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The prevalence of wheezing and its association with serum zinc concentration in children and adolescents in Brazil

Rita de Cássia Ribeiro-Silva[a,*], Rosemeire Leovigildo Fiaccone[b], Maurício Lima Barreto[c], Luce Alves da Silva[a], Luis Fernandes Pereira Santos[a], Neuza Maria Alcantara-Neves[d]

[a] Departamento de Ciências da Nutrição, Universidade Federal da Bahia, Av. Araújo Pinho, 32, Canela, CEP: 40110-150 Salvador, Bahia, Brazil
[b] Instituto de Matemática, Universidade Federal da Bahia, Av. Adhemar de Barros, s/n, Ondina, CEP: 40170-110 Salvador, Bahia, Brazil
[c] Instituto de Saúde Coletiva, Universidade Federal da Bahia, Rua Basílio da Gama, s/n, Campus Universitário Canela, CEP: 40110-040 Salvador, Bahia, Brazil
[d] Departamento de Ciências da Biointeração, Instituto de Ciências da Saúde, Universidade Federal da Bahia, Av. Reitor Miguel Calmon, s/n, CEP: 40110-100 Salvador, Bahia, Brazil

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ABSTRACT

Objective: To assess the influence of zinc serum status on the prevalence of wheezing in a sample of children and adolescents in Northeastern Brazil.
Research methods and procedures: This is a cross-sectional study which included 592 students of 6–12 years old, from the public elementary schools of São Francisco do Conde, Bahia, Northeastern Brazil. Report of wheezing in the past 12 months was collected using a questionnaire of the International Study of Asthma and Allergies in Childhood Program (ISAAC) phase III, adapted to Portuguese. The determination of serum Zn levels was performed using a flame atomic absorption spectrometer. Data on anthropometric status, level of physical activity, pubertal development and socioeconomic information, for each participant were obtained. Multivariate logistic regression analyses were used to assess the associations of interest.
Results: Of the students, 8.6% (95% CI 6.30–10.9) reported having wheezing. The mean (SD) serum zinc level was 114 (22.9 μg/dL). The results of the multiple logistic regression analysis showed, after adjustments, positive and significant association between low serum zinc levels and wheezing. Students categorized as being below the median for serum Zn concentration presented an almost 1.9-fold increase in the wheezing prevalence ratio (OR = 1.9; 95% CI 1.03–3.53).
Conclusion: The main findings of this study suggest that the level of zinc may influence the risk of wheezing in late childhood on the study population.

Introduction

Asthma is a multifactorial illness; its causes are still not completely understood, and there is no consensus on its etiology. A large body of research emphasises the role of environmental pollution, genetic and psychosocial factors furthermore of changing diet and/or nutrient status [1–6]. Numerous studies have suggested that low intake of dietary antioxidants (vitamin E, vitamin C, carotenoids, polyphenols, selenium and zinc) [7–9], a reduction in n-3 PUFAs (polyunsaturated fatty acids) and an increase in n-6 PUFAs [8,10,11] may be associated with the development of asthma and other allergic disorders and may be an important contributing risk factor for the increase in asthma incidence over the last three decades [7]. Zinc (Zn) is an important antioxidant element obtained from food. Zinc is an essential micronutrient for the proper functioning of more than 100 enzymes involved in human metabolism that promote protein folding and helping the regulation of gene expression [12]. Furthermore, zinc plays a central role in modulating the immune system; it is essential for cellular function of the immune response acting as an antioxidant microelement. The literature on zinc as a potent antioxidant is vast, but the role played by zinc in airway inflammation remains unclear [12–14]. Studies have examined abnormal distributions of trace minerals, including zinc, some of them have reported the effect of the lower zinc status in asthma/wheezing [15–18]. On the other hand, some studies have reported discrepant results [19,20] or even an inverse association, as demonstrated by Urushidate et al. [21].

Overall, the body of evidence from these studies is methodologically poor but weakly suggestive of a possible effectiveness of zinc

* Corresponding author at: Rua Desembargador Oscar Dantas, 96 apt 402, Graça, CEP: 40.150-260 Salvador, Bahia, Brazil. Tel.: +55 7132837735.
E-mail address: rcrsilva@ufba.br (R. de Cássia Ribeiro-Silva).

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in preventing asthma/wheezing [22]. Therefore, studies examining the role of this element in the etiology of wheezing and/or asthma are necessary before any conclusion can be drawn. In this work, our aim was to investigate the influence of zinc serum status on the prevalence of wheezing in a sample of children and adolescents from Northeastern Brazil.

Materials and methods

Study design/population/sampling

A cross-sectional design was used to study 6- to 12-year-old children living in São Francisco do Conde (SFC), a municipality located in the metropolitan region of Salvador, Northeast Brazil. This study is part of another large investigation about understanding risk factors for asthma/wheezing [23]. From 1187 students enrolled, the majority came from rural area (779 students) and urban (408 students) from the SFC. Due to the limitation of funding and logistic condition, we choose to select at random half (50%) of these students from each area to participate in this study. However, the number of students who appeared in the collecting point of blood sample measured was 592. Then, 125/204 students from urban area (about 60%) and 467/390 students from rural area (about 120%) were enrolled.

Outcome variables

The prevalence of asthma and rhinitis symptoms was determined using a validated International Study of Asthma and Allergies in Childhood (ISAAC) phase III questionnaire adapted and translated into Portuguese [24]. For this study, wheezing was defined based on the following two questions: (1) "Has your child ever experienced asthma or wheezing in his/her lifetime?"; and (2) "In the last 12 months, has your child experienced wheezing?" The children whose parents answered yes to both questions or who answered yes to only the second question were considered cases for this study.

Determination of zinc serum levels

Laboratory investigations: Venous blood samples were collected from subjects in the morning, before food intake. Serum samples were aliquoted in Eppendorf tubes and stored at −20 °C until the zinc levels were measured. The determination of serum Zn levels was performed using a flame atomic absorption spectrometer (Varian AA240). The calibration graphs were constructed using normal aqueous standards (NIST-USA). All tubes used for blood collection and serum storage were free of trace microelements.

Confounding variables

Anthropometric status

Each participant's weight was obtained using a Master® portable digital scale and a Leicester Height Measure® portable stadiometer (Seca, Hamburg, Germany). The measurements were performed in duplicate using the techniques of Lohman et al. [25]. Body mass index (BMI) was used for the diagnosis of anthropometric status, adopting the percentiles for age and gender proposed by the World Health Organization [26]: underweight (<3rd percentile); normal weight (≥3rd percentile and <85th percentile, category reference); overweight (≥85th percentile and <97th percentile); and obese (≥97th percentile). For this analysis, the overweight and obese categories were combined. Therefore, children with excess BMI were situated in or above the 85th percentile.

Level of physical activity

To evaluate the frequency of physical activity, we used the International Physical Activity Questionnaire (IPAQ), which assesses physical activity for leisure, transport, work and domestic purposes in the past week [27]. This information allows one to estimate the weekly time spent engaged in physical activities. For this study, the final score was dichotomized using a cutoff of 300 min/week of moderate or vigorous physical activity [28]. Children with ≥300 min of activity per week were considered active (reference category), and children with <300 min per week were classified as inactive.

Pubertal development

The evaluation of the stages of sexual maturity was based on the characteristics of breast and pubic hair in girls and genital and pubic hair in boys. Based on this staging, the adolescents were grouped into pre-pubescent (reference category) and pubescent according to the categories described by Marshall and Tanner [29,30]. The identification of these stages was achieved by self-description with the help of portraits provided by the interviewers.

Other variables

The variables used in this study as confounders were as follows: sex (male, female reference category); age (<10 years, ≥10 years reference category); education of caregiver (≤4th grade, 5th grade ≥ reference category); household location (urban, rural reference category); per capita income (as minimum salary (MS); <1 SM, ≥1 SM reference category); number of people living in the household (>3, ≤3 reference category); and the presence of smokers in the household (no reference category, yes).

Ethical issues

Ethical approval was provided by the Ethical Committee of the School of Nutrition, the Federal University of Bahia, Brazil, under registration number 27-09/CEPNUT. Written informed consent detailing all procedures to be performed on the subjects was signed by a parent or legal guardian of each child.

Statistical analysis

For processing and construction of the database, we used Epi Info version 6.04 (Centers for Disease Control and Prevention, Atlanta, GA, USA). The data were entered in duplicate after reviewing the questionnaires and correcting for errors in data collection. The characteristics of the population were identified by descriptive analysis using categorized prevalence data.

The magnitude of the associations between wheezing and zinc status (based on median cutoff) was expressed as odds ratio (OR) with 95% confidence intervals (95% CI). Statistical analyses used two-tailed tests and a significance level of 5%. The logistic multivariate analysis used to study the association between zinc status and wheezing was adjusted for age, sex, the education of caregivers, per capita income, the number of people living in the household, the presence of smokers in the household, body mass index (BMI), pubertal development and physical activity. The choice of variables for modeling was based on knowledge gathered from pre-existing literature [31] and reports on this population [5,23].

Statistical analyses were performed using the Statistical Package for Social Sciences – SPSS, v. 13.0.

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