Relationship between health services, socioeconomic variables and inadequate weight gain among Brazilian children

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This ecological analysis assessed the relative contribution of behavioural, health services and socioeconomic variables to inadequate weight gain in infants (0–11 months) and children (12–23 months) in 140 municipalities in the State of Ceara, north-east Brazil. To assess the total effect of selected variables, we fitted three unique sets of multivariate linear regression models to the prevalence of inadequate weight gain in infants and in children. The final predictive models included variables from the three sets. Findings showed that participation in growth monitoring and urbanization were inversely and significantly associated with the prevalence of inadequate weight gain in infants, accounting for 38.3% of the variation. Female illiteracy rate, participation in growth monitoring and degree of urbanization were all positively associated with prevalence of inadequate weight gain in children. Together, these factors explained 25.6% of the variation. Our results suggest that efforts to reduce the average municipality-specific female illiteracy rate, in combination with participation in growth monitoring, may be effective in reducing municipality-level prevalence of inadequate weight gain in infants and children in Ceara.

Keywords: Brazil; growth; infant nutrition disorders; multivariate analysis; weight gain.

Voir page 902 le résumé en français. En la página 903 figura un resumen en español.

Introduction

Among Brazilian children under 5 years of age, the prevalence of undernutrition has decreased significantly in recent years. Nevertheless, the percentage reduction has been lower for the north-east and north regions compared with the rest of the country (1). The proportion of children with weight-for-age two standard deviations below the median of the NCHS/WHO reference population (2) dropped from 27% in 1975–77 to 12.8% in 1989 in the north-east and from 13.4% to 4.1% in the south-east (1). This persistent inequality may be due to gaps in economic and social development, including differences in income, and access to basic health services, education, water supplies and sanitation (1). Apart from regional differences, variations in the nutritional status of infants and children between municipalities

have been reported within the State of Ceara in north-east Brazil (3, 4). Studies of these variations may permit identification of the determinants of child undernutrition that could be addressed by local governments. We report here the results of an ecological study that examined the relative contributions of behavioural, health services and socioeconomic variables to variations in the prevalence of inadequate weight gain in infants and young children among municipalities in Ceara.

Methods

Study site

Ceara is one of nine states in the north-east of Brazil, the poorest region of the country (5). According to the 1991 census, the State of Ceara had a population of 6 366 647 inhabitants (34.6% rural), of whom approximately 2.5% were aged < 1 year (6). The area has a high prevalence of child undernutrition (5): a cross-sectional survey in 1995 revealed that 25% of children aged 0–36 months had a weight-for-age <10th percentile of the reference population (4). The prevalence of underweight increased with age, from 8% of infants aged 0–5 months to 31% of children aged 12–17 months (4), and was found to be closely related to poor socioeconomic conditions (5).

Data sources

Data for this study were obtained from the 1991 census of the State of Ceara (6) and the Community

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Health Workers' Program (PACS) (*7*), a state government programme of paid community health workers (CHWs) implemented in all 184 municipalities of Ceara. The analyses included only the 140 municipalities that reported complete information on variables of interest every month from January 1994 to June 1996. Data before January 1994 were incomplete for several municipalities.

The CHWs visit the homes of 50–250 assigned families each month to provide health and nutrition education; they also weigh infants and children, and collect information on health indicators (*7, 8*). Pregnant women and children needing treatment are referred to health units for antenatal care. The health workers report information monthly to a supervisor who aggregates the data at the municipality level (*7–9*). Municipality-specific data on water supply and sanitation, household income, illiteracy rates, per capita gross product and percentage urbanization were obtained from the 1991 census (*6*).

Infants and children aged <24 months were weighed monthly at home on a portable beam balance scale, using standard techniques (*7–9*). The weights were recorded on a growth monitoring chart, based on the NCHS/WHO reference growth curves (*2*). Infants or children were classified as having inadequate weight gain if they failed to gain weight or lost weight between two consecutive measurements. As dependent variables, we used the proportion of infants (0–11 months) and children (12–23 months) with inadequate weight gain. This proportion was calculated by averaging the percentage of infants and children with inadequate weight gain in each municipality for each month over the 30-month study period.

As a theoretical basis, we adapted a conceptual framework from Pinstrup-Andersen (*10*). An underlying premise is that proximate and behavioural determinants such as diet, infections, and child care practices are associated with protein–energy malnutrition at the *individual* level. At the *community* level, however, poverty and lack of sanitation, education, or access to primary health care limit the nutritional status of children. Integrated programmes that address these factors at the local or national level are likely to be more successful than interventions targeting a single risk factor for undernutrition (*10*).

The independent variables were classified into behavioural, health service, and socioeconomic factors. The only behavioural factor available was percentage of infants exclusively breastfed in the first 4 months of life. Health service variables included percentage of infants with immunization schedule up-to-date, percentage of infants and children participating in growth monitoring, and percentage of pregnant women with prenatal care up-to-date. These variables were obtained from the PACS by averaging the percentages reported each month in a municipality over the 30-month study period. Socioeconomic variables were obtained from the 1991 census and included the percentage of households with inadequate water supply and inadequate sanitation, percentage of children aged < 7 years living in low-income households ($\leqslant 1.0$ minimum salary), percentage of women aged 15–44 years who were illiterate (female illiteracy rate), per capita gross municipality product (GMP), and the proportion of the population living in urban areas. More detailed definitions of the PACS and census variables are provided elsewhere (*6, 7*).

Analysis

Relationships between the independent variables were examined by Spearman's rank correlation because of the non-normal distribution of some of the variables. To assess the direct effects of behavioural, health services and socioeconomic variables, we fitted three unique sets of multivariate linear regression models for the prevalence of inadequate weight gain in infants and in children. To assess whether part of the effects of socioeconomic variables were indirectly mediated through the health services, we also fitted a set of multivariate linear regression models for socioeconomic variables adjusting for health services. The final predictive models included variables from the three main effect models. Interaction terms between selected variables were added to the main effect models. Finally, we applied a full spectrum of residual diagnostics and influence statistics to examine whether regression assumptions were satisfied and to identify the presence of atypical data points. All data management and analyses were carried out using SAS/PC software version 6.12.

Results

Over the 30-month study period, the average municipality-level prevalence of inadequate weight gain was 28.1% in infants and 34.9% in young children. In Table 1 we show the descriptive statistics (means, standard deviations and ranges) of behavioural, health services and socioeconomic variables. Moderate correlations were found between antenatal care and immunization ($r = 0.60$, $P < 0.0001$), antenatal care and female illiteracy rate ($r = 0.47$, $P < 0.0001$), and female illiteracy rate and low household income ($r = 0.55$, $P < 0.0001$).

The prevalence of infants exclusively breastfed in the first 4 months of life was not significantly associated with prevalence of inadequate weight gain in infants ($\beta = 0.11$; $P = 0.23$) or in children ($\beta = 0.13$; $P = 0.12$) (Table 2, $M1_{infants}$ and $M1_{children}$). In contrast, higher coverage of immunization and growth monitoring and use of antenatal care were each associated with a lower prevalence of inadequate weight gain in infants and children (Table 2). The strongest health services predictor was the percentage of infants and children whose growth was being monitored; a 10 percentage point increase was associated with a 4.5% and 2.9% decrease in the

prevalence of inadequate weight gain in infants and children, respectively (Table 2, M3$_{infants}$ and M3$_{children}$). When the three health services variables were added simultaneously to the same model, only participation in growth monitoring remained a significant predictor of the prevalence of inadequate weight gain in infants ($\beta = 0.44$; $P < 0.0001$) and children ($\beta = 0.27$; $P < 0.0001$).

Of the six socioeconomic variables, female illiteracy rate and percentage of households with low income were each independently associated with prevalence of inadequate weight gain (Table 3, M3$_{infants}$ and M3$_{children}$; M4$_{infants}$ and M4$_{children}$). Per capita GMP and percentage urbanization were inversely associated with inadequate weight gain, and female illiteracy rate was the strongest socioeconomic predictor, explaining 9.7% of the variation in infants and 8.8% in children, without adjusting for other socioeconomic covariates. Each 10 percentage point increase in female illiteracy rate was associated with an increase of 4.4% and 3.8% in the prevalence of inadequate weight gain in infants and children, respectively (Table 3, M3$_{infants}$ and M3$_{children}$). The association between low household income and prevalence of inadequate weight gain in both infants and children was highly attenuated and no longer significant after adjustment for female illiteracy rate (Table 3, M7$_{infants}$ and M7$_{children}$). Similarly, the association between per capita GMP and inadequate weight gain in infants (Table 3, M9$_{infants}$), was attenuated and no longer significant after simultaneous adjustment for other socioeconomic covariates. On the other hand, the association between per capita GMP and inadequate weight gain in children remained significant after adjustment for other socioeconomic covariates (Table 3, M9$_{children}$).

Neither inadequate water supply nor sanitation was significantly associated with the prevalence of inadequate weight gain in infants or children in bivariate or multivariable analysis.

We also examined the significance of interaction terms between socioeconomic variables, including female illiteracy rate and low household income and GMP, but found no significant association between these and the outcome variables.

Health services v socioeconomic factors

To assess whether the effects of socioeconomic variables were mediated through health services variables (e.g., percentage participating in growth monitoring), we compared models that included only the statistically significant socioeconomic factors with those that contained both health services and socioeconomic variables (Table 4). The associations of all socioeconomic variables with prevalence of inadequate weight gain in infants and in children were reduced, but not eliminated, after adjustment for percentage participating in growth monitoring. Thus, female illiteracy and household income may have

Table 1. Univariate statistics for all variables included in analysis of 140 municipalities in the State of Ceara, north-east Brazil

	Mean $\pm$ SD	Minimum	Maximum
PACS data (1994–96)			
Dependent variables			
% of infants with inadequate weight gain	28.1 $\pm$ 10. 1	8.9	61.6
% of children with inadequate weight gain	34.9 $\pm$ 9.3	10.8	61.9
Behavioural variables			
% infants exclusively breastfed in the first 4 months of life	41.7 $\pm$ 9.3	23.3	69.3
Health services variables			
% infants participating in growth monitoring	78.3 $\pm$ 12.4	42.7	99.6
% children participating in growth monitoring	77.8 $\pm$ 12.9	42.3	99.6
% infants with immunization up-to-date	78.9 $\pm$ 12.3	38.6	96.5
% pregnant women with antenatal care up-to-date	71.3 $\pm$ 13.1	27.7	91.6
Census data (1991)			
Socioeconomic variables			
% households with inadequate water supply	78.6 $\pm$ 13.7	26.8	99.8
% households with inadequate sanitation	98.2 $\pm$ 5.6	50.4	100.0
Female illiteracy rate (age 15–44 years)	43.0 $\pm$ 7.1	20.8	62.3
% households with low income	74.9 $\pm$ 9.5	44.5	93.0
Per capita gross municipality product (GMP)	362.5 $\pm$ 676.1	4.0	601.7
% urbanization	43.8 $\pm$ 18.1	11.4	100.0

direct effects on the prevalence of inadequate weight gain, in addition to indirect effects mediated through increased utilization of health services.

As a final step in our analysis, we fitted models for prevalence of inadequate weight gain in infants and children that included all significant and theoretically important variables from all three sets of models. As shown in Table 5, participation in growth monitoring and percentage urbanization were significant predictors of prevalence of inadequate weight gain in infants, explaining 38.3% of the variation. In children, factors associated with inadequate weight gain included participation in growth monitoring, female illiteracy rate, and percentage urbanization. Together these factors explained 25.6% of the variation.

Discussion

In this ecological study in 140 municipalities in the State of Ceara, north-east Brazil, we found that percentage participation in growth monitoring, per capita GMP, percentage of low household income, female illiteracy rate and urbanization were the main predictors of prevalence of inadequate weight gain in

Table 2. Regression models for behavioural and health services determinants of prevalence of inadequate weight gain in infants (0–11 months) and children (12–23 months) in 140 municipalities in the State of Ceara, north-east Brazil, 1994–96

Model	% exclusively breastfed	% immunization up-to-date	% participating in growth monitoring (GM)	% prenatal care up-to-date		Model	
	β value	β value	β value	β value	F	r² (%)	P-value
Infants							
M1	-0.11* (0.09)[a]				1.4	1.0	0.23
M2		-0.14** (0.07)			4.0	2.8	0.05
M3			-0.45*** (0.06)		60.6	30.5	0.0001
M4				-0.14** (0.06)	4.7	3.3	0.03
M5		-0.02* (0.06)	-0.44*** (0.06)		30.2	30.6	0.0001
M6			-0.44*** (0.06)	-0.05* (0.06)	30.6	30.9	0.0001
M7		-0.07* (0.08)		-0.09* (0.08)	2.8	3.9	0.06
M8		0.008* (0.07)	-0.44*** (0.06)	-.05* (0.07)	20.3	30.9	0.0001
Children							
M1	-0.13* (0.08)				2.4	1.7	0.12
M2		-0.13** (0.06)			4.6	3.2	0.03
M3			-0.29*** (.05)		28.1	16.9	0.0001
M4				-0.15** (.06)	6.2	4.3	0.01
M5		-0.08* (0.06)	-0.28*** (0.06)		15.1	18.1	0.0001
M6			-0.28*** (0.05)	-0.10* (0.05)	16.1	19.0	0.0001
M7		-0.06* (0.08)		-0.11* (0.07)	3.5	4.8	0.03
M8		-0.03* (0. 07)	-0.27*** (.06)	-0.08* (.07)	10.7	19.1	0.0001

[a] Figures in parentheses are standard errors.

* $P < 0.10$.

** $P < 0.05$.

*** $P < 0.001$.

infants and children. Associations of other determinants with prevalence of inadequate weight gain, although not significant, were in the expected directions.

The proportion of inadequate weight gain in infants and children was higher among municipalities with lower coverage of primary health care services and poorer socioeconomic status. Furthermore, we found that municipalities with a higher percentage of population living in urban areas had a lower prevalence of inadequate weight gain in infants and children. Our findings are in agreement with those of previous studies demonstrating that access to maternal and child health care services, female education, parental income and per capita gross product are among the most important determinants of variations in child growth at the aggregated level (1, 18–21).

Percentage participation in growth monitoring was associated with a decreased prevalence of inadequate weight gain, after controlling for other factors. Evaluations of growth monitoring and promotion interventions at the individual level in several developing countries have reported equivocal findings. Studies demonstrating a lack of benefit from growth monitoring over other educational interventions were not designed to evaluate the

marginal effect of growth monitoring after controlling for immunization, promotion of appropriate child feeding practices and home management of diarrhoeal disease (22–27). Other studies have shown a decline in levels of malnutrition and have argued that growth monitoring of a population group may be useful for detecting faltering growth and intervening before the child becomes severely malnourished (28–32). Methodological limitations of these studies, such as lack of control groups and information on sample selection, do not allow for assessment of the validity of their results. The negative association between the percentage of infants and children with inadequate weight gain and the percentage participating in growth monitoring in Ceara may be evidence of programme effectiveness, perhaps because malnourished children are referred to health centres (9) and given food supplementation (33) after faltering growth was detected. However, reverse causality cannot be ruled out with a cross-sectional, ecological design. Maternal participation could be higher in municipalities with a lower prevalence of inadequate weight gain, due to better socioeconomic conditions or a stronger commitment to health and nutrition. Alternatively, the strong correlation between participation in growth monitoring and inadequate weight gain could reflect targeting of high-risk infants and

Table 3. **Regression models for socioeconomic determinants of prevalence of inadequate weight gain in infants (0–11 months) and children (12–23 months) in 140 municipalities in the State of Ceara, north-east Brazil, 1994–96**

Model	% inadequate water supply	% inadequate sanitation	Female illiteracy rate	% household with low income	Per capita gross municipality product (GMP)	% urbanization		Model	
	β value	β value	β value	β value	β value	β value	F	r^2 (%)	P-value
Infants									
M1	0.07[e] (0.06)						1.2	0.08	0.27
M2		0.11[e] (0.15)					0.6	0.04	0.45
M3			0.44[b] (0.11)				14.9	9.7	0.0002
M4				0.29[b] (0.08)			11.7	7.8	0.0008
M5					-0.003[c] (0.001)		4.2	3.0	0.04
M6						-0.12[d] (0.05)	7.2	4.9	0.008
M7			0.32[c] (0.14)	0.15[e] (0.11)			8.5	11.0	0.0003
M8			0.28[e] (0.14)	0.15[e] (0.11)	-0.002[e] (0.001)		6.3	12.3	0.0005
M9			0.28[e] (0.15)	0.14[e] (0.12)	-0.002[e] (0.001)	-0.008[e] (0.06)	4.7	12.3	0.001
Children									
M1	0.03[e] (0.06)						0.3	0.02	0.56
M2		0.12[e] (0.14)					0.7	0.05	0.40
M3			0.38[b] (0.10)				13.3	8.8	0.0004
M4				0.23[d] (0.08)			8.0	5.5	0.005
M5					-0.003[c] (0.001)		6.2	4.3	0.01
M6						-0.11[c] (0.04)	6.6	4.5	0.01
M7			0.32[c] (0.13)	0.08[e] (0.10)			6.9	9.3	0.001
M8			0.28[c] (0.13)	0.08[e] (0.09)	-0.002[e] (0.001)		5.9	11.5	0.0008
M9			0.27[e] (0.14)	0.06[e] (0.11)	-0.002[e] (0.001)	-0.02[e] (0.06)	4.4	11.6	0.002
M10			0.34[d] (0.11)		-0.002[e] (0.001)		8.5	11.1	0.0003

[a] Figures in parentheses are standard errors.

[b] $P < 0.001$.

[c] $P < 0.05$.

[d] $P < 0.01$.

[e] $P < 0.10$.

children in municipalities with lower growth monitoring coverage. Aggregate data did not permit us to distinguish whether those with adequate weight gain were well children with normal growth, or underweight children demonstrating catch-up growth following infections. Ongoing improvements in data coverage and training of PACS workers are expected to improve the quality of data aggregated at municipality level, reducing potential misclassification of growth rate outcomes.

The association of female illiteracy rate with variations in the municipality-level prevalence of inadequate weight gain in infants and children emphasizes the importance of female education as an underlying determinant of child health and nutritional status. Similar findings have been reported by previous individual-level and ecological studies (8, 16, 38). Maternal educational level may influence the nutritional status of infants and children in several ways, including better management of household resources, greater use of health care services, lower fertility, better weaning and feeding practices, and improved health knowledge and behaviours (15, 16, 38–40). In India, two cross-sectional studies

showed that children of literate mothers had better anthropometric measurements, showed fewer signs of nutrient deficiency, and had better food consumption patterns than did children of illiterate mothers (16, 38). Case–control studies have found an increased risk (RR = 4.55) of malnutrition among children whose mothers had no schooling compared with those whose mothers had ⩾1 year of schooling after adjusting for health status, environmental and socioeconomic factors (15, 41). An ecological study conducted by Bicego et al. found that at the country level, maternal education was directly associated with the prevalence of underweight among children aged 3–23 months (39). Furthermore, an ecological study conducted by Frongillo et al. found that female literacy was among the significant factors associated with a lower prevalence of stunting at the national level (54). Currently, the average female illiteracy rate in Ceara municipalities is 43%. Lowering this high rate, in combination with high participation in growth monitoring, may be one of the most effective ways of reducing inadequate weight gain among children.

In accord with prior studies, we have found that per capita GMP was a significant determinant of

Table 4. **Health services and socioeconomic determinants of prevalence of inadequate weight gain in infants (0–11 months) and children (12–23 months) in 140 municipalities in the State of Ceara, north-east Brazil, 1994–96**

Model	% participating in growth monitoring	Female illiteracy rate	% household with low income	Per capita gross municipality product (GMP)	% urbanization		Model	
	β value	β value	β value	β value	β value	F	r^2 (%)	P-value
Infants								
M1	-0.42[a] (0.06)[b]	0.31[c] (0.09)				37.2	35.2	0.0001
M2	-0.43[a] (0.06)		0.26[a] (0.07)			39.6	36.7	0.0001
M3	-0.44[a] (0.06)			-0.001[d] (0.001)		32.1	31.9	0.0001
M4	-0.48[a] (0.06)				-0.14[a] (0.04)	44.8	39.7	0.0001
M5	-0.42[a] (0.06)	0.15 (0.12)	0.19[d] (0.09)			26.9	37.3	0.0001
M6	-0.42[a] (0.06)	0.12 (0.12)	0.19[d] (0.09)	-0.001 (0.001)		20.6	37.9	0.0001
M7	-0.44[a] (0.06)	0.07 (0.13)	0.09 (0.10)	-0.001 (0.001)	-0.10[d] (0.05)	17.6	39.7	0.0001
Children								
M1	-0.27[a] (0.05)	0.34[a] (0.09)				21.1	23.6	0.0001
M2	-0.29[a] (0.05)		0.22[c] (0.07)			19.5	22.2	0.0001
M3	-0.28[a] (0.05)			-0.002[e] (0.001)		17.2	20.1	0.0001
M4	-0.31[a] (0.05)				-0.13[c] (0.04)	21.2	23.6	0.0001
M5	-0.28[a] (0.05)	0.24[e] (0.12)	0.11 (0.10)			14.6	24.4	0.0001
M6	-0.27[a] (0.05)	0.21[d] (0.12)	0. 11(0.09)	-0.001[d] (0.001)		11.9	26.1	0.0001
M7	-0.29[a] (0.05)	0.17 (0.13)	0.04 (0.10)	-0.001 (0.001)	-0.07 (0.06)	9.9	27.1	0.0001

[a] P < 0.001.

[b] Figures in parentheses are standard errors.

[c] P < 0.01.

[d] P < 0.10.

[e] P < 0.05.

Table 5. **Regression model of the determinants of variation in the prevalence of inadequate weight gain in infants (0–11 months) and in children (12–23 months) in 140 municipalities in the State of Ceara, north-east Brazil, 1994–96**

Model	% participating in growth monitoring	Female illiteracy rate	% households with low income	Per capita gross municipality product (GMP)	% urbanization		Model	
	β value	β value	β value	β value	β value	F	r^2 (%)	P-value
Infants								
M1	-0.41[a] (0.06)[b]	0.31[c] (0.09)				37.2	35.2	0.0001
M2	-0.43[a] (0.05)		0.22[a] (0.07)			41.4	36.7	0.0001
M3	-0.42[a] (0.06)	0.15 (0.12)	0.19[d] (0.09)			26.9	37.3	0.0001
M4	-0.43[a] (0.05)		0.25[a] (0.07)	-0.001 (0.001)		27.2	37.5	0.0001
M5	-0.45[a] (0.05)		0.12 (0.09)	-0.001 (0.001)	-0.11[d] (0.05)	22.1	39.6	0.0001
M6	-0.47[a] (0.05)				-0.15[a] (0.04)	42.5	38.3	0.0001
Children								
M1	-0.27[a] (0.05)	0.30[c] (0.09)	-0.002[e] (0.001)			15.3	25.2	0.0001
M2	-0.29[a] (0.05)	0.19[e] (0.11)	-0.002 (0.001)		-0.08[e] (0.04)	12.5	27.1	0.0001
M3	-0.29[a] (0.05)	0.22[e] (0.11)			-0.08[e] (0.04)	15.6	25.6	0.0001

[a] P < 0.001.

[b] Figures in parentheses are standard errors.

[c] P < 0.01.

[d] P < 0.05.

[e] P < 0.10.

the prevalence of inadequate weight gain in children, after adjustment for other socioeconomic covariates (*1, 17*). An analysis of regional differences in the nutritional status of Brazilian children (*1*) showed that children from poorer states (i.e., in north and north-east regions), as measured by per capita gross national product (GNP) and household income, had a higher prevalence of undernutrition than those from wealthier states (i.e., in south and south-east regions). Similarly, cross-national studies have reported a significant association between the prevalence of underweight and gross national product (*18–21*). Frongillo et al. (*18*), in an analysis of cross-national data, found that maternal and child care, health services, access to safe water, and government health expenditure as a percentage of GNP were the most important determinants of international variability in child growth.

Low household income, a significant predictor of prevalence of inadequate weight gain in bivariate analysis, was no longer significant after adjustment for female illiteracy rate. This result is contrary to that reported by previous individual (*40*) and ecological studies (*42*) showing that income is an important predictor of child malnutrition. This finding may be explained in part by the correlation between female illiteracy rate and low household income (*r* = 0.55, *P* < 0.0001, not shown).

Inadequate water supply and inadequate sanitation were not significant predictors of prevalence of inadequate weight gain in infants and children, after adjustment for other covariates. These findings contrast with those of some previous studies showing that environmental conditions, including water supply and sanitation, are closely related to the nutritional status of young children (*43–45*). The lack of association may be explained in part by the fact that the percentage of households with inadequate water supply and inadequate sanitation was very consistent between the municipalities included in our study. In 1991, the average percentages of households with inadequate water supply and sanitation were 78.7% and 98.2%, respectively (*6*). Reductions in these high proportions could reduce the prevalence of inadequate weight gain in infants and children among municipalities in Ceara.

Contrary to the results of some case–control and cohort studies, we found that the prevalence of exclusively breastfed infants was not significantly and inversely associated with the prevalence of inadequate weight gain in infants and children, with and without adjustment for other covariates (*37, 46–48*). We lacked ecological data to assess the contribution of other known proximate determinants of underweight such as infections, weaning practices and inadequate dietary intake (*10*).

The results of the present study, the first municipality-level investigation of risk factors for inadequate infant and child weight gain in the State of Ceara, should be interpreted with care (*49–51*). Poor definition and reporting of some variables limited our ability to assess their relationship with the prevalence

of inadequate weight gain. Monthly changes in weight-for-age could be documented in children who were not underweight, or could be associated with either wasting or stunting, which are known to represent different processes of malnutrition with different risk factors (*52*). Variations in the quality of the anthropometric data, such as community health workers' ability to measure weight or determine child age and plot the information accurately on the growth monitoring chart, may have affected the calculation of the outcome variables. Moderate correlations (not shown) found between some socioeconomic and health services utilization variables may have limited our ability to assess the independent determining effect of some variables on the prevalence of inadequate weight gain in infants and children (*12–14*). Multicolinearity is a greater potential problem in ecological studies than in individual-level studies. We chose to eliminate this problem by placing redundant variables in order of importance (*53*). Most of the literature on ecological studies cites the problem of ecological fallacy, which occurs when inferences from group data are extrapolated to individual-level data (*13, 14, 50, 51*). In our study, this is not a concern because our main inferences focused on municipalities rather than individuals.

Strengths of our study include the use of analysis of morbidity and risk factors at the same level of potential interventions. This is of particular importance in Ceara, where decentralization of health services (i.e., municipalization of health) has taken place, and municipalities have been given major responsibilities for health care provision. Studies such as this of community-level factors are important because of the influence that local decisions, organizations, environment and other characteristics may have. While country-level studies have examined factors associated with the prevalence of child undernutrition (*18, 20, 21*), adequate data are rarely available to assess the determinants at the level of the community. The present study bridges this gap by examining the determinants of inadequate weight gain that work at the municipal (community) level. The wide variation among municipalities in the prevalence of infants and children with inadequate weight gain suggests that municipality-level factors are influential. Identification of the determinants of these differences at the community level is of particular importance to nutrition policy and programmes where local government plays a pivotal role in providing primary health care. The methodology used illustrates the potential of the ecological approach in evaluating the impact of public health programmes, and may be applied to settings where the unit of analysis (e.g. municipalities) is the same as that of the intervention.

In conclusion, our findings have direct application to programmes aimed at improving the nutritional status of infants and children, and present a format in which research and programmes can systematically examine risk factors that work at the

ecological level so that interventions can be appropriately targeted. ∎

Acknowledgements

Résumé

Insuffisance du gain pondéral chez le jeune enfant au Brésil

Une analyse écologique a été entreprise pour évaluer dans quelle mesure des variables comportementales, sanitaires et socio-économiques expliquent la variation de la prévalence d'une prise de poids insuffisante chez le nourrisson de 0 à 11 mois et l'enfant de 12 à 23 mois dans 140 municipalités de l'Etat de Ceara au nord-est du Brésil. Les données concernant cette étude ont été tirées du recensement de 1991 de l'Etat de Ceara et du programme des agents de santé communautaires (PACS) — un programme d'agents de santé communautaires rémunérés relevant des autorités qui a été appliqué dans 182 des 184 municipalités de l'Etat de Ceara. L'analyse n'a tenu compte que des 140 municipalités qui ont fourni des données complètes sur les variables étudiées chaque mois de janvier 1994 à juin 1996. Les données avant janvier 1994 concernant plusieurs municipalités étaient incomplètes.

Les agents de santé communautaires du programme PACS se rendent chaque mois au domicile des 50 à 250 familles qui leur sont confiées pour apporter une formation en matière de santé et de nutrition. Les agents de santé communautaires pèsent les nourrissons et les enfants et obtiennent des données sur les indicateurs de santé. Les femmes enceintes sont aiguillées vers des unités de santé pour des vaccins prénatals, de même que les enfants malades et les personnes ayant besoin d'un traitement. Les agents de santé communautaires font rapport chaque mois à un supérieur hiérarchique qui réunit les données au niveau municipal. Les données sur l'approvisionnement en eau et l'assainissement au niveau municipal, le revenu du ménage, le taux d'analphabétisme, le produit municipal brut par habitant et le pourcentage de la population résidant en milieu urbain sont tirées du recensement de 1991. Comme variables dépendantes, on a utilisé la proportion des nourrissons (0–11 mois) et des enfants (12–23 mois) présentant une insuffisance du gain pondéral. Ont été classés comme tels les nourrissons et enfants n'ayant pas pris de poids entre deux visites consécutives. La proportion a été calculée en prenant la moyenne du pourcentage des nourrissons et des enfants présentant une prise de poids insuffisante dans chaque municipalité pour chaque mois au cours de la période de l'étude de 30 mois. Pour évaluer l'effet global des variables comportementales sanitaires et socio-économiques, on a établi trois groupes spécifiques de modèles de régression linéaire multivariés, appliqués à la prévalence d'une prise de poids insuffisante chez le nourrisson et l'enfant. Les modèles prédictifs définitifs d'insuffisance du gain pondéral incluaient les variables des trois groupes de modèles. On a observé une prévalence plus importante dans les municipalités à plus faible couverture par les services de soins de santé primaires et moins bien loties du point de vue socio-économique. Dans les modèles multivariés, le pourcentage des enfants participant à la surveillance de la croissance et le pourcentage de la population résidant en milieu urbain étaient significativement et négativement associés à la prévalence d'une prise de poids insuffisante et expliquaient 38,3% de la variation de la proportion d'enfants ayant une prise de poids insuffisante. On observe chez l'enfant une association significative — positive pour le taux d'analphabétisme des femmes et négative pour la participation à la surveillance de la croissance et le pourcentage de la population résidant en milieu urbain — avec la prévalence de l'insuffisance du gain pondéral. Ensemble, ces facteurs expliquent 25,6% de la variation. Ces résultats font penser que des efforts visant à réduire le taux d'analphabétisme des femmes au niveau municipal associés à une participation à la surveillance de la croissance pourraient permettre de réduire la prévalence d'une prise de poids insuffisante au niveau municipal chez le nourrisson et l'enfant dans l'Etat de Ceara. Les études portant sur les facteurs communautaires, comme celle-ci, sont importantes en raison de l'influence que peuvent avoir en matière de prise de décision les organisations locales. Si des études au niveau des pays ont examiné des facteurs associés à la prévalence de la sous-nutrition de l'enfant, des données adéquates sont rarement disponibles pour évaluer les déterminants au niveau communautaire. L'étude entend combler cette lacune de la recherche en examinant les déterminants de l'insuffisance du gain pondéral qui interviennent au niveau municipal (communautaire).

L'ampleur de la variation — entre les municipalités — de la prévalence d'une prise de poids insuffisante chez le nourrisson et l'enfant fait penser qu'il existe des facteurs locaux à prendre en considération. Il est

particulièrement important d'identifier les déterminants de ces différences au niveau communautaire pour définir une politique et des programmes nutritionnels dans des cadres où les autorités locales jouent un rôle clé en matière de soins de santé primaires. La méthodologie

utilisée illustre les perspectives offertes par l'approche écologique pour évaluer l'impact des programmes de santé publique et peut s'appliquer à tout un éventail de situations où l'unité d'analyse (par exemple, les municipalités) est la même que l'unité d'intervention.

Resumen

Aumento de peso insuficiente entre los niños brasileños

Realizamos un análisis ecológico para evaluar la contribución relativa de variables conductuales, asistenciales y socioeconómicas como explicación de las variaciones de la prevalencia del aumento de peso insuficiente en lactantes (0–11 meses) y niños de corta edad (12–23 meses) de 140 municipios del Estado de Ceara, en el noreste del Brasil. Los datos empleados en el estudio se obtuvieron del censo de 1991 del Estado de Ceara y del programa PACS, un programa de agentes de salud comunitarios remunerados puesto en práctica por la Administración del Estado en 182 de los 184 municipios de Ceara. Sólo se incluyeron en los análisis los 140 municipios que aportaron información completa sobre las variables de interés todos los meses entre enero de 1994 y junio de 1996. Los datos anteriores a enero de 1994 estaban incompletos en el caso de varios municipios.

Los agentes de salud comunitarios del PACS visitan cada mes a las 50–250 familias asignadas para impartir educación sanitaria y nutricional; además, pesan a los lactantes y niños y reúnen información sobre indicadores esenciales de las condiciones de vida y la salud. Las embarazadas son derivadas a unidades de salud para que reciban inmunización prenatal, al igual que los niños enfermos y los necesitados de tratamiento. Los agentes de salud comunitarios dan cuenta de sus observaciones cada mes a un supervisor que agrega los datos por municipios. Los datos sobre los sistemas municipales de abastecimiento de agua y saneamiento, los ingresos familiares, las tasas de analfabetismo, el producto municipal bruto por habitante y el porcentaje de urbanización se obtuvieron a partir del censo de 1991. Consideramos como variable dependiente la proporción de lactantes (0–11 meses) y niños (12–23 meses) con aumento de peso insuficiente; se determinaba que un lactante o niño presentaba esa insuficiencia cuando no ganaba peso entre dos mediciones consecutivas cualesquiera. La citada proporción se calculó promediando el porcentaje de lactantes y niños con aumento de peso insuficiente notificados mensualmente en cada municipio durante el periodo de estudio de 30 meses. Para evaluar el efecto total de las variables seleccionadas, ajustamos tres conjuntos distintos de modelos de regresión lineal multifactorial a la prevalencia de aumento de peso insuficiente en lactantes y niños. Los modelos predictivos finales para el aumento ponderal insuficiente incluyeron variables de los tres conjuntos de modelos. La prevalencia de niños con aumento de peso

insuficiente fue mayor en los municipios con menor cobertura de servicios de atención primaria y menor nivel socioeconómico. En los modelos multivariables, el porcentaje de participación en la vigilancia del crecimiento y el porcentaje de urbanización resultaron estar inversa y significativamente relacionados con la prevalencia de aumento de peso insuficiente entre los lactantes, lo que explicaba el 38,3% de la variación de la proporción de niños con aumento ponderal insuficiente. En los niños, los factores asociados al aumento de peso insuficiente fueron la participación en la vigilancia del crecimiento, la tasa de analfabetismo femenino y el porcentaje de urbanización. Conjuntamente, esos factores explicaban el 25,6% de la variación. Los resultados llevan a pensar que los esfuerzos destinados a reducir la tasa promedio de analfabetismo femenino por municipios, unidos a la participación en la vigilancia del crecimiento, pueden reducir eficazmente a nivel municipal la prevalencia del aumento de peso insuficiente entre los lactantes y los niños pequeños en Ceara. Los estudios sobre los factores que actúan a nivel comunitario, como el presente trabajo, son importantes dada la influencia que pueden tener en materia de toma de decisiones las organizaciones locales. Aunque en diversos estudios realizados a nivel de país se han analizado los factores asociados a la prevalencia de la desnutrición infantil, rara vez se dispone de datos adecuados para evaluar los factores determinantes a nivel de la comunidad. En el presente estudio se intenta colmar esa laguna de investigación examinando los determinantes del aumento de peso insuficiente que operan a nivel municipal (comunidad).

La amplia variación observada entre los municipios en lo que atañe a la prevalencia de lactantes y niños con aumento de peso insuficiente parece indicar que a nivel municipal hay factores que influyen en ese sentido. La identificación de los determinantes de estas diferencias a nivel de la comunidad es de especial importancia para las políticas y los programas nutricionales en los entornos en que las administraciones locales desempeñan una función crucial en la prestación de atención primaria. La metodología utilizada ilustra el potencial del enfoque ecológico para evaluar la repercusión de los programas de salud pública, y puede aplicarse a diversos entornos en que la unidad de análisis (por ejemplo los municipios) coincide con la unidad de intervención.

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