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Shifts towards overweight and double burden of malnutrition among socioeconomically vulnerable children: a longitudinal ecological analysis of Brazilian municipalities

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Abstract

Objective—to investigate the shifts and factors associated with different scenarios resulting from the prevalence of child stunting and overweight in Brazilian municipalities.

Design—This is an ecological study using municipality-level panel data of stunting and overweight prevalence and socioeconomic characteristics from 2008 to 2014. The municipalities were classified according to the WHO-UNICEF prevalence thresholds for stunting and overweight, and were categorized into four nutritional scenarios: no burden (prevalence of stunting <20% and overweight <10%), stunting burden (prevalence of stunting ≥20% and overweight <10%), overweight burden (prevalence of stunting <20% and overweight ≥10%), and double burden (prevalence of stunting ≥20% and overweight ≥10%).

Setting—4,443 Brazilian municipalities.

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Authorship: The authors' contributions were as follows: NJS, RCRS, and MLB designed the study; NJS and FJOA collected data and constructed the database; NJS, RCRS, DR, and RLF outlined the analytical strategy; NJS performed the statistical analyses, interpreted the results, and drafted the manuscript; RCRS, DR, TC, and MLB interpreted the results and critically reviewed the manuscript; and all authors have read and approved the final manuscript.

Ethical Standards Disclosure:
This study was conducted according to the guidelines laid down in the Declaration of Helsinki. As the study exclusively used aggregate secondary data available in the public domain, ethics approval by a research ethics committee and informed consent are waived per Resolution n. 466/2012 of the National Commission of Ethics in Research of the National Health Council of Brazil.

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Participants—Aggregated data of children under 5 years old enrolled in the Brazil's conditional cash transfer program (Bolsa Família).

Results—A mean reduction from 14.2% to 12.7% in the prevalence of stunting and an increase from 17.2% to 18.4% in the prevalence of overweight were observed. The predominant scenarios were overweight burden and double burden. The odds of both scenarios increased with higher GDP per capita and decreased with higher unemployment rates. Stunting and double burden decreased with higher expected years of schooling, and stunting burden increased with household crowding.

Conclusion—Our findings indicate an advanced nutrition transition stage in Brazil, associated mainly with municipal GDP per capita growth, which has contributed to increasing the burden of overweight alone or coexisting with stunting (double burden) among children in the most socioeconomically vulnerable strata of the population.

Keywords

overweight; stunting; double burden; children; poverty; socioeconomic factor

Introduction

The history of humanity has been marked by successive shifts in the dietary patterns and nutritional status of populations[1]. These shifts characterize the so-called nutrition transition[1–3]. Developing countries have experienced a rapid nutrition transition in the past decades, associated with rapid economic development and urbanization, and consequently with declines in physical activity and major changes in the food system such as the increased availability and access to highly processed foods[1]. This scenario has resulted in an overlap of nutrition transition stages, creating conditions for undernutrition forms to coexist with overweight and obesity, a phenomenon known as double burden of malnutrition (DBM), which can occur at individual, household and population levels, and across life-course[2–5].

Socioeconomic conditions are the main structural determinants of malnutrition in all its forms[5,6], which is an important problem in countries with substantial social inequality[7]. Brazil is one of the countries with the highest income inequality rates, despite considerable advances in reducing poverty and improving the population socioeconomic conditions in the past decades[8]. Extreme poverty decreased by more than half, from 8.1% to 3.1%, whereas the poverty rate decreased even more, from 22.8% to 7.9% between 2001 and 2013[9]. Despite the decreases in these rates and an accumulation of public policies and investments that resulted in benefits for the health of the Brazilian population, considerable challenges persist[10].

Nationwide representative surveys have detected a substantial reduction in childhood stunting prevalence from 37% to 7% between 1974 and 2007[2]. The prevalence of overweight remained stable at 6-7% during this period[2]. However, more recent studies have demonstrated that overweight is increasing among children, including those in the poorest strata[11,12]. Trends in children enrolled in the Bolsa Família Program (BFP), the world's largest conditional cash transfer program targeting families living in poverty and extreme

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poverty in Brazil, show a reduction from 14.2% to 12.2% in the prevalence of stunting and an increasing trend from 12.5% to 13.1% in the prevalence of overweight between 2008 and 2012[11].

This increasing burden of overweight along with a still existing burden of stunting among poor children suggest that Brazil faces a DBM in this population. Recent study shows that the DBM has also increased in the poorest low- and middle-income countries (LMICs), mainly due to overweight and obesity increases[4]. The DBM is united by shared drivers and solutions, which include multifactorial aspects, and therefore offers a unique opportunity for integrated nutrition action[13]. However, very few studies to date have simultaneously analyzed the shifting prevalence of under- and overnutrition[4,14,15]. These outcomes have usually been studied separately, making difficult to disentangle the understanding of DBM.

The coexistence of prevalent and paradoxical forms of malnutrition among the most vulnerable socioeconomic strata of the population makes Brazil a potential laboratory for investigating socioeconomic determinants associated with the nutritional status in early childhood. Using a novel approach, the study aimed (i) to describe the shifts toward different scenarios resulting from the prevalence of stunting and overweight in Brazilian municipalities, based on aggregated data of children enrolled in the conditional cash transfer Bolsa Família; and (ii) to analyze municipal-level socioeconomic factors associated with these scenarios.

Methods

Study design and population

This longitudinal ecological study combined the analysis of multiple observation units and temporal trend analysis. Panel data of the prevalence of stunting and overweight among children under five years of age enrolled in BFP in Brazilian municipalities from 2008 to 2014 were analyzed. Municipalities were analyzed based on yearly repeated observations available in administrative databases in the public domain. Of the 5,570 existing municipalities in Brazil, 4,443 were included in the study. 63 municipalities did not have available data for all years, and 1,064 had very few children (<30) with anthropometric measurement in each studied year.

BFP is a conditional cash transfer program that was implemented in Brazil in 2003, targeting families living in poverty (monthly per capita income from R$ 85/ US$ 16 to R$ 170/ US$ 32) or extreme poverty (monthly per capita income up to R$ 85/ US$ 32). Through direct cash transfer and monitoring of education and health conditions, BFP seeks to combat hunger, poverty and other forms of deprivation; to promote food and nutrition security; and access to public services, particularly health care, education and social assistance[16]. The amount received by each family varies according to its monthly per capita income, number of individuals under 17 years old, and presence of pregnant or breastfeeding women. Monitored conditions include vaccinations, nutrition surveillance of children under seven years of age, prenatal visits of pregnant women, and minimum school attendance of 85% for children and adolescents 6 to 15 years old and 75% for adolescents 16 and 17 years old[16]. BFP has shown to successfully improve several child health outcomes, such as

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anthropometric indicators[17], mortality rates[18], and the use of health care services and growth monitoring[19]. In addition, PBF has been recognized for its large coverage of the poor Brazilian population. In February 2020, the program reached 96% (over 13.2 million families) of the eligible poor families[20]. Thus, BFP beneficiaries represent a very large proportion of the socioeconomically vulnerable population in Brazil.

Data sources

Municipal-level data on the nutritional status of children under five years of age enrolled in BFP were obtained from the Food and Nutrition Surveillance System (Sistema de Vigilância Alimentar e Nutricional – SISVAN-Web) public reports[21]. Anthropometric data (weight and height) are collected twice per year by community health workers and family health teams, as part of the nutrition surveillance of children enrolled in BFP, and entered into the SISVAN-Web database at the end of each term, i.e. June (1st term) and December (2nd term). However, the system selects only the latest available measure in the year of each individual to aggregate data at municipal level and generate the annual reports on nutritional status[22]. The number of children enrolled in the program nationwide for whom data were recorded increased from 2.8 million in the first term of 2008 to 4.6 million in the second term of 2017[23]. For the nutritional status assessment of children under 5 years old, SISVAN-Web provides information on height-for-age, weight-for-age, weight-for-height and body mass index-for-age, which are analyzed using the World Health Organization (WHO) Anthro software/macro and quality checks and according to WHO Child Growth Standards and cut-off points[24]. Guidelines for the collection and analysis of anthropometric data in health services have been standardized by SISVAN[25].

Demographic and socioeconomic data were obtained at municipal level from the 2000 and 2010 Demographic Censuses of the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística – IBGE), available at the IBGE Automatic Retrieval System (Sistema IBGE de Recuperação Automática – SIDRA)[26], Department of Informatics of the Unified Health System (Departamento de Informática do Sistema Único de Saúde – DATASUS) TabNet tool[27] and Atlas of Human Development in Brazil, developed by the United Nations Development Programme in partnership with Brazilian institutions[28]. Information on municipal coverage of public health policies, such as the Family Health Strategy (FHS), were obtained from DATASUS e-Gestor public reports[29].

Dependent variable

The prevalence of stunting (height-for-age z-score – HAZ < -2 SD) and overweight (weight-for-height z-score – WHZ > +2 SD) among children enrolled in BFP, obtained from SISVAN-Web reports, was categorized according to the new prevalence thresholds formulated by the WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring[30]. These thresholds were established in relation to the degrees of deviation from normality as defined by the WHO Child Growth Standards, making their use appropriate and advantageous to describe both national and subnational populations according to levels of severity of malnutrition[30].

Based on this classification system, a polytomous four-category variable was created by combining the prevalence of stunting and overweight to characterize nutritional scenarios, such as DBM, where under- and overnutrition coexist in different levels of severity:

- No burden: very low-to-medium prevalence of stunting (<20%) and very low-to-medium prevalence of overweight (<10%);
- Stunting burden: high and very high prevalence of stunting (≥20%) and very low-to-medium prevalence of overweight (<10%);
- Overweight burden: very low-to-medium prevalence of stunting (<20%) and high and very high prevalence of overweight (≥10%);
- Double burden: high and very high prevalence of stunting (≥20%) and high and very high prevalence of overweight (≥10%).

Independent variables

Demographic and socioeconomic data at municipal level were first selected based on the literature on child malnutrition drivers[5,31,32] and social determinants of health[33]. A correlation matrix of all available variables was obtained. Only the variables with weak-to-moderate correlation coefficient ($r<0.5$) were considered in the analyses: urban population – % of the population residing in urban areas[27]; gross domestic product (GDP) per capita – total sum in Brazilian real (R$) of all final goods and services produced divided by the municipality's population[26]; expected years of schooling – mean number of years of schooling a generation of children entering school will have completed by age 18 if the current patterns maintain throughout their schooling life[28]; unemployment rate – % of the population over 16 years old out of work[27]; FHS coverage – % of the population covered by FHS teams, considering a parameter of 3,450 individuals covered per team[29]; and household crowding – % of the population residing in households with more than two individuals/bedroom[28]. For demographic and socioeconomic variables with years not covered by the demographic censuses, values were estimated by linear interpolation and extrapolation from the 2000 and 2010 census years. Variables were also categorized as tertiles or according to reference values when available, such as FHS coverage[34]. Further information about these variables can be found in the Supplementary Table 1.

Data processing and statistical analysis

Data were processed and analyzed using Stata version 15.1 (Stata Corporation, College Station, USA). For descriptive analysis, the annual prevalence of stunting and overweight were calculated, analyzed according to geographic region and population size, and categorized according to the WHO-UNICEF new prevalence thresholds. The proportion of municipalities in each nutritional scenario was also calculated annually. Demographic and socioeconomic variables were described using measures of central tendency and dispersion.

Multinomial logistic regression models with fixed effects were conducted, using the femlogit command available in Stata[35], to test the associations between socioeconomic variables and the different nutritional scenarios in the municipalities across all time period. These models allow to consistently estimate effects of time-varying regressors on the log-odds

of multinomial outcomes when time-invariant unobserved heterogeneity is present[35]. In our study, time-invariant heterogeneity could represent unobserved characteristics of the municipality, such as geographical, historical, sociocultural, or socioeconomic characteristics, that did not change during the period of the study. This attractive feature is accomplished by using only within-individual variation to estimate the regression coefficients.

Crude models were fit to estimate the association of each socioeconomic variable separately with the nutritional scenarios. Adjusted multivariate model was fit based on the backward stepwise regression approach. We started with a full (saturated) model, including all socioeconomic variables, and then we gradually removed one variable at each step to find a reduced model that best explained the data. Akaike (AIC) and Bayesian (BIC) information criteria were used to select the adjusted model. All crude and adjusted models were fit with dummy variables for each analyzed year. Estimates were interpreted based on the adjusted odds ratio (aOR) and their corresponding 95% confidence intervals (95%CI) since they are the most feasible option available to interpret fixed-effects logistic regression models[35].

Results

Of the 4,443 municipalities included in the study, 1,599 (36.0%) were from Northeast, 1,372 (30.9%) from Southeast, 693 (15.6%) from South, 421 (9.5%) from North, and 358 (8.1%) from Central-West region of Brazil. Municipalities with population size ≤ 20,000 and > 100,000 habitants represented 65.43% (n=2,907) and 6.10% (n=271), respectively. When compared with other relevant characteristics, the 4,443 municipalities included in the study (Table 1) were generally similar to all existing municipalities in the country (Suppl. Table 2).

The mean prevalence of stunting among children enrolled in BFP decreased from 14.2% in 2008 to 12.7% in 2014, and the mean prevalence of overweight increased from 17.2% to 18.4% (Supplementary Figure 1). Decreasing trends in the mean prevalence of stunting and increasing trends in the prevalence of overweight were also observed in all geographic regions (Supplemental Figure 2) and population sizes (Supplemental Figure 3).

According to the WHO-UNICEF prevalence thresholds (Figure 1), the rate of stunting was low (2.5-9.9%) or medium (10-19.9%) in most Brazilian municipalities. The proportion of municipalities shifting towards low and medium rates of stunting increased by 2.7% and 6.8%, respectively. In turn, the prevalence of overweight was high (10-14.9%) or very high (≥15%) in most municipalities, with an increasing trend in the very high range, from 52.8% to 65.9%.

The percentage of municipalities experiencing DBM decreased from 18.0% in 2008 to 10.9% in 2014 (Figure 2). The rate of the scenario defined as stunting burden decreased from 1.9% to 0.5% while overweight burden increased by 17.2%, from 65.8% to 83.0%. Lastly, the prevalence of the scenario characterized as no burden decreased from 14.4% to 5.6%.

The proportion of urban population increased from 63.9% in 2008 to 66.7% in 2014. The GDP per capita almost doubled during the analyzed period, increasing from R$ 9,600 to

17,400, i.e., by 81.9%. The number of expected years of schooling exhibited an increasing trend (8.4%). FHS coverage, the main primary health care policy in Brazil, increased from 78.3% to 86.6%. In turn, the median rate of household crowding decreased from 29.7% to 21.6%. The median unemployment rate showed a similar decreasing trend, from 7.6% to 5.2% (Table 1).

The saturated and adjusted models for the associations between independent variables and nutritional scenarios are described in Table 2. Because fixed effects approach requires observations with time-variant data, only 2,670 municipalities were included in the models. According to the adjusted model, the odds of stunting burden were significantly lower for the municipalities in the second tertile of the expected years of schooling variable (aOR 0.40, 95% CI 0.21-0.76) and higher for the municipalities in the second tertile of the overcrowding variable (aOR 5.11, 95% CI 1.02-25.41) compared to the municipalities in the first tertile. The odds of the scenario defined as overweight burden were progressively higher for the municipalities with higher GDP per capita (second tertile: aOR 1.36, 95% CI 1.11-1.33; third tertile: aOR 1.45, 95% CI 1.08-1.09) and gradually lower for those with higher unemployment rates (second tertile: aOR 0.77, 95% CI 0.63-0.92; third tertile: aOR 0.60, 95% CI 0.45-0.80). The odds of DBM (+%ST +%OW) were progressively higher for the municipalities with higher GDP per capita (second tertile: aOR 1.38, 95% CI 1.06-1.79; third tertile: aOR 2.28, 95% CI 1.51-3.45), progressively lower for those with larger expected years of schooling (second tertile: aOR 0.61, 95% CI 0.46-0.80; third tertile: aOR 0.57, 95% CI 0.38-0.85) and lower for those in the tertile with the highest unemployment rate (aOR 0.63, 95% CI 0.42-0.93).

Discussion

This longitudinal ecological study aimed to investigate the shifts toward under- and overnutrition scenarios and their associated socioeconomic factors in Brazilian municipalities, based on aggregated data of children under five years old enrolled in BFP from 2008 to 2014. The results point to a decreasing trend in stunting rates and an increasing trend in overweight rates. However, the data show that most of the municipalities still had moderate levels (10-19.9%) of stunting, according to the WHO-UNICEF new prevalence thresholds[30]. Concomitantly, most municipalities also exhibited high and very high rates of overweight (≥10%), with an increasing trend in the very high prevalence range (≥15%) over time.

Four nutritional scenarios resulting from the combination of stunting and overweight prevalence thresholds were analyzed in our study. This novel approach considers that under-and overnutrition forms can coexist in different levels of severity, and thus offers a unique opportunity to identify shared drivers of both under-and overnutrition and to find integrated solutions[5,13]. The predominant scenario found in the municipalities was overweight burden, which increased by 17.2%, from 65.8% to 83.0%. The DBM scenario ranked second in prevalence; however, it decreased from 18.0% to 10.9%. The least prevalent scenario, stunting burden, decreased from 1.9% to 0.5%.

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These findings seem to reflect a critical and advanced nutrition transition stage in Brazil, where predominant scenarios point shifts toward a decreasing burden of stunting and DBM and an increase in overweight and obesity in the most socioeconomically vulnerable population. A report of the recent Lancet Series on the double burden of malnutrition[4] shows that severe levels of DBM have shifted to the poorest LMICs, especially in the south and east Asia and sub-Saharan Africa, while the number of upper-income LMICs with a DBM has decreased.

Multivariate polytomous analysis was conducted to elucidate the socioeconomic and demographic determinants associated with the different nutritional scenarios. The results from adjusted models indicate that the odds of overweight burden and double burden in the municipalities increased with higher GDP per capita and decreased with higher unemployment rates. The odds of stunting burden and double burden decreased with higher expected years of schooling. Lastly, the odds of stunting burden increased with household crowding.

Our findings are consistent with those of other studies that show increased rates of overweight/obesity alone or combined with undernutrition as GDP increases[1,36]. This association is related to rapid economic development, urbanization, and globalization, which have greatly contributed to shifts in the diet and physical activity patterns in LMICs, especially in developing nations such as Brazil[1,2]. Changes in the economic structure, the liberalization of international food trade, and foreign direct investments have transformed our food systems and their ability to deliver healthy diets[4]. Thus, dietary patterns have been shifting away from their traditional composition and moving towards diets dominated by ultra-processed foods that are high in sugar, fat and salt and low in micronutrients and fiber. Also, major technological shifts in the workplace, home, leisure and transportation have decreased physical activity levels [1,4]. All these changes together have contributed to increasing overweight and obesity rates.

Contrary to available evidence on the effect of unemployment on health and nutrition[37–39], we found that the increase in unemployment rate was negatively associated with the scenarios characterized by a high burden of overweight alone and DBM. This finding is difficult to explain and may be related to the limitations of ecological data or to the unemployment rate variable, which is considered to have low sensitivity due to the high prevalence of informal work in Brazil (above 30%) despite the reduction observed in the last decades[40].

The results further showed that the increase in the expected years of schooling was negatively associated with the nutritional scenarios characterized by a high prevalence of undernutrition alone and DBM. This finding corroborates the results of other studies that identified a positive influence of maternal or paternal education level on child nutrition[41,42]. Notably, access to education enables parents, in particular mothers, to acquire knowledge on health and nutrition, which may favor the provision of a balanced diet and nutritive foods needed for healthy growth and development in children[43].

The increase in household crowding rate was associated with the scenario characterized by a high prevalence of stunting. Existing evidence indicate that the prevalence of undernutrition is higher among large families experiencing food insecurity[44]. A study conducted with families enrolled in BFP in Alagoas[39], one of the poorest states in Brazil, found that the odds of food insecurity were four times higher for households with four or more people. The relationship between these two variables is clearly seen in periods of crisis, such as inflation of food prices or temporary unemployment. These conditions reduce household food availability and, consequently, the per capita food consumption in large families[45]. In addition to its association with food insecurity, overcrowding is a well-known component of the causal network of child undernutrition by increasing the risk of infectious diseases[46].

The prevalent burden of overweight along with the still existing burden of stunting found in the study, as well as the association between the analyzed nutritional scenarios and the economic and social context of the municipalities, evidence the vulnerability of children enrolled in BFP to multiple forms of malnutrition. Given the magnitude of this problem, which currently poses an increasing challenge to global health[1,4], the WHO has encouraged double-duty actions for nutrition, which include interventions, programs, and policies with potential to simultaneously reduce the risk or burden of both undernutrition (including wasting, stunting, and micronutrient deficiency) and overweight or diet-related NCDs[13]. Conditional cash transfer programs, such as BFP, are potential candidates for double-duty actions. However, evidence on the effects of such programs on outcomes related to both sides of DBM is needed to enable adequate design and orientation of actions to combat all forms of malnutrition.

One of the main limitations of the present study derives from the impossibility to extrapolate the conclusions drawn from municipality-level aggregate data to the population at the individual level, inference problem known as ecological fallacy. However, the ecological design provided an effective approach to address the study aim. The use of aggregate units of analysis, such as municipalities, enabled us to investigate nutritional scenarios, including DBM at population level, and explore contextual variables associated with them. Another possible limitation is the quality and reliability of secondary data. In this regard, data were obtained from government sources, such as health information systems and demographic censuses, which are known to have high-quality standards. Possible bias resulting from interpolation for some independent variables were minimized through variable categorization, thus reducing fluctuations artificially caused by the method. Only municipalities with available data and with at least 30 children assessed for nutritional status in each year were considered, optimizing the data quality and internal validity of the study. Despite these strict criteria, 4,443 municipalities were included in the study, i.e., 80% of the total number. When compared with the characteristics of the 5,507 municipalities with available data (Supplemental Table 2), which correspond to 98.9% of all existing municipalities, we observed that the municipalities included in the study (Table 1) were generally similar to the entire set of 5,507 municipalities. However, the loss of 1,773 municipalities in the fixed effects models due to time-invariant data may represent a limitation for the external validity of the results from the regression models. Comparing the characteristics of the two subsets of municipalities, which remained in (Supplemental Table 3) and were dropped from the regression models (Supplemental Table

4), we observed that both subsets have in general similar characteristics, except for the percentage of urban population which was higher for the municipalities dropped from the models. Thus, interpretation and generalization of these results must be made with some caution. Despite that, panel data analysis represents the main strength of the present study, as it increased the causal inference power of the evidence found, compared to traditional analysis of cross-sectional data.

In conclusion, the results indicate a decreasing trend in the prevalence of stunting and an increasing trend in the prevalence of overweight among children enrolled in the Bolsa Família conditional cash transfer. The predominant nutritional scenarios in most municipalities were characterized by high rates of overweight and by DBM, both associated with the increase in GDP per capita. The expected years of schooling, unemployment rate, and household crowding were also associated with the scenarios analyzed in the study.

Our findings point to an advanced and critical stage of nutrition transition among the most socioeconomically vulnerable strata of the Brazilian population. This situation demands formulating and/or readjusting policies and programs with potential to simultaneously reduce the risk and burden of overweight and obesity as well as undernutrition. We hope that these results guide public policy makers in fully achieving the country's commitment to the United Nations Decade of Action on Nutrition and the Sustainable Development Goal 2, to reduce all forms of malnutrition among children under five years old by 2025.

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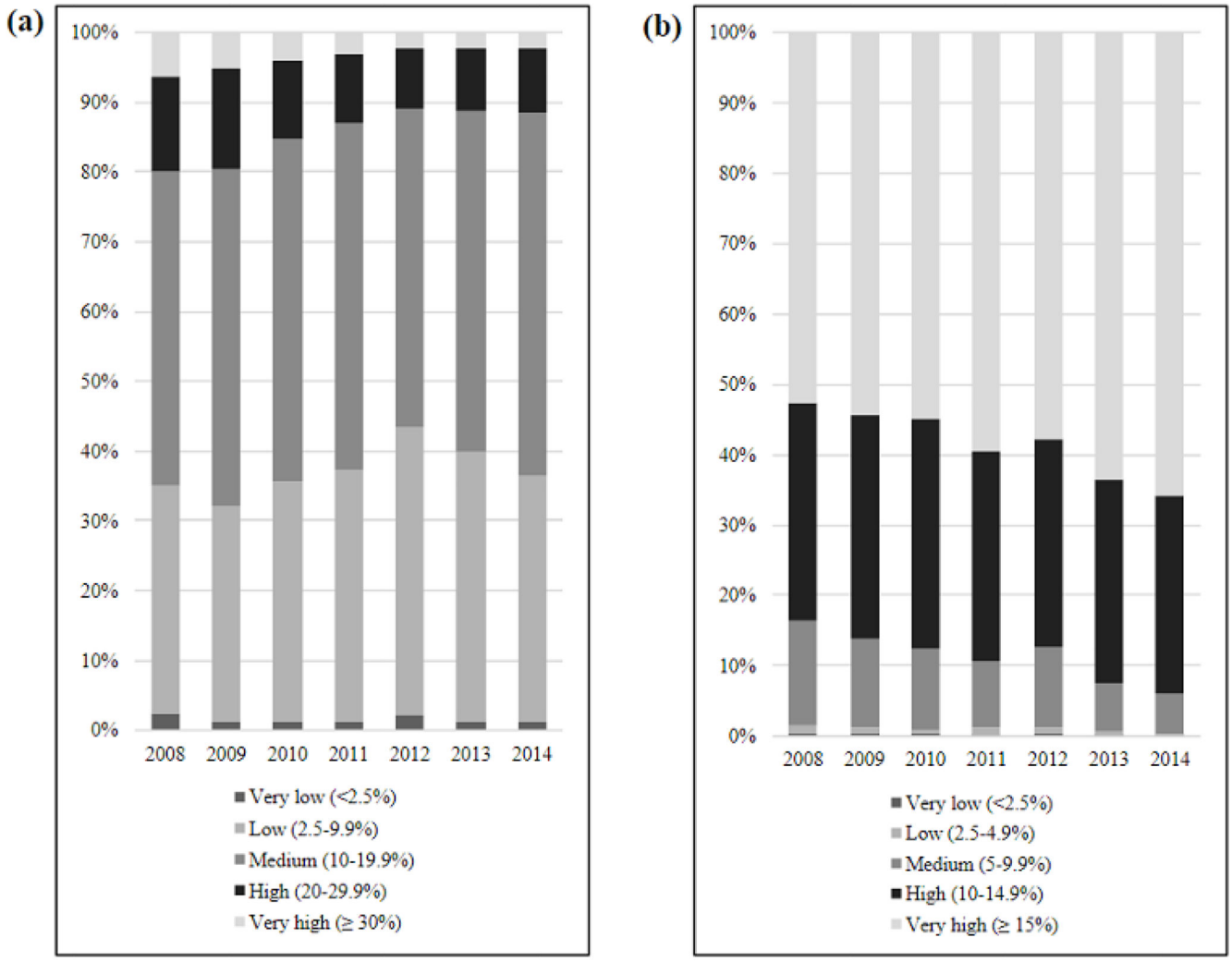

Figure 1.

Frequency of municipalities according to the prevalence thresholds[#] for stunting (a) and overweight (b) in children enrolled in the Bolsa Família Program, Brazil, 2008-2014 (n=4443).

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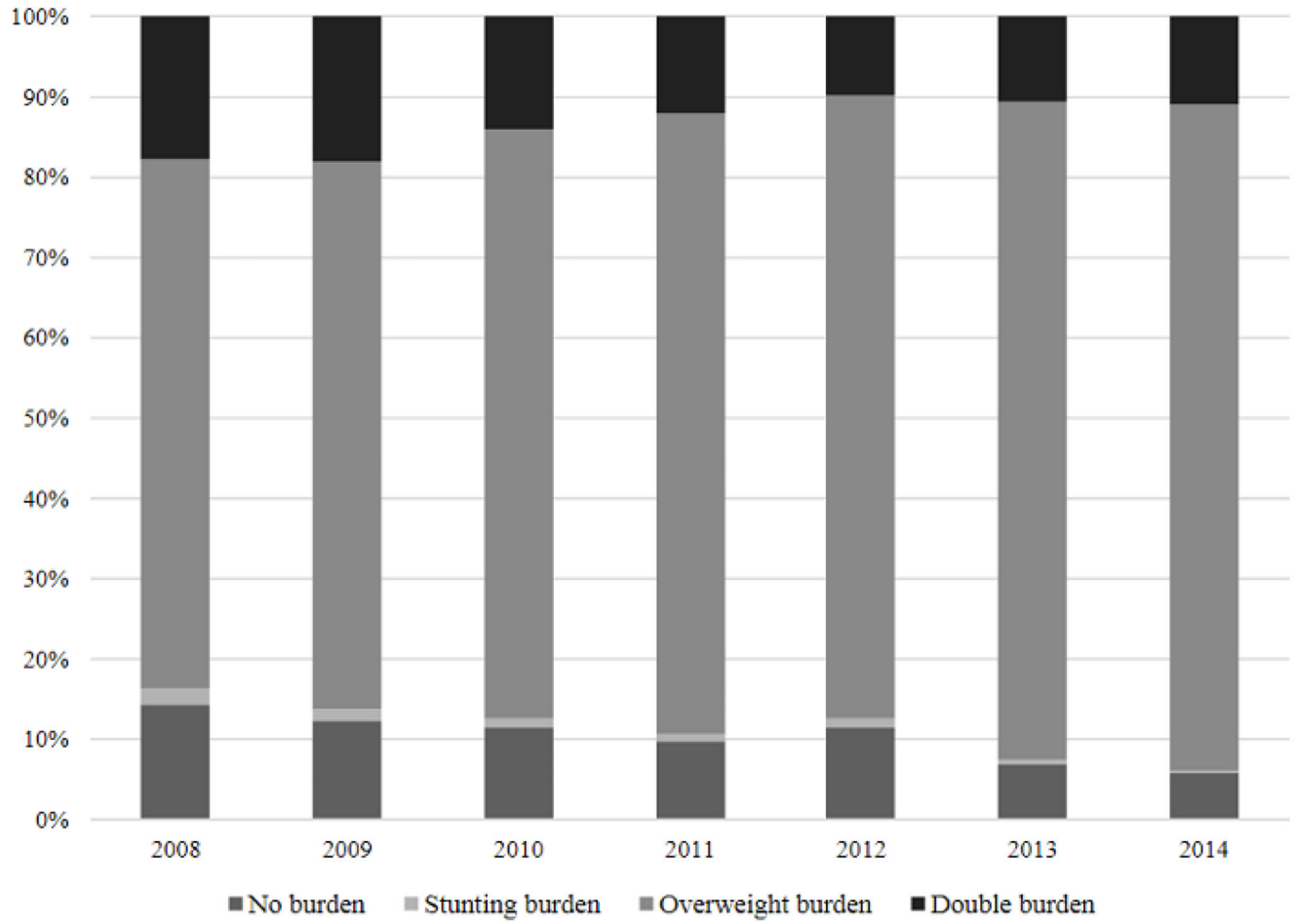

Figure 2. Shifts toward stunting, overweight, double burden scenarios among children enrolled in Bolsa Família Program in Brazilian municipalities, 2008-2014 (n=4443).

No burden: very low-to-medium prevalence of stunting (<20%) and overweight (<10%) Stunting burden: high and very high prevalence of stunting (≥20%) and very low-to-medium prevalence of overweight (<10%) Overweight burden: very low-to-medium prevalence of stunting (<20%) and high and very high prevalence of overweight (≥10%)

Double burden: high and very high prevalence of stunting (≥20%) and overweight (≥10%)

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Table 1

Demographic and socioeconomic characteristics of the Brazilian municipalities included in the study, 2008-2014 (n=4443).

Variables	2008		2010		2012		2014		% change 2008-2014
	Median	IQR	Median	IQR	Median	IQR	Median	IQR	
Urban population (%) *	64.6	35.4	65.7	35.1	66.9	34.9	68.1	34.7	5.4
GDP per capita (R$)	6627	7362	8294	8960	10316	11300	12298	13571	85.6
Expected years of schooling (years) *	9.1	1.5	9.4	1.4	9.6	1.3	9.9	1.4	8.4
Unemployment rate (%) *	7.1	4.3	6.2	4.2	5.3	4.4	4.4	4.8	-38.7
FHS coverage (%)	98.8	37.8	100.0	32.2	100.0	30.3	100.0	19.0	1.2
Household crowding (%) *	27.9	17.1	25.1	16.5	22.2	16.1	19.4	15.7	-30.3

IQR: interquartile range; FHS: Family Health Strategy; GDP: gross domestic product.

* Variables estimated by linear interpolation and extrapolation from 2000 and 2010 demographic census.

Table 2

Crude and adjusted models[1] for the association of demographic and socioeconomic characteristics with scenarios of stunting, overweight and double burden among children enrolled in the Bolsa Família Program in Brazilian municipalities, 2008-2014.

Variables	Crude models §						Adjusted model §					
	Stunting burden		Overweight burden		Double burden		Stunting burden		Overweight burden		Double burden	
	OR	95% CI	OR	95% CI	OR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI
Urban population												
1st tertile (<54.80%)	1.00	–	1.00	–	1.00	–	–	–	–	–	–	–
2nd tertile (54.80-78.51%)	1.01	0.30-3.45	0.80	0.51-1.26	1.23	0.70-2.18	–	–	–	–	–	–
3rd tertile (≥78.51%)	0.75	0.05-10.54	0.65	0.34-1.23	1.28	0.54-3.02	–	–	–	–	–	–
GDP per capita												
1st tertile (< R$ 6430)	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–
2nd tertile (R$ 6430-13018)	0.66	0.36-1.22	**1.36**	**1.12-1.66**	**1.35**	**1.04-1.75**	0.64	0.34-1.19	**1.36**	**1.11-1.66**	**1.38**	**1.06-1.79**
3rd tertile (≥ R$ 13018)	1.28	0.46-3.53	**1.46**	**1.09-1.97**	**2.40**	**1.59-3.62**	1.25	0.44-3.55	**1.45**	**1.08-1.96**	**2.28**	**1.51-3.45**
Expected years of schooling												
1st tertile (< 9.03 years)	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–
2nd tertile (9.03-9.94 years)	**0.38**	**0.20-0.71**	0.84	0.68-1.04	**0.58**	**0.45-0.76**	**0.40**	**0.21-0.76**	0.85	0.68-1.05	**0.61**	**0.46-0.80**
3rd tertile (≥ 9.94 years)	0.49	0.20-1.21	0.97	0.71-1.3	**0.54**	**0.37-0.80**	0.51	0.20-1.28	0.97	0.71-1.32	**0.57**	**0.38-0.85**
Unemployment rate												
1st tertile (<4.42%)	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–
2nd tertile (4.42-7.32%)	0.58	0.30-1.09	**0.77**	**0.64-0.93**	**0.74**	**0.56-0.97**	0.59	0.31-1.13	**0.77**	**0.63-0.92**	0.77	0.58-1.00
3rd tertile (≥7.32%)	0.54	0.23-1.24	**0.59**	**0.44-0.78**	**0.59**	**0.40-0.87**	0.56	0.24-1.31	**0.60**	**0.45-0.80**	**0.63**	**0.42-0.93**
FHS coverage												
Incipient (<30,0%)	1.00	–	1.00	–	1.00	–	–	–	–	–	–	–
Intermediate (30.0-70.0%)	2.55	0.92-7.03	1.21	0.87-1.68	1.02	0.61-1.71	–	–	–	–	–	–
Consolidate (≥70,0%)	2.14	0.72-6.40	1.34	0.93-1.91	1.22	0.72-2.07	–	–	–	–	–	–
Household crowding												

Variables	Crude models [§]						Adjusted model [§]					
	Stunting burden		Overweight burden		Double burden		Stunting burden		Overweight burden		Double burden	
	OR	95% CI	OR	95% CI	OR	95% CI	aOR	95% CI	aOR	95% CI	aOR	95% CI
1st tertile (< 18.45%)	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–	1.00	–
2nd tertile (18.45-29.40%)	4.54	0.93-22.25	0.99	0.82-1.22	0.90	0.65-1.23	**5.11**	**1.02-25.51**	1.01	0.83-1.23	0.97	0.70-1.33
3rd tertile (≥29.40%)	4.35	0.69-27.36	0.82	0.59-1.13	0.81	0.51-1.29	4.73	0.73-30.45	0.83	0.60-1.15	0.81	0.51-1.31
Number of observations	18690						18690					
Number of municipalities	2670						2670					

No burden (reference category): very low-to-medium prevalence of stunting (<20%) and overweight (<10%)

Stunting burden: high and very high prevalence of stunting (≥20%) and very low-to-medium prevalence of overweight (<10%) Overweight burden: very low-to-medium prevalence of stunting (<20%) and high and very high prevalence of overweight (≥10%) Double burden: high and very high prevalence of stunting (≥20%) and overweight (≥10%)

OR: odds ratio; aOR: adjusted odds ratio; 95% CI: 95% confidence interval

FHS: Family Health Strategy; GDP: gross domestic product.

[1] Multinomial logistic regression models with fixed effects

[§] Model adjusted with dummy variables for each year