and obesity (5.5%) and the lowest for underweight and wasting (0.1%).

The prevalence of nutritional indicators regarding each group indicated that stunting was highest in Group III and lowest in Group I. In contrast, overweight and obesity were highest in Group I and lower in Groups IV and III, respectively (Table 3).

The greatest prevalence of parasitized children was observed in Group III (94.4%), followed by Groups IV, II, and I (86.5, 83.5, and 48.1, respectively), with statistically

TABLE 2. Socio-environmental characteristics of the group

Characteristics	Abbreviation	Percentage by Group				χ^2	*P*-value
		I	II	III	IV		
Structural qualities and amenities							
Building materials	BM					516.66	<0.01
Low-quality prefab		6.8	10.6	1.5	5.4		
Fired-brick masonry		76.5	27.9	6.6	17.7		
Makeshift materials		16.0	58.8	91.1	76.8		
Others		0.7	2.7	0.8	0.0		
Dirt floor	DF	0.0	2.4	3	3.8	11.14	<0.01
Overcrowding	OC	13.4	61.7	88.0	48.8	292.95	<0.01
Drinking water (main source)							
Piped water system	PWS	83.3	87.6	9.5	2.8	945.78	<0.01
Protected well	PW	12.0	0.9	10.8	62.2	504.68	<0.01
Rain-tank storage	RTS	2.0	2.4	9.8	25.3	140.12	<0.01
Unprotected well (natural source)	UW	2.0	0.0	28.6	39.0	264.03	<0.01
Public faucet	PF	2.3	8.3	46.1	1.2	408.62	<0.01
Wastewater disposal	WD					675.22	<0.01
Open-air defecation		0.0	1.7	6.8	2.3		
Sewage system		0.0	0.0	0.0	0.0		
Septic tank		97.1	61.9	6.2	20.7		
Latrine		2.9	36.4	87.0	77.0		
Solid waste disposal	SWD					837.13	<0.01
Open-air pits		0.0	0.0	10.2	14.3		
Incineration		14.5	12.8	68.0	72.8		
Nonsanitary burial		2.7	0.0	5.7	9.1		
Public waste collection and removal		82.8	87.2	16.1	3.8		
Socio-economic status							
Lodging status	LS					60.95	<0.01
House owner		87.0	76.3	80.3	81.1		
Lease holder		7.5	10.6	1.2	2.3		
Free lodging		5.5	13.1	18.5	16.6		
Father's education	FE					542.17	<0.01
Unschooled		0.0	8.3	11.2	3.6		
Primary		42.3	75.0	86.2	91.6		
Secondary		33.7	14.6	2.6	4.1		
Tertiary		13.4	10.0	0.0	0.8		
University		10.7	1.0	0.0	0.0		
Mother's education	ME					616.67	<0.01
Unschooled		0.7	6.1	9.9	3.5		
Primary		30.7	71.2	87.8	87.7		
Secondary		22.3	17.2	2.3	7.4		
Tertiary		32.3	4.5	0.0	1.0		
University		14.0	0.9	0.0	0.5		
Father's work	FW					640.66	<0.01
Formal worker		42.6	40.4	9.2	17.4		
Unskilled worker		4.8	14.0	6.9	24.6		
Informal worker		4.1	26.7	75.8	29.1		
Autonomous worker		47.4	9.6	1.4	28.1		
Unemployed		1.0	9.2	6.6	0.8		
Mother's work	MW					548.95	<0.01
Formal worker		48.6	27.7	3.7	4.9		
Unskilled worker		0.0	1.7	3.4	11.2		
Informal worker		2.1	6.6	24.9	17.8		
Autonomous worker		28.8	2.8	0.9	19.5		
Housewife		20.5	61.2	67.1	46.6		
Health insurance	HI	84.8	42.6	23.4	73.5	261.53	<0.01
Public assistance							
Monetary support	MS	45.2	52.1	34.7	20.1	69.15	<0.01
Nutritional support	NS	0.0	12.8	18.5	0.0	89.36	<0.01
Farming practices							
Orchard	O	48.9	18.5	31.3	73.5	195.82	<0.01
Animal husbandry	AH	22.2	7.1	44.5	80.2	329.97	<0.01
Other aspects							
Contact with dogs	CD	83.0	49.9	76.2	98.8	268.73	<0.01
Contact with cats	CC	30.0	27.4	49.9	76.8	237.61	<0.01
Contact with farm animals	CFA	27.7	9.1	36.3	87.7	539.09	<0.01

significant differences between Group I and the remaining ones, and between Groups III and IV ($P < 0.01$).

Table 4 summarizes the prevalence of pathogenic parasitic species in each group; the highest percentage was found in Group III and the lowest species richness and prevalences in Group I, compared to the other groups.

Finally, the percentage of monoparasitism was highest in Group II (33.1%), whereas biparasitism prevailed in Group IV (30.3%) and polyparasitism in Group III

TABLE 3. Prevalences (%) in indicators of nutritional status by group

	Group					
Indicator	I	II	III	IV	Comparison	*P*-value
Stunting	1.7	5.9	9.5	6.1	III–I	0.01
Overweight	13.3	11.8	11.7	8.0	I–IV	0.05
					II–IV	0.03
Obesity	12.3	4.7	3.2	3.3	I–II	0.01
					I–III	0.01
					I–IV	0.01

TABLE 4. Prevalence (%) of parasitic species by group

	Group					
Species	I	II	III	IV	Comparison	*P*-value
G. lamblia	8.7	22.3	25.1	15.0	III–I	0.01
					III–IV	0.02
B. hominis	34.6	62.6	69.3	63.7	III–I	0.01
H. nana	0.0	4.3	10.8	1.9	III–II	0.05
					III–IV	0.01
A. lumbricoides	1.0	0.7	7.8	0.7	All	NS
S. stercoralis	0.0	10.8	26.8	3.0	III–II	0.01
					III–IV	0.01
Ancylostomids	1.9	8.6	26.4	18.4	III–I	0.01
					IV–I	0.01
					III–II	0.01
					IV–II	0.03

NS: Nonsignificant.

(45.0%). This pattern of distribution of the parasitoses showed significant differences ($\chi^2 = 174.9$; $P < 0.01$).

DISCUSSION

The population of Aristóbulo del Valle exhibited high socio-environmental differentiation in agreement with the results previously obtained by Oyhenart et al. (2008) for another city in Argentina. Thus, the children included in Group I belonged to the families with good educational levels, living in homes built using good-quality materials, and with access to public services. These children had low prevalence of stunting, but high overweight and obesity. Similar results, but with higher prevalence of stunting and lower overweight, were obtained for Group II formed by children whose families also had similar access to public services, as observed in Group I. The better sanitary conditions of both groups may well be a strong factor influencing the low prevalence of parasitized children and of each parasitic species, and even more influential on the fewer number of parasitic species found in comparison with the rest of the groups. According to the traditionally parameters that are used for urban–rural differentiation, both groups would be associated with what is categorized "urban," and redefined herein into "high urban" (Group I) and "middle urban" (Group II). Regarding this issue, Ruel (2000) stated that an important consideration, when comparing urban and rural indicators of poverty and malnutrition, is the fact that urban areas are highly heterogeneous and thus "city" averages mask enormous differences within such areas. In agreement, the heterogeneity of both urban groups was not only reflected in the lower quality of building materials but also in the education level and the parents' type of employment, mainly associated with the high prevalence of obesity found in the "high urban" group. In urban areas, women are usually more educated, which increases their likelihood of working and their ability to get better-paid jobs, and hence increasing the opportunity to optimize their time. Nevertheless, maternal time constraints usually result in shifts in dietary patterns; with more money and less time available, mothers tend to buy more processed and ready-to-eat foods, as opposed to the traditional complementary foods, which often require longer processing and cooking times (Ruel, 2000). Similarly, Tacoli and Satterthwaite (2013) reported that although urban women are a highly diverse group, the constraints faced by poorer women are very different from those that affect higher-income women, who are likely to have greater access to education and better incomes that enable them to hire domestic workers.

In 2005, UNICEF declared that poverty was the main cause of high childhood morbility and mortality rates. A thousand million children in developing countries lack access to at least one of the basic goods or services that would allow them to survive, develop, and thrive; more than 16% of the children below 5 years do not receive adequate nutrition and suffer severe malnourishment (UNICEF, 2005). In particular, in Argentina and starting with the social-economic crisis of 2001–2002, the levels of poverty and social inequality rose, and the situation in northern Argentina became relevant in the news, highlighting the cases of acute malnourishment as the visible manifestation of the problem. The National Institute of Statistics and Censuses (Instituto Nacional de Estadísticas y Censos, INDEC) indicated that in 2002, 60% of the population in the northern provinces was below the poverty line, and in some cases, as in the provinces of Misiones and Corrientes, these values were more than 70% (Bolzán et al., 2005). This situation of poverty could be clearly observed in the children of the Group III, which was also located in an environment with similar characteristics that the "periurban." In this group formed by low-income families, living in slums with high overcrowding, whose parents had only completed the primary level of education and presented the highest unemployment rate, the children were frequently stunted although the values for overweight and obesity were similar to those of "middle urban." This might be explained, according to Peña and Bacallao (2000), by the diet of low-income urban sectors in which the proportion of fats in the daily intake increased considerably in the last 25 years, leading to growing values of overweight and obesity. Grains, added sugars, and added fats are inexpensive, good-tasting, and convenient and their consumption has been linked to lower quality diets, lower diet costs, and lower socioeconomic status (Drewnowski, 2012). Also, this type of diet shows deficient intake of essential nutrients, especially proteins increasing the risk of developing infectious and nontransmissible chronic diseases (; Bingham et al., 2013; Eyles et al., 2012; Ezzati and Elio Riboli, 2013; Ferrante et al., 2011; Pedraza, 2009). According to Bogin et al. (2007), under adverse conditions, trade-offs result in reduced survival and poor growth.

Similarly, this "periurban" group showed the greatest prevalences of parasitized children and the highest number of pathogenic parasitic species. The deficient environmental sanitary conditions (i.e., use of public faucets and

latrines, incineration) combined with higher overcrowding could worsen this situation. In agreement, Marcos et al. (2003) have reported, for other child populations living in similar environments, the coexistence of different species of pathogenic enteroparasites in a single individual as bi- or polyparasitism. The intensity of the parasitic infection will depend on the pathogenic role of the species involved, the immunological status of the patient, and the number of species parasitizing (Nematian et al., 2004). Similar results were reported by Gamboa et al. (2003, 2009), who observed in three areas of La Plata city (Buenos Aires, and Argentina) an increasing gradient in the prevalences of parasitoses from the urban to the marginal area according to a decrease in the socio-environmental conditions.

Finally, the children included in Group IV, with similar structural qualities and amenities to those referred traditionally as "rural," also showed distinctive features: the prevalence of stunting and parasitoses was higher than the "high urban," similar to "middle urban" and lower than "periurban." The similarity between "rural" and "middle urban" indicates that cities are not uniformly healthier than rural environments, and also supports Fotso's (2007) observation that poverty and malnourishment are gradually moving from rural to urban settings.

The increasing gradient—high urban, middle urban, rural, and periurban—observed for the prevalence of undernourishment was not found in the analysis of overweight and obesity. The "high urban" group presented the highest prevalences of overweight and obesity, whereas the "rural" group showed the lowest values. These results agree with those reported by Popkin (1999), who proposed that urban areas had more obesity than rural ones. Similarly, the "rural" population of Aristóbulo del Valle would be in a less advanced stage of the nutritional transition process, because it is composed mostly by families of "colonos" which, according to that reported by Martinez et al. (2003), maintain agricultural-farming activities for small-scale trade and for their own consumption, suggesting a more diversified and healthy diet.

CONCLUSIONS

Stunting and parasitic infections occur mainly in the "periurban" group, that is the group of higher socio-environmental vulnerability. On the other hand, the highest prevalence of overweight and obesity and the lowest parasitism is observed in the "high urban" group. The similarity between "rural" and "middle urban" groups in stunting prevalence reveals that cities are not healthier than rural environments. On the contrary, the fact that the "rural" group presents the lowest prevalence of overweight reaffirms that poverty and malnutrition are progressively moving from rural to urban areas, and that rural children have still more diverse and healthy diets favored by the consumption of homemade products (i.e., orchards, animal husbandry, etc.), placing them at an earlier stage of the nutrition transition.

ACKNOWLEDGMENTS

The authors are grateful to Luis Castro, Pilar Martinez, Julia Diaz, and the local authorities and educational staff of Aristóbulo del Valle, Misiones, for their valuable assistance and collaboration.

LITERATURE CITED

Alves Lima AM, Câmara Alves L, Da Gloria Faustino MA, Silva de Lira NM, Magalhaes Â, De Lima MM, Cabral Teixeira W, Gomes Borges JC, De Souza Pimentel D. 2007. Búsqueda de huevos de anquilostomideos y toxocarídeos en el suelo de residencias y escuelas en el barrio de Dois Irmaos, Recige-Pe (Brasil). Parasitol Latinoam 62:89–93.

Barsky A. 2005. El periurbano productivo, un espacio en constante transformación. Introducción al debate con referencias al caso de Buenos Aires. Scripta Nova 9:194–236.

Becerril Flores MA, Romero Cabello R. 2004. Parasitología Médica: de las moléculas a la enfermedad. México: Mc Graw Hill Interamericana, 301 p.

Bingham DD, Varela-Silva MI, Ferrão MM, Augusta G, Mourão MI, Nogueira H, Marques VR, Padez C. 2013. Socio-demographic and behavioral risk factors associated with the high prevalence of overweight and obesity in Portuguese children. Am J Hum Biol 25:733–742.

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.

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 Arg Pediatr 103:545–555.

Bush AO, Lafferty KD, Lotz JM, Shostak AW. 1997. Parasitology meets ecology on its own terms: Margolis et al. Revisited. J Parasitol 83:575–583.

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 Antrop Biol 9:105–121.

CNPyV. 2001. Censo Nacional de población, hogares y vivienda. Instituto Nacional de Estadística y Censos (INDEC). Ministerio de Economía de la Nación. Buenos Aires. Argentina. Disponible en: http://www.indec.gov.ar.

Crompton DW. 2000. The public health importance of hookworm disease. Parasitol 121:39–50.

Drewnowski A. 2012. The economics of food choice behavior: why poverty and obesity are linked. In: Drewnowski A, Rolls BJ, editors. Obesity treatment and prevention: new directions. Basel: Nestlé Nutr Inst Workshop Ser. Nestec Ltd., Vevey/S. Karger AG. p 95–112.

Dufour DL, Piperata BA. 2004. Rural-to-urban migration in Latin America: an update and thoughts on the model. Am J Hum Biol 16:395–404.

Ebrahim S, Kinra S, Bowen L, Andersen E, Ben-Shlomo Y, Lyngdoh T, Ramakrishnan L, Ahuja RC, Joshi P, Mohan SD, Mohan M, Smith GD, Prabhakaran D, Reddy KS. 2010. The effect of rural-to-urban migration on obesity and diabetes in India: a cross-sectional study. PLoS Med 7:1–12.

Entrena Durán F. 2004. Los límites difusos de los territorios periurbanos: una propuesta metodológica para el análisis de su situación socioeconómica y procesos de cambio. Sociologias 6:28–63.

Eyles H, Ni Mhurchu C, Nghiem N, Blakely T. 2012. Food pricing strategies, population diets, and non-communicable disease: a systematic review of simulation studies. PLoS Med 9: e1001353.

Ezzati M, Elio Riboli MD. 2013. Behavioral and dietary risk factors for noncommunicable diseases. N Engl J Med 369:954–964.

Ferrante D, Linetzky B, Konfino J, King A, Virgolini M, Laspiur S. 2011. Encuesta Nacional de factores de riesgo 2009: evolución de la epidemia de enfermedades crónicas no transmisibles en Argentina. Estudio de corte transversal. Rev Argent Salud Pública 2:34–41.

Fotso JC. 2007. Urban-rural differentials in child malnutrition: trends and socioeconomic correlates in Sub-Saharan Africa. Health Place 13: 205–223.

Frisancho AR. 2008. Anthropometric standards for the assessment of growth and nutritional status. Ann Arbor: University of Michigan Press.

Gamboa MI, Basualdo JA, Córdoba MA, Pezzani BC, Minviell EMC, Lahitte HB. 2003. Distribution of intestinal parasitoses in relation to environmental and sociocultural parameters in La Plata, Argentina. J Helminthol 77:15–20.

Gamboa MI, Kozubsky LE, Costas ME, Garraza M, Cardozo MI, Susevich ML. 2009. Asociación entre geohelmintos y condiciones socioambientales en diferentes poblaciones humanas de Argentina. Rev Panam Salud Publica 26:1–8.

Gamboa MI, Navone GT, Orden AB, Torres F, Castro L, Oyhenart EE. 2011. Socio-environmental conditions, intestinal parasitic infections and nutritional status in children from a suburban neighborhood of La Plata, Argentina. Acta Trop 118:184–189.

Garraza M, Sugrañes N, Navone GT, Oyhenart EE. 2011. Sobrepeso, obesidad en relación a condiciones socio-ambientales de niños residentes en San Rafael, Mendoza. Rev Arg Antrop Biol 13:19–28.

Juárez MM, Rajal VB. 2013. Intestinal parasitoses in Argentina: major causal agents found in the population and in the environment. Rev Argent Microbiol 45:191–204.

Korkes F, Kumagai FU, Belfort RN, Szejnfeld D, Abud TG, Kleinman A, Florez GM, Szejnfeld T, Chieffi PP. 2009. Relationship between

intestinal parasitic infection in children and soil contamination in an urban slum. J Trop Pediatr 55:42–45.
Lohman TG, Roche AF, Martorell R. 1988. Anthropometric standardization reference manual. Champaign, Illinois: Human Kinetics Books.
Marcos L, Maco V, Terashima A, Samalvides F, Miranda E, Gotuzzo E. 2003. Parasitosis intestinal en poblaciones urbana y rural en Sandia, Departamento de Puno, Perú. Parasitol Latinoam 58:35–40.
Martinez MR, Pochettino ML, Arenas PM. 2003. La horticultura: estrategia de subsistencia en contextos pluriculturales, Valle del Cuña Pirú, Misiones, Argentina. Delpinoa 45:89–97.
Masterson Creber RM, Smeeth L, Gilman RH, Miranda JJ. 2010. Physical activity and cardiovascular risk factors among rural and urban groups and rural-to-urban migrants in Peru: a cross-sectional study. Rev Panam Salud Publica 28:1–8.
Moffat T. 2003. Diarrhea, respiratory infections, protozoan gastrointestinal parasites, and child growth in Kathmandu, Nepal. Am J Phys Anthropol 122:85–97.
Navone GT, Gamboa MI, Oyhenart EE y AB Orden. 2006. Parasitosis intestinales en poblaciones Mbyá-Guaraní de la Provincia de Misiones. Aspectos epidemiológicos y nutricionales. Cad Saude Publica 22: 1089–1100.
Nematian J, Nematian E, Gholamrezanezhad A, Ali Azgari A. 2004. Prevalence of intestinal parasitic infections and their relation with socioeconomic factors and hygienic habits in Tehran primary school students. Acta Trop 92:179–186.
Oyhenart EE, Castro LE, Forte LM, Sicre ML, Quintero FA, Luis MA, Torres MF, Luna ME, Cesani MF, Orden AB. 2008. Socio-environmental conditions and nutritional status in urban and rural schoolchildren. Am J Hum Biol 20:373–498.
Oyhenart EE, Garraza M, Bergel ML, Torres MF, Castro LE, Luis MA, Forte LM, Gamboa MI, Zonta ML, Cesani MF, Quintero FA, Luna ME, Navone GT. 2013. Caracterización del estado nutricional, enteroparasitosis y condiciones socio-ambientales de la población infanto-juvenil del partido de La Plata. Rev Arg Antrop Biol 15:47–60.
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 Publica 22:194–201.
Pedraza DF. 2009. Obesidad y Pobreza: marco conceptual para su análisis en Latinoamérica. Saúde e Sociedade 18:103–117.
Peña M, J Bacallao. 2000. La Obesidad en la pobreza: un problema emergente en las Américas. En: Peña M y J Bacallao, editors. La obesidad en la pobreza: un nuevo reto para la salud pública. Washington, D.C.: Organización Panamericana de la Salud. p 3–11.
Pérez BM. 2003. Efectos de la urbanización en la salud de la población. An Venez Nutr 16:1–16.
Plan Estratégico de la ciudad de Aristóbulo del Valle, 2006. Municipalidad de Aristóbulo del Valle, Provincia de Misiones, Argentina. Informe final, 112 p.
Pochettino M L, Martínez M R y M Crivos. 2002. Landscape domestication among two Mbyá-Guaraní communities in Misiones, Argentina. In Stepp JR, Wyndham FS, Zarger RK, editors. Ethnobiology and biocultural diversity. Athens: University of Georgia Press. p 696–704.
Popkin BM. 1999. Urbanization, lifestyle changes and the nutrition transition. World Dev 27:1905–1916.
Popkin BM. 2002. The shift in stages of the nutrition transition in the developing world differs from past experiences. Public Health Nutr 5: 205–214.
Quihui-Cota L, Valencia ME, Crompton DWT, Phillips S, Hagan P, Diaz-Camacho SP, Triana Tejas A. 2004. Prevalence and intensity of intestinal parasitic infections in relation to nutritional status in Mexican schoolchildren. Trans R Soc Trop Med Hyg 98:653–659.
Rai SK, Hirai K, Abe A, Ohno Y. 2002. Infectious diseases and malnutrition status in Nepal: an overview. Malays J Nutr 8:191–200.
Ruel MT. 2000. Urbanization in Latin America: constraints and opportunities for child feeding and care. Food Nutr Bull 21:12–24.
Soriano SV, Manacorda AM, Pierangeli NB, Navarro MC, Giayetto AL, Barbieri LM, Lazzarini LE, Minvielle MC, Grenovero MS, Basualdo JA. 2005. Parasitosis intestinales y su relación con factores socioeconómicos y condiciones de hábitat en niños de Neuquén, Patagonia, Argentina. Parasitol Latinoam 60:154–161.
Stephenson LS, Latmham MC, Ottesen EA. 2000. Malnutrition and parasitic helminth infections. Parasitology 121:23–38.
Tacoli C, Satterthwaite D. 2013. Gender and urban change. Environ Urban 25:3–8.
Taranto NJ, Cajal SP, De Marzi MC, Fernández MM, Frank FM, Brú AM, Minvielle MC, Basualdo JA, Malchiodi EL. 2003. Clinical status and parasitic infection in a Wichí Aboriginal community in Salta, Argentina. Trans R Soc Trop Med Hyg 97:554–558.
Thompson RCA. 2001. The future impact of societal and cultural factors on parasitic diseases. Some emerging issues. Int J Parasitol 31:949–959.
Tiyo R, Guedes TA, Falavigna DLM, Falavigna-Guilherme AL. 2008. Seasonal contamination of public squares and lawns by parasites with zoonotic potential in southern Brazil. J Helminthol 82:1–6.
UNICEF (United Nations International Children's Emergency Fund). 2005. Estado Mundial de la Infancia. La infancia amenazada. Nueva York: Fondo de las Naciones Unidas para la Infancia, p 10–30. Available from: http://www.unicef.org.
UNICEF (United Nations International Children's Emergency Fund). 2012. Estado mundial de la infancia. Niñas y niños en un mundo urbano. Resumen Ejecutivo. Fondo de las Naciones Unidas para la Infancia. Available from: http://www.unicef.org.
Velázquez GA. 2004. Aglomeraciones de tamaño intermedio y Calidad de Vida en la Argentina de los noventa. In Velázquez GA, Lucero P, Mantobani JM, editors. Nuestra Geografía Local. Población, urbanización y transformaciones socio-territoriales en el Partido de General Pueyrredon, Argentina, 1975–2000. GESPyT. Departamento de Geografía. Facultad de Humanidades. UNMdP.
WHO (World Health Organization). 2005. Prevención y control de la esquistosomiasis y geohelmintiasis. Serie de informes técnicos, 912. Ginebra. 73 p.
Zonta ML. 2011. Crecimiento, estado nutricional y enteropasitosis: un abordaje interdisciplinario. Rev Nutr Práctica 15:99–102.
Zonta ML, Bergel ML, Cociancic P, Gamboa MI, Garraza M, Cesani MF, Oyhenart EE, Navone GT. 2013. Enteroparasitosis en niños de Villaguay, Entre Ríos: un estudio integrado al estado nutricional y al ambiente. Rev Arg Parasitol 1:86–109.
Zonta ML, Garraza M, Castro L, Navone GT, Oyhenart EE. 2011b. Pobreza, estado nutricional y enteropasitosis infantil: un estudio transversal en Aristóbulo del Valle, Misiones, Argentina. Nutr clín diet hosp 31:48–57.
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.
Zonta ML, Oyhenart EE, Navone GT. 2011a. Nutritional vulnerability in Mbyá-Guaraní adolescent and adults, living in Misiones, Argentina. Am J Hum Biol 23:592–600.