Intestinal parasitoses are associated with lower values of weight and height in school-aged children from low socioeconomic level

Parasitoses intestinais se associam a menores índices de peso e estatura em escolares de baixo estrato socioeconômico

Parasitosis intestinales se asocian con menores índices de peso y estatura en niños de bajo nivel económico

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ABSTRACT

Objective: To evaluate the association between the prevalence of intestinal parasitosis with socioeconomic and environmental factors, as well as with weight, height and hemoglobin levels in two different socioeconomic groups of children in Osasco (SP), Brazil.

Methods: This cross-sectional study compared 84 children aged from six to ten years old from a slum area without proper sanitation and poor housing with 35 children attending private school with good socioeconomic level and housing conditions in the same city. Children with diarrhea for less than 30 days or severe illness were excluded. A standard questionnaire was applied for assessing social and environmental conditions. The nutritional assessment was done by Z scores for weight for age, height for age and body mass index. Capillary blood hemoglobin determination was done by HemoCue® method and intestinal parasitosis examination was performed by the Hoffman, Ritchie, Kinyoun and anal swab methods.

Results: Intestinal parasitosis occurred in 60.7% of children from the slum and in 5.9% of children from private schools ($p<0.001$; OR 24.7). The average Z scores of weight for age, height for age and body mass index were lower in infected children (-0.78±0.84; +0.50±0.90; -0.76±0.96) compared to non infected children (-0.18±1.18; +0.03±1.10; -0.28±1.16) with statistical differences ($p<0.05$). There was no difference in average hemoglobin levels between infected and non infected children by intestinal parasitosis in the slum group (12.6±1.1g/dL and 12.8±1.2g/dL); $p=0.58$.

Conclusions: Intestinal parasitosis were more prevalent among children from the slum and were associated with lower weight and height.

Key-words: parasitic diseases; child nutrition; anemia.

RESUMO

Objetivo: Avaliar a prevalência de parasitoses intestinais, correlacionando-as com os fatores socioeconômicos e ambientais, peso, estatura e hemoglobina, em crianças de dois estratos socioeconômicos, no município de Osasco (SP).

Métodos: Estudo transversal, comparando 84 crianças de seis a dez anos, residentes em área sem saneamento básico e moradia precária, com 35 crianças de escola particular no mesmo município, que possuíam boas condições socioeconômicas e de moradia. Excluíram-se aquelas com diarreia há menos de 30 dias ou doença grave. Utilizou-se questionário padronizado para avaliar as condições socioambientais. A avaliação nutricional foi realizada mediante escores Z de peso para idade, estatura para

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idade e índice de massa corpórea. A determinação da hemoglobina em amostra de sangue capilar foi realizada pelo método Hemocue® e a pesquisa de parasitas intestinais, pelos métodos de Hoffman, Ritchie, Kinyoun e *swab* anal.

Resultados: Parasitose intestinal ocorreu em 60,7% das crianças da favela e em 5,9% das crianças da escola particular (p<0,001; OR 24,7). A média dos escores Z de peso para idade, estatura para idade e índice de massa corpórea foi menor nas crianças parasitadas (-0,78±0,84; +0,50±0,90; -0,76±0,96) em relação àquelas não parasitadas (-0,18±1,18; +0,03±1,10; -0,28±1,16), sendo as diferenças estatisticamente significantes (p<0,05). Não houve diferença nos valores médios de hemoglobina entre as crianças parasitadas e não parasitadas do grupo da favela (12,6±1,1g/dL e 12,8±1,2g/dL); p=0,58.

Conclusões: A parasitose intestinal foi mais prevalente em crianças da favela e se associou a menores índices de peso e de estatura.

Palavras-chave: doenças parasitárias; nutrição da criança; anemia.

RESUMEN

Objetivo: Evaluar la prevalencia de parasitosis intestinales correlacionándolas con los factores socioeconómicos y ambientales, peso, estatura y hemoglobina, en niños de dos niveles socioeconómicos en el municipio de Osasco, São Paulo (Brasil).

Métodos: Se realizó un estudio transversal, comparando 84 niños entre 6 y 10 años, residentes en área sin saneamiento ambiental y vivienda precaria, con 35 niños de escuela privada en el mismo municipio, que poseían buenas condiciones socioeconómicas y de vivienda. Se excluyeron aquellas con diarrea hace menos de 30 días o enfermedad grave. Se utilizó cuestionario estandarizado para evaluar las condiciones socioambientales. La evaluación nutricional fue realizada mediante escores Z de peso para la edad, estatura para la edad e índice de masa corporal. La determinación de la hemoglobina en muestra de sangre capilar fue realizada por el método Hemocue® y la investigación de parasitas intestinales por los métodos de Hoffman, Ritchie, Kinyoun y Swab anal.

Resultados: Parasitosis intestinal ocurrió en 60,7% de los niños del suburbio y en 5,9% de los niños de la escuela privada (p<0,001; OR 24,7). El promedio de los escores Z de peso para la edad, estatura para la edad e índice de masa corporal fue menor en los niños parasitados (-0,78±0,84; +0,50±0,90; -0,76±0,96) respecto a aquellos no parasitados (-0,18±1,18; +0,03±1,10; -0,28±1,16), siendo las diferencias estadísticamente significantes (p<0,05). No hubo diferencia en los valores promedios de hemoglobina entre los niños parasitados y los no parasitados del grupo del suburbio (12,6±1,1g/dL y 12,8±1,2g/dL), (p=0,58).

Conclusiones: La parasitosis intestinal fue más prevalente en niños del suburbio y se asoció a menores índices de peso y estatura.

Palabras clave: enfermedades parasitarias; nutrición del niño; anemia.

Introduction

Parasitic infections are a severe public health problem in developing countries[1] and have a robust association with poor socioeconomic and sanitary conditions[1,2]. Children are the most vulnerable group to infestation by intestinal parasites, since they generally do not perform personal hygiene tasks correctly and expose themselves to earth and water, both of which are important sources of contamination[3]. Pondero-statural deficits and iron deficiency anemia are among the most significant consequences of the morbidity associated with childhood intestinal parasite infections[2].

Although a survey of children under the age of five in the city of São Paolo showed that the prevalence of parasite infections had reduced[4], there are still countless pockets of poverty where low incomes are combined with appalling basic sanitation and hygiene conditions and limited access to public health services. In such locations children are the most vulnerable group both to infectious and parasitic diseases and also to malnutrition. For example, a study conducted in the municipality of Osasco demonstrated that there was a significant reduction in mortality caused by diarrhea among the under fives between 1990 and 2000 but that this reduction was less pronounced in the districts that have the worst living conditions and sanitation combined with high demographic density and little urban infrastructure[5].

Another recent study, also conducted in Osasco, demonstrated that the feces of children living in pockets of poverty had lower quantities of protective bacteria, lactobacillus and bifidobacterium, when compared with a control group living in favorable socioeconomic conditions. Within the subset from the favela there was also an association between lower numbers of protective bacteria and poor nutritional status[6]. The association between socioenvironmental conditions and

exposure to health risks has also been clearly demonstrated in studies that have found that factors such living in homes with dirt floors and no taps were associated with malnourished children in urban favelas[7].

On the basis of this probable association between poor economic, living, hygienic and sanitary conditions and an increased frequency of intestinal parasite infestations and malnutrition and also on the basis of the relationship between intestinal parasites and nutritional deficits, this study was conducted with the objective of determining the prevalence of parasitic infections and correlating this with socioeconomic and environmental factors and the weight, height and hemoglobin levels of children aged 6 to 10 years from two different socioeconomic strata in the municipality of Osasco, SP, Brazil.

Method

This was a cross-sectional study conducted in the municipality of Osasco, in the state of São Paulo, between August of 2006 and June of 2007. Two groups of children were recruited: group 1 comprised residents of a favela and group 2 contained children enrolled at a private school. The two groups therefore belonged to two distinct socioeconomic strata.

Inclusion criteria were age from 6 to 10 years and a minimum of 30 days free from diarrhea. Exclusion criteria were clinical evidence of severe diseases such as heart disease, nephropathy and neuropathy.

Group 1 contained children from a favela located in an area known to lack adequate basic sanitation, close to a municipal sanitary landfill, where low income families live. The children in this group were chosen by lots in an attempt to select a representative sample of the population. The families often 84 of the 100 children chosen agreed to allow them to take part in the study.

Group 2 contained 35 children enrolled at a private school whose families voluntarily gave permission for them to take part. These children come from families living in good socioeconomic conditions and living in homes with good basic sanitation.

The present study was approved by the Research Ethics Committee at the *Universidade Federal de São Paulo*, and the parents or guardians of all participants signed free and informed consent forms at the time of recruitment.

Trained professionals administered a standardized questionnaire to the children's parents. The questions covered the following information: mother's educational level, number of inhabitants per residence, type of residence (masonry or wood construction), basic sanitary conditions (whether the home is connected to the sewage network and the type of water supply), presence of pets at home, presence and type of yard. The study population's socioeconomic status was classified using the Brazilian Economic Classification Criteria (*Critério de Classificação Econômica Brasil*)[8], which distributes families into five social classes (A, B, C, D or E) with A being the most privileged.

Intestinal parasite infections were diagnosed by analysis of at least two fecal samples from each child. The children's parents were instructed to collect samples in universal sterile containers. Samples were analyzed using the Hoffman spontaneous sedimentation method and the formol-ether method proposed by Ritchie and Kinyoun[9], to test for the presence of cysts, eggs or larvae of intestinal parasites. Parents were also instructed to take an anal swab sample, a test specific to the eggs of *Enterobius vermicularis*[9], since the other methods are not appropriate for this diagnosis.

Weight and height were measured according to Jelliffe's[10] recommendations for studies in the community. Children were weighed in their underwear on a Filizola mechanical balance with 150kg capacity and 100g precision. Height was measured with a portable vertical anthropometer accurate to 0.1cm. Children were measured standing unshod with back and legs straight.

The weight and height results were used to calculate Z-scores adjusted for age and sex for weight for age, height for age and body mass index (BMI). These calculations were performed with Epi-Info 3.4.3 (2007), which uses the National Center for Health Statistics reference data[11].

Hemoglobin concentration was assayed in capillary blood samples collected by finger prick into microcuvettes. The tests were performed immediately using a Hemocue® portable photometer[12]. The cutoff point adopted for anemia was <11.5g/dL[13].

Statistical analyses used were Fisher's exact test, the Mann-Whitney test, Student's *t* test and the chi-square test with Sigma Stat 3.5 and Epi-Info 3.4.3. The cut off for rejection of the null hypothesis was set as an alpha error of 5%.

Results

Table 1 shows demographic, socioeconomic and environmental characteristics, anthropometric indicators and hemoglobin levels for the children studied.

The two groups had similar ages (p=0.639). Males predominated in the favela group and the private school group

had a majority of females, but the difference was not statistically significant (p=0.066). The children in the private school group were predominantly from ABEP socioeconomic classes A and B[8] and all of them lived in homes built from masonry with running water and sewage. The children in the favela group were classified as follows: 27 (32.1%) in class C and 57 (67.9%) were in classes D or E. Just 33 (39.3%) of the children in the favela group lived in houses built from masonry, 38 (45.2%) had running water inside their homes and 8 (9.5%) lived in homes connected to the public sewage system.

With regard to anthropometric indicators, the children who lived in the favela had lower median z scores for weight for age, height for age and BMI than the children from the private school and all differences were statistically significant (Table 1). The favela children also had lower median hemoglobin levels (p<0.001). Thirteen (15.5%) of the favela children were anemic and there were no cases of anemia among the children from the private school (p=0.008).

Just two (5.9%) of the 34 children from the private school had parasite infections, and the only parasite detected was *Giardia lamblia* in both of them. In turn, 51 (60.7%) of the 84 children in the favela group had some type of intestinal parasite (p<0.001; OR=24.7; 95% confidence from 5.2 to 160.9). The favela children who had parasites, broke down to 63.0% (29/51) boys and 57.9% (22/51) girls, but the difference was not statistically significant (p=0.797, Table 2).

Thirty-two (62.7%) of the children living in the favela who had intestinal parasitosis were hosting at least one pathogenic parasite and 19 (37.3%) had non-pathogenic parasites. Nine (37.2%) children had a single parasite, 18 (35.3%) had two types of parasite and 14 (27.5%) had more than two different parasites, with the most common combinations of parasites being *Entamoeba coli* with *Endolimax nana* (21.6%), followed by *Giardia lamblia* with *Entamoeba coli* (7.9%).

Table 3 shows the relationships between socioeconomic and environmental factors and the frequency of all intestinal parasite infections for the children in the favela group. Associations were detected between higher densities of inhabitants per residence (more than four people) and intestinal parasites (p=0.003). There was a higher frequency of intestinal parasitosis among children from socioeconomic

Table 1 - Demographic, socioeconomic and environmental characteristics, anthropometric indicators and hemoglobin levels of children from a private school and from a favela – Osasco, 2006

	Private school (n=35)	Favela (n= 84)	*p*
Age (years)	8.7 (7.2 – 9.3)	8.3 (7.2 – 9.2)	0.639
Sex			
Male	12 (34.3%)	46 (54.8%)	0.066
Female	23 (65.7%)	38 (45.2%)	
Economic classification			
A	10 (28.6%)	-	
B	24 (68.6%)	-	
C	1 (2.8%)	27 (32.1%)	<0.0001
D	-	41 (48.8%)	
E	-	16 (19.1%)	
Anthropometric indicators (Z scores)			
Weight-age	0.46 (-0.19 – 1.60)	-0.76 (-1.30 – -0.55)	<0.001
Height-age	0.07 (-0.33 – 0.86)	-0.24 (-0.76 – 0.06)	0.008
BMI	0.56 (-0.34 – 1.69)	-0.56 (-1.30 – -0.03)	<0.001
Hemoglobin (g/dL)	14.2 (12.8 – 14.7)	12.9 (11.6 – 13.6)	<0.001
Anemia (Hb<11.5g/dL)	-	13 (15.5%)	0.008
Masonry construction	35 (100.0%)	33 (39.3%)	<0.0001
Running water	35 (100.0%)	38 (45.2%)	<0.0001
Sewage	35 (100.0%)	8 (9.5%)	<0.0001

BMI: body mass index

Table 2 - Distribution of intestinal parasites by sex for children from the favela - Osasco, 2006

Intestinal parasites	Male Sex (n=46)	Female Sex (n=38)	Total (n=84)
Free from parasites	18 (39.1%)	15 (39.5%)	33 (39.3%)
Infected with parasites	29 (63.0%)	22 (57.9%)	51 (60.7%)
Giardia lamblia	10	3	13 (15.5%)
Ascaris lumbricoides	6	6	12 (14.3%)
Entamoeba histolytica	5	2	7 (8.3%)
Trichuris trichiura	3	4	7 (8.3%)
Enterobius vermiculares	3	2	5 (5.9%)
Cyclospora cayetanensis	2	1	3 (3.6%)
Blastocystis hominis	2	0	2 (2.4%)
Cryptosporidium parvum	1	0	1 (1.2%)
Non pathogenic			
Endolimax nana	14	13	27 (32.1%)
Entamoeba coli	14	10	24 (28.6%)
Iodamoeba butschlii	3	2	5 (5.9%)

Table 3 - Comparisons of the proportions of children from the favela with intestinal parasites by socioeconomic and environmental conditions - Osasco, 2006

	Intestinal Parasite Infection		OR (95%CI)	*p*
	Yes (n=51)	No (n=33)		
Educational level/mother (years)				
≤8	47 (92.2%)	28 (84.8%)	2.10	0.306
>8	04 (7.8%)	05 (15.2%)	(0.44-10.36)	
No. inhabitants at home				
>4	39 (73.6%)	14 (26.4%)	4.41	0.003
≤4	12 (38.7%)	19 (61.3%)	(1.55-12.77)	
Running water				
Illegal	50 (61.0%)	32 (39.0%)	1.56	1.00
Legal	01 (50.0%)	01 (50.0%)	(0.0-59.7)	
Human waste disposal				
Alternative	46 (61.3%)	30 (38.7%)	0.92	1.00
Sewage system	05 (62.5%)	03 (37.5%)	(0.16-4.90)	
Type of construction				
Wooden/mixture	31 (60.8%)	20 (39.2%)	1.0	0.831
Masonry	20 (60.6%)	13 (39.4%)	(0.37-2.71)	
Socioeconomic Classification				
D or E	39 (76.5%)	18 (54.5%)	2.71	0.062
C	12 (23.5%)	15 (45.5%)	(0.96-7.76)	
Pets				
Yes	26 (52.0%)	24 (48.0%)	0.39	0.079
No	25 (73.5%)	09 (26.5%)	(0.14-1.10)	

OR: Odds Ratio, 95%CI: confidence interval of 95%

Table 4 - Z scores for the anthropometric indicators weight for age, height for age and BMI by presence or absence of intestinal parasites in children from the favela - Osasco, 2006

Anthropometric indicators	Parasite infection (n=51)	Free from parasites (n=33)	*p**
Weight/age	-0.78±0.84	-0.18±1.18	0.008
Height/age	-0.50±0.90	+0.03±1.10	0.017
Body mass index	-0.76±0.96	-0.28±1.16	0.040

*Student's *t* test

classes D and E, when compared with class C, but the difference did not attain statistical significance (p=0.062). The same was true of pets at home (p=0.079).

Analysis of the relationship between intestinal parasite infections and nutritional status in the children in the favela group showed that mean z scores for weight for age, height for age and body mass index were all lower for children with parasites when compared with those free from intestinal parasites, as can be observed in Table 4. No statistical difference were observed in mean hemoglobin levels children of children in the favela group when compared in terms of presence or absence of intestinal parasites (12.6±1.1g/dL and 12.8±1.2g/dL, respectively; p=0.581).

Discussion

Although the prevalence of intestinal parasite infections has reduced among under-5s in the city of São Paulo[4] and probably in Brazil as a whole, the issue is still a cause for concern. A proportion of the studies that have been published to date are concerned with analysis of specific intestinal parasites, whereas our research project analyzes the issue of intestinal parasitosis with respect to socioeconomic strata, environmental characteristics and weight, height and blood hemoglobin levels as indicators of nutritional status. The results show that the prevalence of intestinal parasites is greater among children living in a favela, which can be explained by the poor socioeconomic and basic sanitary conditions to which they are exposed, as can be observed from Table 1. It should be stressed that just two children from the private school group had asymptomatic giardiasis. The children in the sample from the favela had lower Z-scores for weight and height (Table 1), and lower hemoglobin levels than the sample from the private school. These results are a reflection of the "vicious circle of poverty" that can be observed in Brazil and which is characterized by unhealthy living conditions, inadequate diet, both in terms of quantity and quality and recurrent infectious processes[7].

In this study we also chose to investigate commensal intestinal protozoans, since pathogenic and non-pathogenic parasites have the same routes of transmission and commensal parasites are therefore another indicator of socio-environmental conditions and of environmental contamination[14]. The water used in the residences where the favela group of children live was analyzed and the results showed elevated rates of contamination, with 77.4% of total coliforms and 51.4% of fecal coliforms, which indicates a high degree of environmental contamination[15]. The parasites identified in the children studied here are similar to those that have been observed in other surveys of fecal parasite content that have been conducted in Brazil, where *Giardia lamblia*, *Ascaris lumbricoides* and *Trichuris trichiura* are generally the most common[16]. It was found that 15.5% of children in the favela group had giardiasis, which is comparable with the results of studies undertaken in Natal, RN, (15.1%)[14] and Belo Horizonte, MG, (17.9%)[17]. The frequencies of *A. lumbricoides* (10.8%) and *T. trichiura* (8.3%) detected among the children in our favela group were lower than results that have been reported by other authors[18], but are similar to the results of a study conducted in three different mesoregions of the Brazilian state of Minas Gerais, in which the prevalence rates among school children aged 7 to 14 years were 10.3% for *Ascaris lumbricoides* and 4.7% for *Trichuris trichiura*[19], and were also similar to the results of another survey conducted in a municipality in Greater São Paulo, where the frequencies were 13.9% for ascariasis and 3.7% for trichuriasis[20].

The favela group had lower weight, height and hemoglobin results than the private school group which may be the result of interactions between the many different factors that differentiate these two groups. Thus, reduced nutritional intake and intestinal malabsorption attributable to asymptomatic environmental intestinal pathologies, which, over the long term, can lead to reduced height and weight[21], are both factors that are likely to contribute to this situation. Intestinal parasite infections may be involved in this process

or may merely have a relationship of coexistence. It could be postulated that the lower hemoglobin values are related to reduced intake of bioavailable iron, as has been shown in a dietary survey conducted by Mello, [15] since ancylostomiasis was not detected in this population.

With regard to *Giardia lamblia*, there is evidence of intestinal iron malabsorption in children with giardiasis with chronic diarrhea, but this association is not present among children with asymptomatic giardiasis[22], which was the most common type of parasitosis observed in this study.

Even though a relatively small number of children from the favela were studied, it was possible to identify certain factors that were associated with parasitosis which are located along the spectrum of greater or lesser degrees of poverty (Tables 3 and 4). Although the association did not attain statistical significance, children from socioeconomic strata D and E were at greater risk of intestinal parasite infections (OR 2.71; p=0.062). Studies have demonstrated that family income and parents' educational level are both risk factors for parasite infections[4], but in this study the association with educational level was not detected. Other factors, such as the presence of sewage and legal water supplies, also failed to demonstrate an association with a lower risk of intestinal parasites.

In contrast, the factor four or more inhabitants in the residence was associated with a 4.41 times greater chance of intestinal parasites. This result is in agreement with the literature, which states that in large families there is increased interpersonal contact meaning that greater density of inhabitants facilitates dissemination of parasites[23]. With regard to housing with dirt yards and pets, it is important to point out that these can be important vehicles for the transmission of pathogens. However, our results showed that having pets at home was related to a tendency to a lower risk of parasitosis (OR 0.39; p=0.079). One interpretation of this finding could be that households in great poverty are unable to maintain pets.

The children in the favela group who had parasite infections had lower mean results for the nutritional indicators weight for age, height for age and BMI, when compared with those free from parasites, irrespective of the parasites' pathogenicity. This result was in line with the results of a study conducted in Aracaju with children from a public school[24], but the same observation has not been reproduced by other authors[4,25]. This raises the question of whether the association between nutritional deficits and parasites is the result of worse environmental conditions along the spectrum of poverty on which the group studied is situated.

In a wider context, it indicates that in developing countries intestinal parasites contribute to morbidity and mortality in the population, primarily among children. Morbidity is related to nutritional deficits that can cause pondero-statural deficits, protein-energy malnutrition and iron deficiency anemia[26], which, in turn, can compromise children's learning and growth[3]. When parasitic infections are present, nutritional status can be negatively affected by reduced nutritional intake and/or increased nutrient losses due to vomiting, diarrhea or blood loss[26].

Despite the fact that the literature describes a strict relationship between parasitic infections and iron deprivation anemia[26], we did not observe any difference in mean hemoglobin levels related to presence or absence of intestinal parasitosis in the children from the favela. Other authors have also failed to detect this relationship[24,25]. A series of factors determine the emergence of anemia in people with parasites, including the species of parasite and the parasite load, the duration of infection, the body's iron reserves and iron consumption, dietary iron bioavailability and physiological iron requirements[27].

The high prevalence rates of intestinal parasite infections that are still observed in Brazil can in part be explained by the high cost of improving infrastructure and basic sanitation. Furthermore, there is a need for educational programs to raise the population's awareness of basic personal hygiene and food hygiene procedures[28].

Children are more healthy, both physically and intellectually, after they have been treated for parasitic infections and/or iron deficiency anemia[26]. In this context, it is important to adopt preventative measures to reduce the frequency of infestations by intestinal parasites and of relapses; namely 1. drug treatment to reduce morbidity by reducing the parasitic load; 2. improvement of sanitary conditions in order to reduce transmission by controlling contamination via feces and/or contaminated water; 3. educational measures to encourage correct hygiene habits[3].

It is important to point out that one limitation of this study was the decision to select only children who had been free from diarrhea for the preceding 30 days, which could have led to a reduced prevalence of intestinal parasites. Another aspect that merits attention is the fact that very few private schoolchildren's families accepted the invitation to take part in the study, preventing sample selection by lots, which is how the favela group members were chosen. Despite these limitations, the results of this study add to the body of evidence showing that parasitic infections are

directly linked with questions of environmental and personal hygiene, and are related to socioeconomic and educational factors. In the favela group, anemia was identified in 15.5% of the schoolchildren tested and was unrelated to intestinal parasite infection. Finally, it is important to point out that the fight to control intestinal parasite infections is dependent on the successful implementation of public policies that, in addition to promoting economic growth, lead to better income distribution and access to good quality public health services.

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