doi:10.1017/S1368980012005551

Food and nutrition insecurity: a marker of vulnerability to asthma symptoms

Rita de Cássia Ribeiro-Silva[1,*,†], Ana Marlúcia Oliveira-Assis[1], Samuel Badaró Junqueira[2], Rosemeire Leovigildo Fiaccone[3], Sandra Maria Chaves dos Santos[1], Maurício Lima Barreto[4], Elizabete de Jesus Pinto[1], Luce Alves da Silva[1], Laura Cunha Rodrigues[5] and Neuza Maria Alcantara-Neves[2]

[1]Departamento Ciência da Nutrição, Escola de Nutrição, Universidade Federal da Bahia, Salvador, Bahia, Brasil: [2]Departamento de Ciências da Biointeração, Instituto de Ciências da Saúde, Universidade Federal da Bahia, Salvador, Bahia, Brasil: [3]Instituto de Matemática, Universidade Federal da Bahia, Salvador, Bahia, Brasil: [4]Instituto de Saúde Coletiva, Universidade Federal da Bahia, Salvador, Bahia, Brasil: [5]Department of Epidemiology and Population Health, London School of Hygiene and Tropical Medicine, London, UK

Submitted 18 November 2011: Final revision received 1 November 2012: Accepted 9 November 2012

Abstract

Objective: To evaluate the association between food and nutrition insecurity and asthma in children from Latin America.
Design: Cross-sectional study.
Setting: São Francisco do Conde, Bahia, north-eastern Brazil.
Subjects: The study included 1307 children aged 6–12 years from public elementary schools. Asthma symptoms were collected using a questionnaire that was translated and adapted from the International Study of Asthma and Allergies in Childhood, phase III. The diagnosis of asthma was determined based on reports of wheezing in the previous 12 months. The Brazilian Food Insecurity Scale was used to identify food insecurity. We also obtained demographic, socio-economic and anthropometric information for each participant. We used multivariate logistic regression analyses to assess the associations of interest.
Results: Of the children surveyed, 10·4 % had a history of wheezing and 64·5 % had some degree of food and nutrition insecurity. We found a positive dose–response relationship and statistically significant associations of asthma with moderate (OR = 1·71, 95 % CI 1·01, 2·89) and severe (OR = 2·51, 95 % CI 1·28, 4·93) food and nutrition insecurity.
Conclusions: The results show that moderate and severe food and nutrition insecurity are markers of vulnerability to wheezing. It is important to note that the results of studies in this field have potential implications for social policies that promote food security. Further studies to identify the mechanisms involved in the relationship between food and nutrition insecurity and asthma are needed.

Keywords
Asthma
Wheezing
Food and nutrition insecurity
Children
Adolescents

Asthma is a chronic respiratory disease characterised by lower airway hyper-responsiveness and variable airflow limitation, reversible spontaneously or with treatment, that is most common among children[1]. In recent decades, there has been a significant increase in asthma prevalence in different populations[2]. It is estimated that approximately 300 million people worldwide are asthmatic, with significant variations in prevalence between different countries and regions[3]. The International Study of Asthma and Allergies in Childhood (ISAAC) found an average asthma prevalence of 24·3 % among urban Brazilian children[4]. Recent studies in Salvador, Brazil have shown that a minor proportion of these cases was attributable to atopy, while the majority (80 %) were non-atopic[5–7].

Asthma is a multifactorial illness; its causes are still not completely understood and there is no consensus on its aetiology. A large body of research emphasises the role of environmental and genetic factors in the onset of asthma[8]. Recently, there has been great interest in the relationship between psychosocial factors and asthma morbidity[9]. Food and nutrition insecurity (FNI) has been linked to psychological distress and maternal depressive symptoms, which can also have negative effects on the mother's children[10,11]. Associations between FNI and chronic diseases, including asthma, have been reported[12,13]. A hypothesis suggests that family stress contributes to the occurrence of asthma[14,15]. FNI is defined as limited or

† Address for correspondence: Rua Desembargador Oscar Dantas, 96 apt 402, Graça, CEP 40.150-260, Salvador, Bahia, Brasil.

*Corresponding author: Email rcrsilva@ufba.br

uncertain availability of, or the inability to acquire, adequate, safe and acceptable nutritious food due to limited financial resources. Approximately 30·2% of Brazilian households are considered food insecure; this value rises to 46·1% in the north-eastern region of the country[16].

While there is compelling evidence for the associations between stress and asthma and between FNI and stress, the evidence for an association between asthma and FNI is limited. The present study aimed to evaluate the association between FNI and asthma in a population of children from a small municipality in north-eastern Brazil.

Materials and methods

Study/population/sample

A cross-sectional design was used to study children aged 6–12 years living in São Francisco do Conde, a municipality located in the metropolitan region of Salvador, north-east Brazil. This municipality has 33 183 inhabitants and a high urbanisation rate (80·2%). The city council is the largest local employer. In Bahia state, out of 417 municipalities, São Francisco do Conde ranks third in the economic development index but has a far lower position regarding social (30th), education (139th) and health (178th) development indices[17].

We used data from the Education Department of the Municipality of São Francisco do Conde for the year 2010 to estimate the sample size. From all 3734 registered students, there were 2649 from rural areas and 1085 from urban areas. These students were distributed across twenty-two schools in the county school system. To minimise travel costs and time for subject recruitment, only schools with 150 or more students were included in the sample. We performed a random selection of schools using clustered sampling. All students aged 6–12 years in each selected school were eligible to participate in the study. Considering that the prevalence of respiratory allergies, FNI, malnutrition and helminth infection varies from 15% to 40%, a sample size of 531 and 834 students from urban and rural areas, respectively, was determined taking into account 3% error and 95% confidence. We added 10% to the total sample size to account for students declining to participate in the study, resulting in 1500 students.

Procedures

Data were collected between August and December 2010 by qualified and trained personnel. The principal of each selected school received a letter that included an explanation of the study's objectives and methodology and an invitation for his/her students to participate in the research study. The students' parents attended informational meetings where they received extensive information on the project and were invited to enroll their children in the study. Participating parents signed a consent form and were invited to complete the study questionnaires.

Outcome variable

The prevalence of asthma and rhinitis symptoms was measured using a previously validated questionnaire from the ISAAC, phase III, translated into Portuguese[18]. For the present study, the presence of asthma was defined based on two questions: (i) 'Has your child ever experienced asthma or wheezing in his/her lifetime?' and (ii) 'In the last 12 months, has your child experienced wheezing?' The children who had a positive answer to both questions or to the second question only were considered to have asthma (wheezing) in the last 12 months.

Main independent variable

FNI was measured using the Brazilian Food Insecurity Scale (BFIS), which has been adapted and validated for the Brazilian non-institutionalised population[19]. Questions about food insecurity were answered by the person responsible for feeding the family. The BFIS contains fifteen items that are used to measure food security among the population. Responses to these items are also used to assess different degrees of food insecurity experienced by families (mild, moderate and severe). We considered the presence or absence of residents under 18 years old in households when determining the level of food insecurity based on the scale score[20]. In households with children under 18 years old, the following cut-off points were used: 1–5 (mild FNI), 6–10 (moderate FNI) and 11–15 (severe FNI). A BFIS score of zero indicated food security. For the present study we adopted three dummies to characterise food and nutrition insecurity: dummy 1 was mild, dummy 2 was moderate, and dummy 3 was severe.

Potential confounding variables

The following potential confounding factors were considered in the study, where Ref. indicates the reference category: sex (male; female = Ref.), age (<10 years; ≥10 years = Ref.), mother's education level (≤4th grade; ≥5th grade = Ref.), place of residence (urban; rural = Ref.), per capita income (in Brazilian minimum salaries (BMS), <1/2 BMS; ≥1/2 BMS = Ref.), number of people living in the household (>4; ≤4 = Ref.), tobacco smoke exposure (yes; no = Ref.) and BMI. We used the WHO standard reference tables (2007)[21] to determine the percentile value of BMI for age and sex for each participant. To classify these BMI measurements, we used the WHO's criteria established in 2006[22]. For our analysis, overweight and obesity categories were aggregated. Therefore, individuals with BMI ≥ 85th percentile were considered to have excess weight.

Statistical analysis

For processing and construction of the database, we used Epi Info version 6·04. The data were entered in duplicate after reviewing the questionnaires and correcting for errors from the coding field.

The characteristics of the population were identified by descriptive analysis using categorised data for prevalence and means and standard deviations for continuous variables. The magnitude of the associations between asthma and different levels of food insecurity was expressed as odds ratios with 95% confidence intervals. The statistical analysis used two-tailed tests and a significance level of 5%.

The presence of confounding variables was explored using multivariable logistic regression models. We used the backward modelling strategy in the multivariable logistic regression analysis, considering as confounding variables those that caused a difference in the magnitude of the association of ≥10% when excluded from the model[23]. However, gender and age were included and retained in the model independent of this criterion. The choice of variables for modelling was based on knowledge gathered from pre-existing literature.

The statistical analyses were performed using the statistical software package SPSS version 13·0.

Ethical issues

Ethical approval was provided by the Ethical Committee of the School of Nutrition, Federal University of Bahia, Brazil (registration number 27-09/CEPNUT). Written informed consent detailing all procedures to be carried out with the participants was signed by a parent or the legal guardian of each child.

Results

Of the total number of students initially selected (1500 students), 193 (12·9%) did not participate in the study. These sample losses were due to refusal or the child moving to another city or transferring to another school. The final study sample consisted of 1307 students of both sexes, aged 6–12 years.

There was a slightly higher percentage of male students (53·6%) and a higher percentage of children aged 6–9 years (51·3%). Other descriptive characteristics of the study sample are shown in Table 1. It was found that 10·4 (95% CI 8·7, 12·1) % of study participants had symptoms consistent with asthma (wheezing in the last 12 months). In addition, 64·5% of participants were experiencing FNI, of which 42·5% were mild, 15·9% moderate and 6·1% severe.

The results of the multivariate unconditional logistic regression model adjusted for sex, age, tobacco smoke exposure, place of residence and anthropometric status showed that children with moderate FNI were 1·71 times more likely (95% CI 1·01, 2·89) to have asthma (wheezing) compared with food-secure children. The odds increased to 2·51 (95% CI 1·28, 4·93) under conditions of severe food insecurity (Table 2).

The goodness-of-fit test (Hosmer–Lemeshow test) indicated that the model showed satisfactory calibration ($P > 0·05$).

Table 1 Frequency of asthma according to characteristics of the study population: elementary-school children (*n* 1307) aged 6–12 years, São Francisco do Conde, Bahia, north-eastern Brazil, 2010

			Asthma		
Variable	*n*	%	*n*	%	*P* value
Sex					
Female	607	46·4	63	10·4	0·780
Male	700	53·6	76	10·9	
Age (years)*					
6–9	666	51·3	78	11·8	0·231
10–12	626	48·7	61	9·7	
Education of caregiver*					
Illiterate	55	4·6	5	9·1	0·646
1st to 4th grade	312	26·1	36	11·5	
5th to 8th grade	315	26·4	28	8·9	
Second degree or higher	513	42·9	58	11·3	
Place of residence*					
Rural	872	66·6	84	9·6	0·096
Urban	432	33·3	55	12·6	
Family income*,†					
≤1/2 BMS	834	70·0	88	10·6	0·923
>1/2 BMS	357	30·0	37	10·4	
Number of individuals per household*					
≤4	632	52·6	63	49·6	0·472
>4	569	47·4	64	11·2	
Anthropometric status*					
Underweight	121	9·4	14	10·1	0·296‡
Normal weight	952	74·1	97	10·2	
Overweight	125	9·7	15	12·0	
Obese	87	6·8	13	14·9	
Tobacco smoke exposure*					
No	1043	80·5	104	10·0	0·148
Yes	252	19·5	33	13·1	
FNS situation*					
FNS	445	35·5	39	8·8	0·006‡
FNI mild	534	42·5	54	10·1	
FNI moderate	200	15·9	27	13·5	
FNI severe	76	6·1	14	18·4	

FNS, food and nutrition security; FNI, food and nutrition insecurity.
*Different totals because of non-available data.
†Measured in Brazilian minimum salaries (BMS). Value in 2010 = R$ 510·00 (Brazilian reais; equivalent to $US 290·70).
‡Using the χ^2 test; other *P* values obtained using Mantel–Haenszel's linear association test.

Discussion

The prevalence of asthma symptoms recorded among school children in São Francisco do Conde (10·4%) is lower than the prevalence reported in other regions of Brazil[3]. A possible explanation for this discrepancy is that most of the studies on asthma in Brazil have been carried out in large cities, whereas the present study was performed in a small town and its rural surroundings. However, this prevalence is comparable with those recorded in urban areas in Argentina, Chile and Mexico[3].

Using a multivariable logistic regression analysis adjusted for sex, age, tobacco smoke exposure, place of residence and anthropometric status, we observed a statistically significant, positive and markedly dose-dependent association between FNI and asthma (wheezing). The potential confounding variables used in the analysis have been identified in several previous studies as associated with both asthma and food insecurity in childhood[24–26]. The literature has

Table 2 Univariate and multivariate associations between food and nutrition insecurity and asthma in the studied population: elementary-school children (*n* 1307) aged 6–12 years, São Francisco do Conde, Bahia, north-eastern Brazil, 2010

	Univariate model		Multivariate model*	
Variable	OR	95 % CI	OR	95 % CI
FNS situation				
FNS	1·00	Ref.	1·00	Ref.
FNI mild	1·17	0·76, 1·81	1·19	0·77, 1·84
FNI moderate	1·63	0·97, 2·74	**1·71**	**1·01, 2·89**
FNI severe	**2·36**	**1·21, 4·59**	**2·51**	**1·28, 4·93**
Potential confounding variables				
Gender				
Male	1·00	Ref.	1·00	Ref.
Female	0·95	0·66, 1·35	1·10	0·75, 1·61
Age (years)				
≥10	1·00	Ref.	1·00	Ref.
<10	1·24	0·87, 1·76	1·39	0·94, 2·05
Education of caregiver				
≥5th grade	1·00	Ref.	1·00	Ref.
Illiterate to 4th grade	1·13	0·75, 1·71	1·19	0·78, 1·81
Place of residence				
Rural	1·00	Ref.	1·00	Ref.
Urban	1·35	0·94, 1·94	1·66	1·11, 2·47
Family income†				
>1/2 BMS	1·00	Ref.	1·00	Ref.
≤1/2 BMS	1·02	0·68, 1·53	1·30	0·38, 4·92
Number of individuals per household				
≤4	1·00	Ref.	1·00	Ref.
>4	1·14	0·79, 1·65	1·27	0·84, 1·92
Anthropometric status				
Normal weight	1·00	Ref.	1·00	Ref.
Underweight	1·15	0·63, 2·09	1·22	0·62, 2·42
Overweight/obese	1·34	0·85, 2·10	1·43	0·89, 2·32
Tobacco smoke exposure				
No	1·00	Ref.	1·00	Ref.
Yes	1·36	0·89, 2·06	1·55	0·99, 2·44

FNS, food and nutrition security; FNI, food and nutrition insecurity; Ref., reference category.
Statistically significant odds ratios and 95 % confidence intervals are denoted in bold font.
*Multivariate model adjusted for sex, age, tobacco smoke exposure, place of residence and anthropometric status.
†Measured in Brazilian minimum salaries (BMS). Value in 2010 = R$ 510·00 (Brazilian reais; equivalent to $US 290·70).

consistently reported that FNI is associated with poor well-being and lower quality of life for families[11,27–29]. However, the mechanisms for this relationship remain poorly understood. It is unclear whether the experience of food insecurity is associated with adverse health effects independent of the effects of poverty. Our study results are in agreement with a few previous investigations that evaluated the relationship between FNI and asthma[13]. The influence of food insecurity on asthma in children and adolescents is in accordance with the argument that food insecurity leads to various health problems, such as depression, anxiety and maternal stress. It is possible that when the mother's emotional condition is impaired the mother–child bond can be weakened, with consequent effects on the level of care and an increase in the risk for disease[9,30–33]. We also consider that constant exposure to food insecurity is a source of chronic stress and can contribute to emotional and behavioural problems, such as anxiety, depression and conduct disorders in children, which can trigger or worsen asthma symptoms[10,14]. Further research is warranted to better understand the pathways by which experiences of food insecurity may contribute to poor health outcomes, and specifically to asthma.

Limitations and strengths of the study

The current study has limitations inherent to cross-sectional studies. Specifically, because all of the variables are estimated at one time point in the cross-sectional design, temporality cannot be established, limiting the inference of a causal relationship between FNI and asthma. If FNI causes asthma, it must be mediated by a chain of other psychosocial related factors. An additional limitation is that there is no attempt to measure such factors in our study. The literature is controversial regarding whether psychosocial factors are confounding or mediator factors in the association between FNI and asthma[34–37]. We are in the group that argues in favour of psychosocial factors mediating the association between FNI and asthma. Then, the absence of this information precludes us to assess if psychosocial factors reduce or erase the association. Furthermore, we do not have dietary intake data available, making it difficult to ascertain if those with greater degrees of food insecurity have diets that are significantly different from those without food insecurity, especially for some groups of foods that have been associated with asthma prevalence. We emphasise the importance of conducting further modelling approaches, including some

other predictor variables that potentially could measure factors that predispose children to both food insecurity and asthma and that were not included in our models.

The strengths of our study include its large and homogeneous study population; that it was carried out in a small town and its surrounding rural area; and the focus on food insecurity. It should be noted also that possible confounding effects related to socio-economic status were minimised in the present study.

Conclusions

The prevalence of asthma symptoms among the studied children reinforces the need to intervene on the factors that are associated with asthma vulnerability. Furthermore, the results point to severe food insecurity as a marker of vulnerability to asthma symptoms in this and maybe other similar populations. It could be inferred that public policies focused on decreasing food insecurity have a role in decreasing the burden of asthma during childhood and adolescence. The results also suggest the need for further studies to identify the mechanisms involved in the relationship between FNI and wheezing/asthma.

Acknowledgements

Sources of funding: This work was supported by the Fundação de Amparo à Pesquisa do Estado da Bahia (FAPESB; project nos. 7638/2009 and 7597/2009) and the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES; process no. 1254/10-3). *Conflicts of interest:* The authors declare no conflict of interest. *Authors' contributions:* R.d.C.R.-S. participated in the study design, data collection, interpretation of results and writing of the manuscript. A.O.A.-M. participated in the interpretation of results and writing of the manuscript. S.J.B. participated in the field work and reviewed the manuscript. R.L.F. designed the work and reviewed the manuscript. S.M.d.S.C. participated in the interpretation of results and revision of the manuscript. M.L.B. reviewed the manuscript. E.d.J.P. reviewed the manuscript. L.A.d.S. participated in the interpretation of results and revision of the manuscript. L.C.R. participated in the interpretation of results and revision of the manuscript. N.M.A.-N. participated in the study design and revision of the manuscript.

References

1. O'Byrne PM (2009) Allergen-induced airway inflammation and its therapeutic intervention. *Allergy Asthma Immun* **1**, 3–9.
2. Anandan C, Nurmatov U, van Schayck OC *et al.* (2010) Is the prevalence of asthma declining? Systematic review of epidemiological studies. *Allergy* **65**, 152–167.
3. Cooper PJ, Rodrigues LC, Cruz AA *et al.* (2009) Asthma in Latin America: a public heath challenge and research opportunity. *Allergy* **64**, 5–17.
4. Solé D, Wandalsen GF, Camelo-Nunes IC *et al.* (2006) Prevalence of symptoms of asthma, rhinitis, and atopic eczema among Brazilian children and adolescents identified by the International Study of Asthma and Allergies in Childhood (ISAAC) – Phase 3. *J Pediatr (Rio J)* **82**, 341–346.
5. Cooper PJ, Rodrigues LC & Barreto ML (2012) Influence of poverty and infection on asthma in Latin America. *Curr Opin Allergy Clin Immunol* **12**, 171–178.
6. Souza da Cunha S, Barreto ML, Fiaccone RL *et al.* (2010) Asthma cases in childhood attributed to atopy in tropical area in Brazil. *Rev Panam Salud Publica* **28**, 405–411.
7. Barreto ML, Cunha SS, Fiaccone R *et al.* (2010) Poverty, dirt, infections and non-atopic wheezing in children from a Brazilian urban center. *Respir Res* **11**, 167.
8. von Mutius E (2002) Environmental factors influencing the development and progression of pediatric asthma. *J Allergy Clin Immunol* **109**, 6 Suppl., S525–S532.
9. Priftis KN & Anthracopoulos MB (2008) The causal relationship between stress and asthma. *Allergol Immunopathol (Madr)* **36**, 343–346.
10. Murphy JM, Wehler CA, Pagano ME *et al.* (1998) Relationship between hunger and psychosocial functioning in low-income American children. *J Am Acad Child Adolesc Psychiatry* **37**, 163–170.
11. Belsky DW, Moffitt TE, Arseneault L *et al.* (2010) Context and sequelae of food insecurity in children's development. *Am J Epidemiol* **172**, 809–818.
12. Hendrickson MA, O'Riordan MA, Arpilleda JC *et al.* (2010) Effects of food insecurity on asthma outcomes in the pediatric emergency department. *Pediatr Emerg Care* **26**, 823–829.
13. Kirkpatrick SI, McIntyre L & Potestio ML (2010) Child hunger and long-term adverse consequences for health. *Arch Pediatr Adolesc Med* **164**, 754–762.
14. Feitosa CA, Santos DN, do Carmo MBB *et al.* (2011) Behavior problems and prevalence of asthma symptoms among Brazilian children. *J Psychosom Res* **71**, 160–165.
15. do Carmo MBB, Santos DN, Amorim LDAF *et al.* (2009) Minor psychiatric disorders in mothers and asthma in children. *Soc Psychiatry Epidemiol* **44**, 416–420.
16. Instituto Brasileiro de Geografia e Estatística (2010) *Pesquisa Nacional por Amostra de Domicílios – segurança alimentar 2004/2009.* Rio de Janeiro: IBGE.
17. Superintendência de Estudos Econômicos (2008) *Índice de desenvolvimento econômico e social dos municípios baianos.* Salvador: Superintendência de Estudos Econômicos.
18. Sole D, Vanna AT, Yamada E *et al.* (1998) International Study of Asthma and Allergies in Childhood (ISAAC) written questionnaire: validation of the asthma component among Brazilian children. *J Investig Allergol Clin Immunol* **8**, 376–382.
19. Pérez-Escamilla R, Segall-Corrêa AM, Kurdian Maranha L *et al.* (2004) An adapted version of the US Department of Agriculture Food Insecurity module is a valid tool for assessing household food insecurity in Campinas, Brazil. *J Nutr* **134**, 1923–1928.
20. Marín-León L, Segal-Corrêa AM, Panigassi G *et al.* (2005) A percepção de insegurança alimentar em famílias com idosos em Campinas, São Paulo, Brasil. *Cad Saude Publica* **21**, 1433–1440.
21. de Onis M, Onyango AW, Borghi E *et al.* (2007) Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ* **85**, 660–667.
22. WHO Multicentre Growth Reference Study Group (2006) *WHO Child Growth Standards: Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age: Methods and Development.* Geneva: WHO.
23. Rothman K & Greenland S (1998) *Modern Epidemiology.* Philadelphia, PA: Lippincott-Raven.

Public Health Nutrition

24. Semba RD, Campbell AA, Sun K *et al.* (2011) Paternal smoking is associated with greater food insecurity among poor families in rural Indonesia. *Asia Pac J Clin Nutr* **20**, 618–623.
25. Zaslow M, Bronte-Tinkew J, Capps R *et al.* (2009) Food security during infancy: implications for attachment and mental proficiency in toddlerhood. *Matern Child Health J* **13**, 66–80.
26. Baig-Ansari N, Rahbar MH, Bhutta ZA *et al.* (2006) Child's gender and household food insecurity are associated with stunting among young Pakistani children residing in urban squatter settlements. *Food Nutr Bull* **27**, 114–127.
27. McIntyre L, Connor SK & Warren J (2000) Child hunger in Canada: results of the 1994 National Longitudinal Survey of Children and Youth. *CMAJ* **163**, 961–965.
28. Cook JT, Frank DA, Berkowitz C *et al.* (2004) Food insecurity is associated with adverse health outcomes among human infants and toddlers. *J Nutr* **134**, 1432–1438.
29. Alaimo K, Olson CM, Frongillo EA *et al.* (2001) Food insufficiency, family income, and health in US preschool and school-aged children. *Am J Public Health* **91**, 781–786.
30. Schneider AP, Stein RT & Fritscher CC (2007) The role of breastfeeding, diet and nutritional status in the development of asthma and atopy. *J Bras Pneumol* **33**, 454–462.
31. Silver EJ, Bauman LJ & Ireys HT (1995) Relationships of self-esteem and efficacy to psychological distress in mothers of children with chronic physical illnesses. *Health Psychol* **14**, 333–340.
32. Weinreb L, Wehler C, Perloff J *et al.* (2002) Hunger: its impact on children's health and mental health. *Pediatrics* **110**, e41.
33. Dean WR & Sharkey JR (2011) Rural and urban differences in the associations between characteristics of the community food environment and fruit and vegetable intake. *J Nutr Educ Behav* **43**, 426–433.
34. Klinnert MD, Nelson HS, Price MR *et al.* (2001) Onset and persistence of childhood asthma: predictors from infancy. *Pediatrics* **108**, E69.
35. Chida Y, Hamer M & Steptoe A (2008) A bidirectional relationship between psychosocial factors and atopic disorders: a systematic review and meta-analysis. *Psychosom Med* **70**, 102–116.
36. Laraia BA, Siega-Riz AM, Gundersen C *et al.* (2006) Psychosocial factors and socioeconomic indicators are associated with household food insecurity among pregnant women. *J Nutr* **136**, 177–182.
37. Maes KC, Hadley C, Tesfaye F *et al.* (2010) Food insecurity and mental health: surprising trends among community health volunteers in Addis Ababa, Ethiopia during the 2008 food crisis. *Soc Sci Med* **70**, 1450–1457.

Public Health Nutrition