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SOCIOECONOMIC AND HEALTH DETERMINANTS OF CHILD MALNUTRITION: AN ANALYSIS OF SPATIAL DISTRIBUTION

Ligia Rejane Siqueira Garcia

Doctorate degree in Collective Health by UFRN, Professor of the Nutrition Course at FACISA / UFRN, Santa Cruz (RN), Brazil.

Angelo Giuseppe Roncalli

Post doctoral from University College London, Professor of the Postgraduate Program in Collective Health, UFRN, Natal (RN), Brazil.

ABSTRACT: The spatial distribution of stunting in low-income Brazilian children and its correlation with socioeconomic and health service indicators are analyzed. Current ecological study, based on national secondary data, employed the variables child malnutrition, socioeconomic indicators and health services in Brazil. Univariate and bivariate statistical techniques were used for spatial analysis. A spatial dependence was reported for child malnutrition ($I=0.52$; $p=0.010$), with the lowest prevalence in the most developed regions of the country (South and Southeast regions). A negative association was detected between child malnutrition and per capita income ($p<0.001$) and Human Development Index ($p<0.001$), whilst there was a positive association between malnutrition and investments in primary care ($p<0.001$). Spatial asymmetries were found with a higher prevalence of malnutrition in the north-northeast regions and associations with socioeconomic and health service indicators, reflecting a historical process of inequalities in Brazil.

KEY WORDS: Child health; Child nutrition disorders; Health status disparities; Nutritional epidemiology.

DETERMINANTES SOCIOECONÔMICOS E DE SAÚDE DA DESNUTRIÇÃO INFANTIL: UMA ANÁLISE DA DISTRIBUIÇÃO ESPACIAL

RESUMO: Determinantes socioeconômicos e de saúde da desnutrição infantil: uma análise da distribuição espacial. Objetivo: analisar a distribuição espacial da desnutrição em crianças brasileiras de baixa renda e sua correlação com indicadores socioeconômicos e de serviços de saúde. Método: Estudo ecológico, com dados secundários de representação nacional, tendo como variáveis a desnutrição infantil, os indicadores socioeconômicos e de serviços de saúde no Brasil. Utilizaram-se técnicas de estatística univariada e bivariada para a análise espacial. Resultados: Foi observada uma dependência espacial para a desnutrição infantil ($I=0{,}52$; $p=0{,}010$), com as menores prevalências nas regiões mais desenvolvidas do país, Sul e Sudeste. Associação negativa foi obtida entre desnutrição infantil e a renda per capita ($p<0{,}001$) e o IDH ($p<0{,}001$). E associação positiva entre a desnutrição e os Investimentos na atenção primária ($p<0{,}001$). Conclusão: Foram encontradas assimetrias espaciais, com maior prevalência de desnutrição nas regiões norte-nordeste e associações com os indicadores socioeconômicos e de serviços de saúde, o que reflete um processo histórico de desigualdades no país.

PALAVRAS-CHAVE: Disparidades nos níveis de saúde; Epidemiologia nutricional; Saúde da criança; Transtornos da nutrição infantil.

Autor correspondente:
Ligia Rejane Siqueira Garcia
ligiarejane@yahoo.com.br

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INTRODUCTION

Child height deficit is the product of a complex interrelationship of factors which represent negative environmental influences on children´s health. Growth impairment is associated with children malnutrition, with serious consequences on morbidity and mortality in childhood, lower performance in education, scanty productivity in adulthood and the transference of poverty to future generations[1,2].

Besides being a past malnutrition index, the evaluation of child height is an indirect measure of the population´s life quality since most health and nutrition problems during childhood are related to inadequate food intake and recurrent infections related to the population´s life standard[3].

One of the millennium´s development targets, claimed in 2000, by the UN, featured a fifty percent decrease of world prevalence of anthropometric deficits in less than five-year-old children. The target should be attained by 2015. In spite of much progress, the theme continued to be salient due to the Aims for Sustainable Development, one of the aims for 2015, or rather, the abolishment of all forms of malnutrition in five-year-old children[4].

Hunger and child malnutrition are historically related to poverty. During the last few years, the establishment of a program for the conditioned transference of income, called Family Income Program (Programa Bolsa Família or PBF) was one of the several efforts in social policies to reduce poverty and inequalities and to eliminate hunger in Brazil. PBF targeted families in conditions of poverty and extreme poverty, with the beneficiaries´ counterpart within the education and health sectors. Coupled to health, education and productive inclusion, the program aimed at better life conditions for the families it benefitted, breaking the cycle within the intergeneration transmission of poverty[5].

Malnutrition factors differ among different types of geographic realities and few spatial studies on child malnutrition exist on PBF beneficiaries. Consequently, one should try to understand the geographical factors associated with child malnutrition since such analyses may contribute towards the planning of social and health public policies. Current study investigates the spatial distribution of malnutrition in children of low-income families and its co-relationship with social indexes and health services.

METHODOLOGY

Current ecological study comprises the analysis´s spatial unit, the Intermediary Division of Urban Articulation, or rather, a regional cross-section created by the Brazilian Institute of Geography and Statistics (IBGE), according to the Cities´ Influence Region.[6] Submission and approval by the Committee for Ethics in Research was not required due to the conditions of aggregated data, without the identification of agents, available in public data bases.

Brazil is divided into 27 federal units (26 states and one Federal District) and five regions defined by their natural features (Figure 1A). However, in an attempt to divide the units differently, the IBGE proposed a new type of territorial division called Regional Urban Division which takes into account the following criteria: urbanization process, market integration, and interconnected administrative, infrastructure and production activities.[10] Within a more comprehensive scale, fourteen Amplified Regions of Urban Articulation (EUAR) were identified. At a second level, employed in current analysis, cities were grouped into 161 Intermediary Regions of Urban Articulation (IUAR) characterized by their capacity in polarizing a great number of municipalities in their supply for goods and high complex services, with a concentration of public and private administration activities (Figure 1B).

Dependent variable comprised stunting according to index height/age in under-five-year-old children listed in the PBF, obtained by aggregated reports for each municipality and available at the Administration System of the Family Income Program (DATASUS/ Ministério da Saúde) for 2010. Stunting may be defined as the stature rate at least below two standard deviations of stature median for age (below -2 scores-z of stature for age) compared to reference parameter proposed by WHO.[7] Age bracket was determined by the strong influence of environmental factors on health and nutrition state.

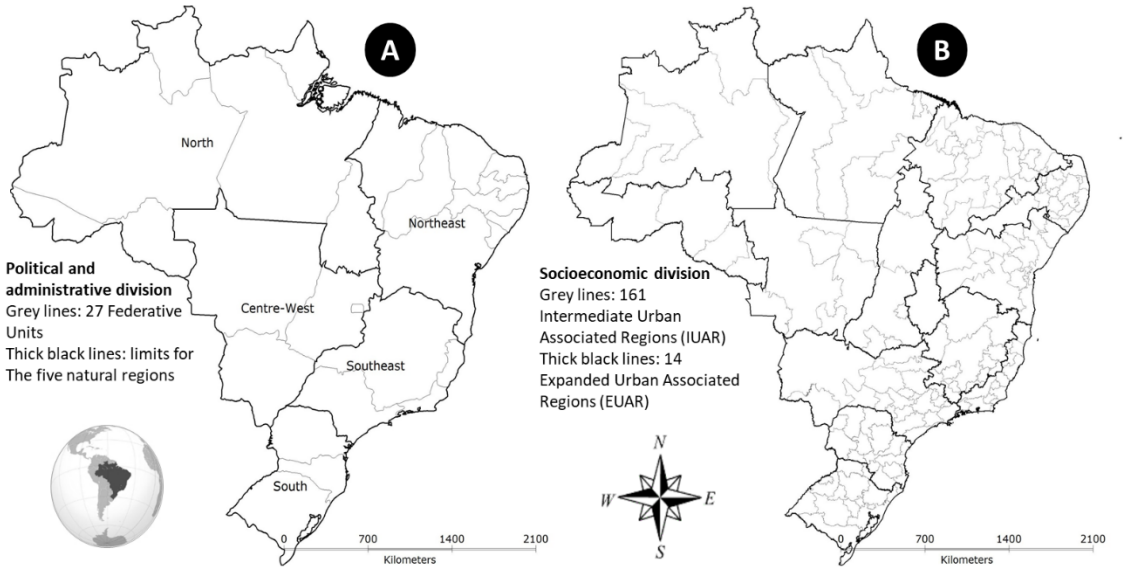

Figure 1. Brazil´s territorial division. A = the political and administrative division of the country; B = social and economic division of the country´s territory by urban articulation.
Source: IBGE[6]

Stratification criteria proposed by the Information Interagency Network on Health in Brazil (RIPSA) were employed to classify the areas of urban articulation according to the prevalence of stunting, such as prevalence (a) low: less than 10%; (b) medium, between 10% and 19%; (c) high, between 20% and 29%; (d) very high: equal to or higher than 30%.[8] The above criterion was employed to establish a gradient required for statistical analysis and comparison with international studies, even though it may not be a value judgment with regard to the relevance of the intersection points.

The inclusion of data on the prevalence of stunting in children enrolled in PBF of 205 municipalities (4% of total number) was impossible due to sheer lack of information. Five hundred and ten municipalities were also excluded due to atypical multi-varied observations by Mahalanobis´s D^2, or rather, extreme and inconsistent rates within a set of variables which may have undue influence on results and identified by statistical distance between the multiple variables studied, taking into account the co-variance matrix. Therefore, current analysis refers to data from 4,855 (87%) Brazilian municipalities.

Independent socioeconomic variables were retrieved from the Atlas of Human Development by the Brazilian Agency of Development Programs of the United Nations and were originally based on the gross data of the 2010 Demographic Census organized by the IBGE. Human Development Index (HDI) is a compound index comprising education level, longevity and income, and is generally used by the UN for international comparisons on life-quality levels. The variable mean income per capita indicates income distribution by the country´s smallest political and administrative units.

GINI coefficient is one method to measure the degree of inequality by the concentration of distribution of per capita family income. Illiteracy rate of the population aged 15 years old and over gives an idea of the coverage of schooling for the population of this age group. Investment in Primary Care is the index related to health services, measured by Brazilian reais per capita, and available from the Information System of Government Budget in Health (SIOPS), which provides the level of priority that a particular municipality gives to first care services.

Spatial dependence of each variable was calculated by Terra View 4.1.0 and Moran Global Index which estimates spatial self-co-relationship. The index may vary between -1 and +1, and evaluates associations within a data set. Negative rates indicate inverse co-relationship, whilst positive ones indicate direct co-relationship. Rates close to zero demonstrate the inexistence of spatial self-co-relationship. Significance level was $p < 0.05$.

Bivariate analysis was undertaken by Moran´s dispersion diagram. It investigates whether spatial distribution of the dependent variable (childhood stunting) in a region has any relationship with rates of an independent variable in the neighboring regions. Bivariate analysis was also demonstrated by co-relation maps (LISA) that demonstrate the spatial co-relation between the variable child malnutrition and the independent ones (bivariate Moran Index) by GeoDa 0.9.9.14.

Each color in the co-relation map represents a quadrant of the dispersion graph which identifies four types of spatial associations: High-High indicates that the rate of the variable (childhood stunting) and the mean rate of the index analyzed (independent variable) of neighbors is above average; Low-Low indicates that the variable stunting and mean index of neighbors are below average; Low-High represents low rates of variable stunting are surrounded by high rates of the independent variables; How-Low indicates that high rates of variable stunting are surrounded by low rates of the independent variables.

RESULTS

It must be underscored that 65.83% of the 161 regions of urban articulation under analysis corresponded to low childhood stunting prevalence classification; 28.57% of the regions had average prevalence; 4.35% had high prevalence and 1.24 fitted the very high prevalence category. Table 1 shows descriptive statistics of the variables studied.

Figure 2 shows distribution of independent and dependent variables in intermediary areas of urban articulation. Regions with high childhood stunting prevalence predominate in PBF beneficiaries in the North and Northeast regions of Brazil. Low prevalence rates were concentrated in the Central, Southeastern and Southern regions of Brazil. A small area in the southeastern region, featuring high prevalence, is the exception. There was a spatial self-co-relationship for childhood stunting, with significant Moran Global Coefficient ($I=0.52$; $p=0.010$).

Table 1. Descriptive statistics of child malnutrition, socio-economic and health service indexes in the intermediary region of urban articulation in Brazil

Variable	Mean	Standard deviation	Minimum	Maximum
Prevalence of child malnutrition (%)	14.12	5.12	7.41	39.43
HDI (rate)	0.69	0.06	0.61	0.79
Per capita income (R$)	654.50	251.58	255.76	1306.55
GINI Index (rate)	0.52	0.04	0.45	0.61
Illiteracy rate of population aged or over 15 years old (%)	12.76	7.96	3.39	25.26
Investment in primary care (R$ per capita)	39.40	9.97	22.33	59.73

Spatial distribution of HDI reveals polarization, with best results in the center-south region, whereas worst results may be mainly met in the northeastern and northern regions ($I=0.85$; $p=0.01$; Figure 2). There is an isolated central region with the highest national per capita income surrounded by conglomerates which represent intermediate rates in the center-south region and worse rates predominating in the north-northeast region ($I=0.80$; $p=0.01$; Figure 2). In the case of Gini Index, spatial dependence ($I=0.81$; $p=0.010$; Figure 2) has been reported, with better areas within the southern and south-eastern regions. Illiteracy of populations within the 15-year-old or over bracket is concentrated in the north-eastern region, some intermediary areas in the north and a great conglomerate with the best results in the center-southern region and part of the northern one ($I=0.90$; $p=0.01$; Figure 2). Investments in primary care formed conglomerates in several Brazilian regions ($I=0.73$; $p=0.01$; Figure 2), with greater investments in the northeastern and northern regions.

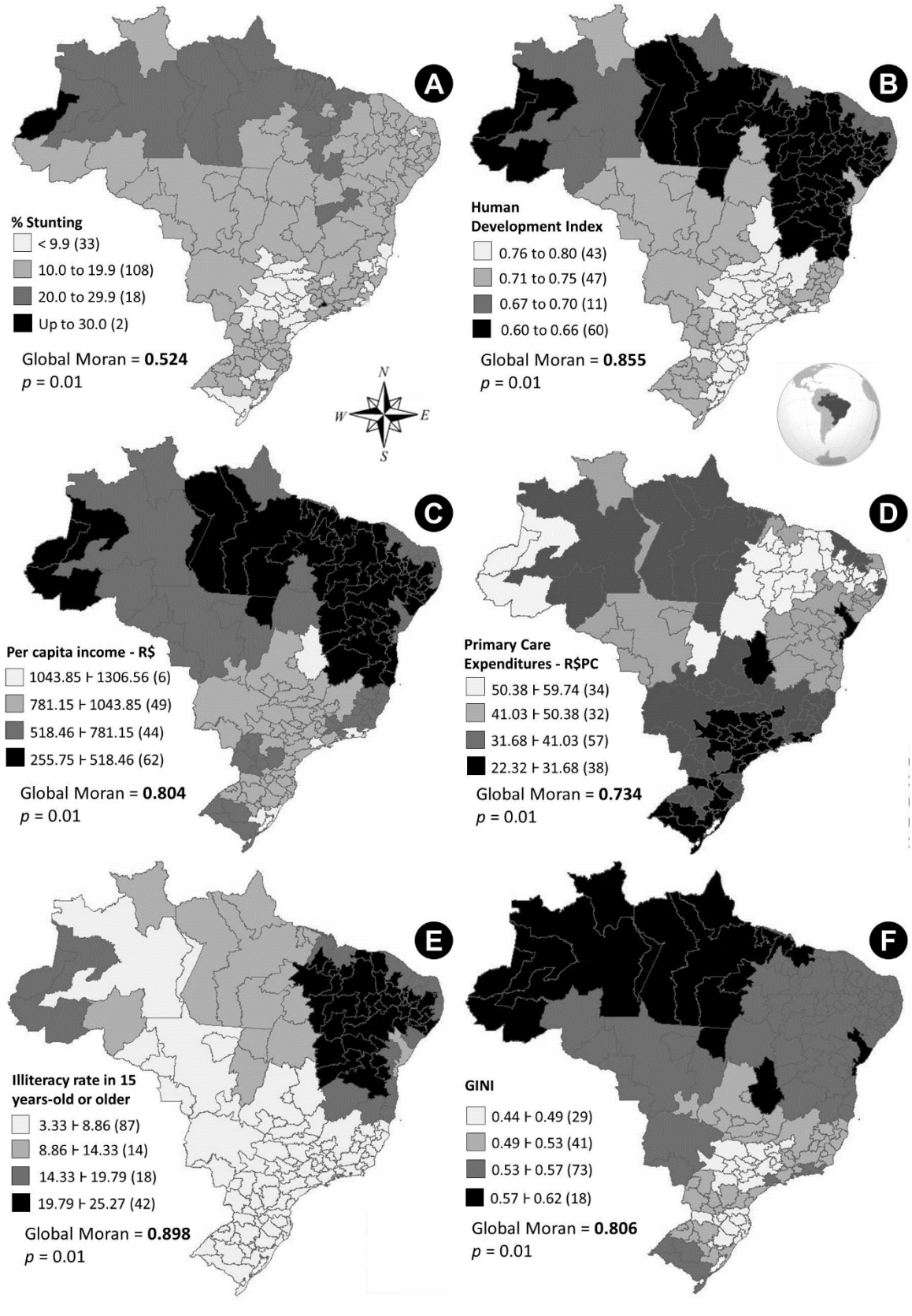

Figure 2. Spatial distribution map of variables: dependent (A) and independent (B to F). Numbers in brackets are the number of regions in each category. Data for 161 regions.

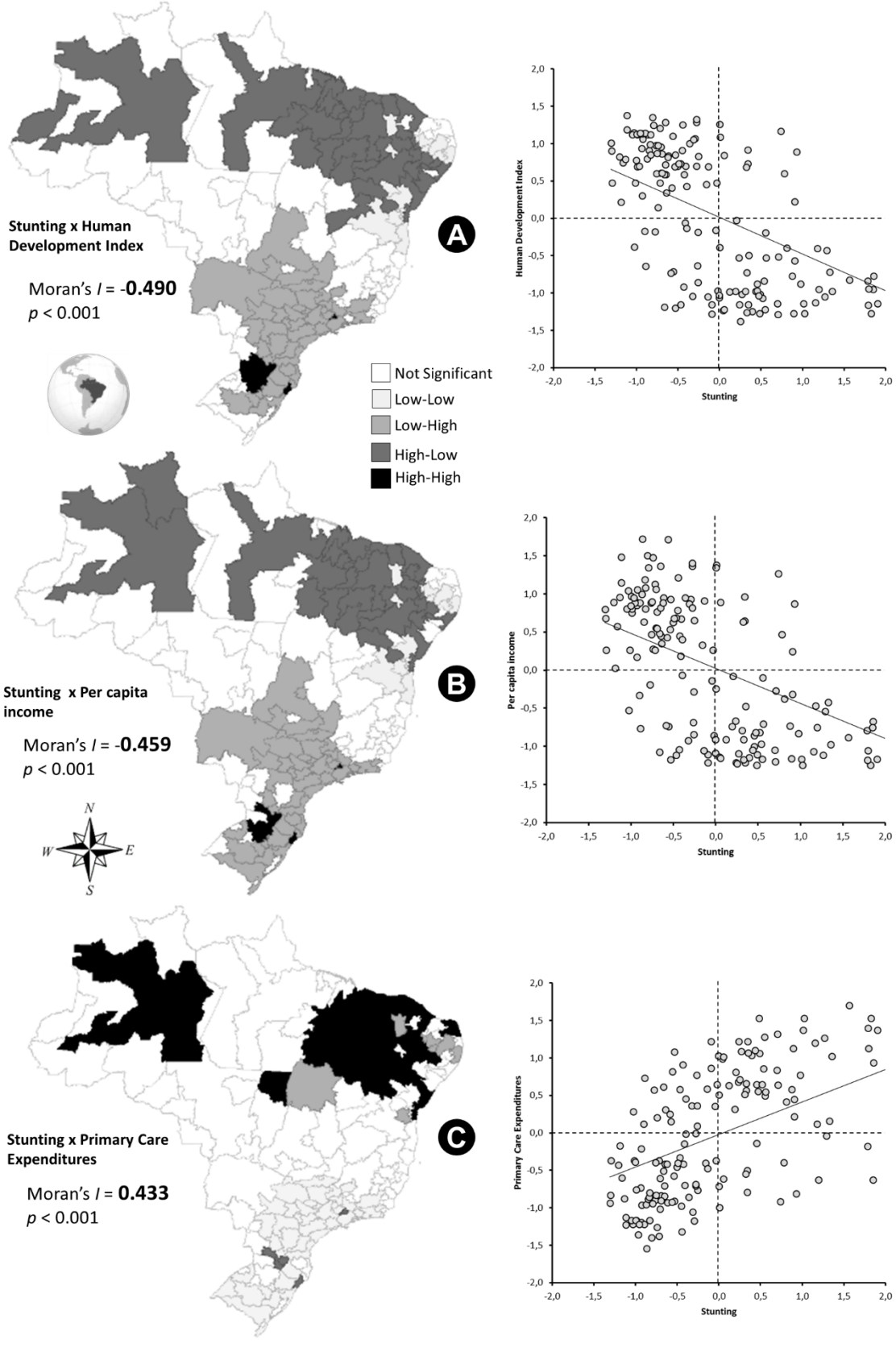

Figure 3. Maps and dispersion graphs with bivariate spatial analysis between childhood stunting and independent variables. A = spatial co-relationship with HDI; B = per capita income; C = Primary Care investments. Data for 161 regions.

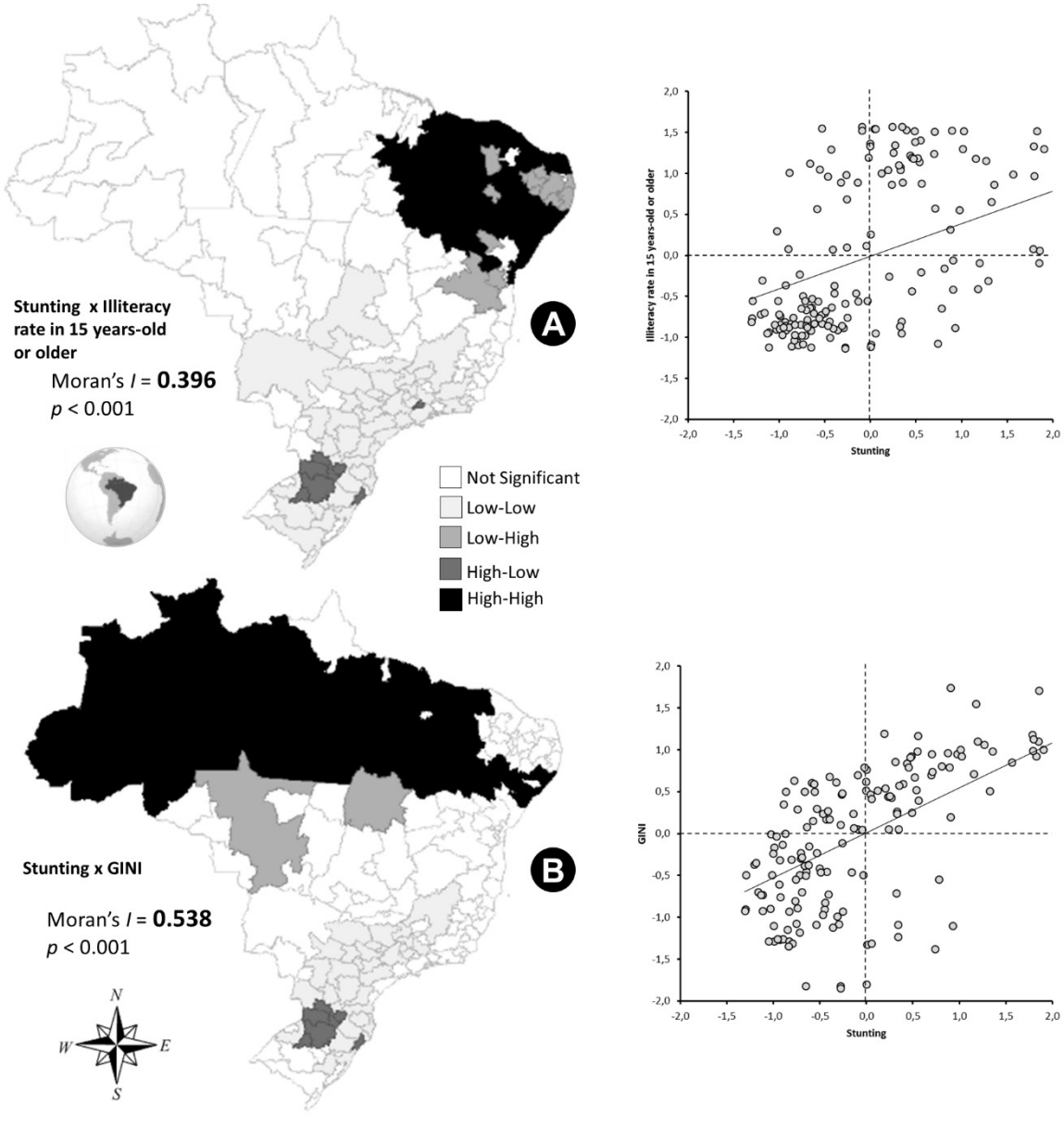

Figure 4. Maps and dispersion graphs with bivariate spatial analysis between childhood stunting and independent variables. A = spatial co-relationship with Illiteracy Rate in people 15- years-old; B = GINI Index. Data for 161 regions.

Results of bivariate Moran inference *I* in Figures 3 and 4 reveal positive self-co-relationship between prevalence of child malnutrition and Geni Index variables, Illiteracy rate of population within the 15-year-old or over age bracket and Investments in Primary Care. Consequently, municipalities with high prevalence of childhood stunting in PBF beneficiaries are likely to be surrounded by neighboring municipalities with high income inequality rates, illiteracy rates in people over 15-years-old and with greater investments in basic care. On the other hand, there is an inverted association between the variable dependent and the variables Per capita Income and HDI. In other words, the higher the prevalence of childhood stunting in the area, the lesser is the per capita income and HDI.

DISCUSSION

Current study revealed spatial dependence and regional disparities with regard to child malnutrition in PBF beneficiaries. Regional variability in the prevalence of childhood stunting has been reported in several Brazilian studies undertaken among the general population, although they failed to specify the PGF beneficiary[9,10]. It should be highlighted that average prevalence of childhood stunting in current analysis (14.7%) was higher than rate in a population-based inquiry on Brazilian children (POF 2008/2009), with 6%[10]. The Brazilian administration acknowledges that child malnutrition and overweight in PBF beneficiaries are significant health issues that have to be coped with[11].

Brazil has still to face the problem of hunger and malnutrition even though a signification decrease has occurred in recent decades. The issue of food insufficiency is not related to small food supply since national agriculture produces sufficient quantities for the necessity of the Brazilian population. Hunger and malnutrition are the result of food inaccessibility due to low buying power of millions of Brazilians[12,13].

Consequently, current analysis also showed inequalities in social and economic indexes and indicated a better distribution in the center and southern regions of the country. Regional inequalities are the result of the country´s historical settlements and economic development. Initially, economic activities featuring sugar cane culture prevailed in the northeastern region. Mining was the prevalent activity in the country´s central region during the 18th century. In the 19th century, coffee culture and subsequent industrialization consolidated a strong development process in the southeastern region, especially in the states of São Paulo and Rio de Janeiro.[14] The process underscored investments in infrastructure and qualification for the region which became significant within the national scenario due to better social, economic and development indexes till the present.

The territory´s structure and organization are the basis that condition public policies and the social and economic agents that make up society[15]. Consequently, Brazil, as a continental country, should try to solve its problems by public policies focused on the decrease of regional inequalities and on national integration. The transference income programs, such as the Family Income Program, have been highlighted as a policy for social protection and struggle against poverty.

Income transference has a positive impact on children´s health with significant results in the decrease of malnutrition, especially among children less than two years old[16]. However, increasing food acquisition does not necessarily mean improvement in the families´ food security. Several studies have shown an intake increase in processed food and suggest that several factors intervene in food choice, such as advertisements, costs and information access on feeding and nutrition[17].

Other studies demonstrated positive results in diet and nutritional quality in beneficiaries of income transference program when compared to non-beneficiaries in Brazil[18,19]. Consequently, a significant segment of the population still has a food security problem either due to lack of food, or to poor food quality, or to life and health conditions that impair the adequate use of available food[20].

Studies on the causes of decrease in child malnutrition in Brazil have shown important factors: increase in mothers´ schooling rates, increase in families´ buying power, spread of health assistance and improvement in sanitary conditions[21]. Current analysis, therefore, demonstrates a direct spatial co-relationship between child nutrition and illiteracy and an inverse co-relationship with per capita income.

Higher mothers´ schooling rates may affect care given to children and may indirectly interfere in reproduction patterns (number of children and inter-birth intervals), with consequences on care, since mothers will have more time with fewer children. Based on national and international ecological studies, the literature has dealt systematically on this influence[22,23].

It is also well-known that family income affects the child´s neuro-psycho-motor development, even though per capita income in itself does not essentially represent worse health conditions. It is highly relevant to know how income is distributed. [24] Influence of income on the child´s health and nutrition status may be relativized by other factors. It is greater in less developed regions where supply of goods and services is limited. GINI

Index, also analyzed in current study, demonstrated that income inequality has a positive spatial co-relationship with child malnutrition.

Brazil is historically notorious for its robust inequalities in income distribution among fifteen countries worldwide, in spite of progress during the last decades favoring economic growth and distributive income policies, with special reference to PBF[25].

HDI-M is an index that, besides income, takes into account education and life expectancy as parameters for the measurement of social well-being. Current study revealed a negative spatial self-co-relationship with childhood stunting, corroborating studies by Luciano and colleagues[26].

Quality and availability of health services are basic to fulfill the health aims of income transference programs. Current analysis detected a direct spatial association of investments in primary care with variable results and, thus, suggested an important focalization of investments of public resources in regions with great vulnerability. It should be highlighted that within primary health care, specifically through the Family Health Strategy (ESF), activities are developed for the follow-up in child growth and development. PBF-benefitted children have a follow-up nationwide. Consequently, the effect of income transference program and good first care services reduce child mortality, especially when poverty-related deaths caused by malnutrition and diarrhea are taken into account[27, 28].

Since child malnutrition is almost always associated with low socioeconomic levels and deficient maternal-childhood care, the most affected areas are given priority with a higher investment rates in health services. Although there is no reference index, local investment in primary care was employed as proxy in health assistance availability.

A problem in studies with aggregated data by area refers to the spatial definition of frontiers, also known as "modifiable areal unit problem". It deals with alterations in estimates obtained within a system of area units according to the diverse ways the units are grouped[29]. Consequently, the intermediary areas of urban articulation in the model were analyzed, avoiding a greater randomized fluctuation when aggregated data per municipality are taken into account; similarly, data homogeneity when Brazilian studied are considered as analysis unit.

Current study was foregrounded on data retrieved from demographic censuses and data bases, which makes possible the generalization of nationwide results. Possible limitations, inherent to studies employing secondary data, would be lack of data, measuring type due to a lack of standardization of equipments used and to the height measurement process by evaluators in health units, and limitations inherent to the employment of a delineation type to effect causal inferences due to aggregated data.

The importance of each index and their interaction on child growth result in situations which are proper to each geographic space. Since Brazil is a continental country, the systematic monitoring of the nature and form of the articulation of factors that integrate the causal network of nutritional problems is of paramount importance. The rationalizing criterion of resources in policy planning and in programs requires forwarding the issue of inequality according to regions and areas.

CONCLUSION

Spatial asymmetries were detected by a predominance of lower prevalence rates for child malnutrition and better socioeconomic indexes in the center-southern regions when compared to other regions. There was an association of socioeconomic indexes and health services with child malnutrition, the result of settlement history, investments and income distribution with repercussions on the population´s health conditions, an incompatible scenario with the country´s development degree. On the other hand, a positive association with investments in primary care suggests a trend to supplement the greatest health demands and make progress in social rights for the entire population, especially the neediest in the northern and northeastern regions of the country.

Results reinforce the combat against child malnutrition as a priority on the national policy agenda, especially in situation of social vulnerability (children from low-income families). In spite of historical progress in the decrease in child malnutrition in Brazil, one should insist that child malnutrition may affect child morbidity-mor-

tality and the individual´s holistic development. Regions with the highest prevalence rates may have lower productivity and economic development. Inter-sector strategies, such as access to schooling, income and health services, should be propped by the principle of equity to guarantee better conditions in life and child development. The possibility of heterogeneous effects in social programs within different Brazilian situations may be taken into account in forthcoming researches.

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