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Association between nutritional status, environmental and socio-economic factors and *Giardia lamblia* infections among children aged 6—71 months in Brazil

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Summary A cross-sectional study was conducted on a randomised sample of 405 children aged 6—71 months in Brazil to investigate the association between nutritional status, environmental and socio-economic factors and *Giardia lamblia* infection. Data collection entailed an interview, anthropometric measurements and the collection of faeces and venous blood samples. The analysis was performed using multivariate logistic regression. The prevalence rate for *G. lamblia* was 26.3%. Nutritional status evaluation showed that 7.9% of the children had chronic malnutrition and 11.1% had acute malnutrition. The risk factors associated with infection by *G. lamblia* were an age of 2 years or older [odds ratio (OR) = 2.4], living in a two-bedroom house or smaller (OR = 2.3), living among a family of five or more people (OR = 2.4) and living in a house without access to a sewerage system (OR = 2.1). Non-participation in the social service programme was associated with a lower risk of infection (OR = 0.2). The model adjusted for age, including only biochemical and nutritional variables, showed weak associations with *G.lamblia* infection for two variables: inadequate animal protein intake according to the Dietary

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Reference Intake recommendation and low haemoglobin concentration. The sociodemographic and environmental risk factors classically described were associated with *G. lamblia* infection, but nutritional variables were only weakly associated with it.

1. Introduction

Parasite infections are a public health issue, especially in developing countries.[1,2] Among enteroparasites, *Giardia lamblia* is the protozoan most frequently found, with estimated prevalence rates of 20—30% in developing countries and 2—5% in developed countries.[3,4] Environmental and socio-economic factors, as well as hygiene habits, are important determinants of *G. lamblia* infection prevalence.[5,6]

Giardiasis is characterised as a wide-spectrum illness, although the majority (60—80%) of infected individuals is asymptomatic. The main clinical symptom is diarrhoea, but abdominal pain and weight loss are also reported.[7] In 2001, Katz and Taylor[8] suggested that giardiasis might influence the growth and development of infected children. Concomitantly, protein-energy malnutrition can increase susceptibility to and morbidity from *G. lamblia* and other parasite infections.[9] However, studies of the association between nutritional deficiency and giardiasis are contradictory.

In Brazil, some studies have shown that children infected by *G. lamblia* have a significantly lower weight per age (W/A) and height per age (H/A) than children who are not infected.[10,11] These results were corroborated by a study carried out in Ecuador[12] showing that children with giardiasis had a higher risk of growth deficits than did non-infected children. However, Sawaya et al.[13] did not find any association between infection by *Giardia* and nutritional status.

In this study, we investigated the association between nutritional status, environmental and socio-economic factors and *G. lamblia* infection among children aged 6—71 months who were living in Itinga, Minas Gerais, Brazil.

2. Materials and methods

2.1. Study design, area and population

A cross-sectional epidemiological study was conducted during July 2005 in 6- to 71-month-old children living in rural and urban areas of Itinga, Vale of Jequitinhonha, one of the poorest regions in the state of Minas Gerais in southeast Brazil. The human development index (HDI)[14] of Itinga is 0.624, placing it in 799th place of the state's 853 municipalities.

The sample size was determined on the basis of the following parameters: 1671 children aged 6—71 months were living in Itinga, according to the Brazilian Institute of Geography and Statistics (IBGE);[15] parasite infection prevalence was estimated to be between 18 and 78%;[6,16] the minimum difference tolerated between the estimates and the real values of such prevalence = 5%; alpha error = 0.05 and design effect = 1.5. We thus calculated that the study called for at least 393 children, and 405 were included.

The units sampled were households identified through the municipal health service records. The number of households selected in the rural and urban regions was proportional to the existing number of households in each region. The randomised sampling process was conducted in two stages: (1) a random sample of city blocks (urban area) and localities (rural areas) was selected proportionally to the existing blocks and localities; and (2) within each selected block and locality, random samples of households were drawn, proportional to the number of existing households. All children aged 6—71 months living in the selected households were invited to participate in the study.

2.2. Data collection

Upon arriving at the randomly selected households, teams of two trained interviewers obtained informed consent from a parent or other person responsible for the child. The interviewers were provided with instruction manuals and used a pre-coded questionnaire when conducting the interviews. Information was collected on the following groups of characteristics: demographic and social questions on child-related variables (e.g. sex, age, race, weight, height, reported morbidities, access to health service), socio-economic status of the parents (e.g. education level, income, schooling, employment, number of family members, number of children), household and environmental conditions (e.g. construction materials of walls, roof and floor, number of rooms, water quality, access to sanitation, public water, sewage availability, domestic refuse storage and disposal).

The interviews were complemented by evaluation of the children's food and dietary intake using a validated semi-quantitative food-frequency questionnaire, tailored for the dietary habits of the Vale of Jequitinhonha region. The person in charge of preparing the children's meals was interviewed. To standardise this information, the Food Photo Record Album[17] was used to help measure the meal portions and food preparations consumed by the infants.

To analyse the per capita/day consumption, the Brazilian Food Composition Tables were used. The translation of meals into weight or volume and calculation of macro- and micronutrient intake was carried out using the STATA software, version 9.0 (Stata Corp., College Station, TX, USA). To evaluate nutrient intake, the cut-off point method developed by Beaton was used.[18]

Estimates of daily consumption of each nutrient were compared with the Dietary Reference Intake (DRI) values used for the dietary evaluation of population groups. Inadequacy of diet was determined by calculating the prevalence of individuals with intake values lower than those recommended by the DRI (Estimated Average Requirement, Adequate Intake), taking into account sex and life stage.