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Association of intestinal helminthic infection and nutritional status of primary school children in Gombe State, Nigeria

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Abstract:

Background: Intestinal helminthic infections are among the commonest infections worldwide. It often affects the poorest communities and has similar geographic distribution with malnutrition. Intestinal helminthic infection contributes to undernutrition through subtle reduction in digestion and absorption of food, chronic inflammation and loss of nutrients. The objective of this study is to determine the prevalence of intestinal helminthic infection and its relationship with nutritional status of primary school children in Gombe, Gombe State, Nigeria.
Methodology: This was a cross sectional study of 350 pupils selected through multistage random sampling technique from 24 primary schools in Gombe, Gombe State, Nigeria from July 2018 to January 2019. Demographic information including age, gender, height, and weight were collected from each participant with a designed collection form. The data were analysed using SPSS version 24.0, and presented as frequency distribution and mean ± SD. The Chi-square test (with Odds ratio and 95% confidence interval) was used to test for association between prevalence of helminthiasis and factors such as gender, age group and school type. A p value of less than 0.05 was considered statistically significant at 95% confidence interval.
Results: The prevalence of intestinal helminthic infection was 23.7% (83/350). Eighty (96.4%) of the 83 infected pupils were in public schools while only 3 (3.6%) were in private schools (p<0.001). The prevalence of helminthiasis was significantly higher in underweight pupils (34%, OR=2.113, p=0.0065)) and significantly lower (5.4%, OR=0.1637, p=0.0037) in overweight pupils while the prevalence was not significantly associated with normal weight (p=0.5482) or obesity (p=1.000).
Conclusions: Intestinal helminthic infection is a public health problem in children with adverse significant relationship with nutritional status. Provision of toilet facilities in schools and periodic de-worming of pupils aimed at reducing loss of nutrients from intestinal helminthiasis are recommended.

Keywords: Intestinal helminths, school, pupils, nutritional status.

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Association de l'infection helminthique intestinale et de l'état nutritionnel des enfants de l'école primaire dans l'État de Gombe, au Nigeria

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Résumé:

Contexte: Les infections intestinales helminthiques sont parmi les infections les plus courantes dans le monde. Elle affecte souvent les communautés les plus pauvres et a une répartition géographique similaire à la malnutrition. L'infection helminthique intestinale contribue à la dénutrition par une réduction subtile de la digestion et de l'absorption des aliments, une inflammation chronique et une perte de nutriments. L'objectif de cette étude est de déterminer la prévalence de l'infection helminthique intestinale et sa relation avec l'état nutritionnel des enfants de l'école primaire à Gombe, dans l'État de Gombe, au Nigeria.

Méthodologie: Il s'agissait d'une étude transversale de 350 élèves sélectionnés par une technique d'échantillonnage aléatoire à plusieurs étapes dans 24 écoles primaires de Gombe, dans l'État de Gombe, au Nigéria, de juillet 2018 à janvier 2019. Des informations démographiques, notamment l'âge, le sexe, la taille et le poids, ont été recueillies auprès de chaque participant avec un formulaire de collecte conçu. Les données ont été analysées à l'aide de SPSS version 24.0, et présentées sous forme de distribution de fréquence et de moyenne ± ET. Le test du chi carré (avec rapport de cotes et intervalle de confiance à 95%) a été utilisé pour tester l'association entre la prévalence des helminthiases et des facteurs tels que le sexe, le groupe d'âge et le type d'école. Une valeur de p<0,05 a été considérée comme statistiquement significative à un intervalle de confiance de 95%.
Résultats: La prévalence des helminthiases intestinales était de 23,7% (83/350). Quatre-vingts (96,4%) des 83 élèves infectés étaient dans des écoles publiques alors que seulement 3 (3,6%) étaient dans des écoles privées (p<0,001). La prévalence des helminthiases était significativement plus élevée chez les élèves en insuffisance pondérale (34%, OR=2,113, p=0,0065)) et significativement plus faible (5,4%, OR=0,1637, p=0,0037) chez les élèves en surpoids, alors que la prévalence n'était pas significativement associée à un poids normal poids (p=0,5482) ou obésité (p=1,000).
Conclusion: L'infection intestinale helminthique est un problème de santé publique chez l'enfant ayant une relation défavorable significative avec l'état nutritionnel. La mise à disposition de toilettes dans les écoles et le déparasitage périodique des élèves visant à réduire la perte de nutriments due aux helminthiases intestinales sont recommandés.

Mots-clés: helminthes intestinaux, école, élèves, état nutritionnel.

Introduction:

Intestinal helminthiases are among the most common infections worldwide. It affects the poorest and most deprived communities (1, 2). The World Health Organization (WHO) estimates that over 1.5 billion people are infected with helminths worldwide (1). Over 270 million preschool-age children and over 600 million school-aged children live in areas where these helminths are intensively transmitted. The public health burden and prevalence of intestinal helminths in Nigeria are increasing, with 45% of school-age children infected annually (3,5,6). Globally, about 100 million children experience stunting or wasting because of worm infestation (7). Undernutrition remains the world most serious health challenge and the single biggest contributor to child mortality (7).

Intestinal helminthic infections contribute to child undernutrition through subtle reduction in digestion and absorption of food, chronic inflammation and loss of nutrient, thus resulting in decreased immunity and increased susceptibility to infections (2,8). In addition, intestinal helminths secrete toxic bioactive compounds within the small intestine of the host, which deplete nutrients and impair absorption, thereby playing an important role in childhood malnutrition (9,10).

The 2018 National Nutrition and Health Survey (NNHS) showed that Nigeria accounts for 36% of malnourished children worldwide. However, the prevalence of malnutrition in Gombe State, Nigeria was 44% (11). This burden is likely to be increasing due to the activities of the terrorist organization "*Boko Haram*" which has led to displacement of people from Borno and Yobe to other north-eastern States especially Gombe State, thereby increasing the population of Gombe, leading to water scarcity and increased rate of infections, especially helminthic infections. This might further worsen the nutritional status of children in Gombe. There is therefore the need to improve the nutritional status of children in this State which has prompted the conduct of this study.

Information on the prevalence of helminthiasis will be necessary to provide appropriate authorities on the need to implement periodic deworming of primary school pupils in Gombe, as this may improve the nutritional status of pupils, to enable them attain their full potentials as adults. The objective of this study therefore is to determine the prevalence of intestinal helminthiasis among primary school pupils in Gombe LGA of Gombe State in Nigeria and to establish its association with nutritional status of the pupils.

Materials and method:

Study area:

The study was conducted in Gombe local government area (LGA), Gombe, the capital of Gombe State, located in the north-east geopolitical zone of Nigeria. Gombe LGA has 11 wards with a projected population of 280,000. There are 150 registered primary schools, of which 33 are government-aided and 117 are privately owned. Gombe has two distinct weather conditions; dry season (November to March) and the rainy season (April to October) with an average rainfall of 850mm (12). The indigenous people are mainly traders, farmers, artisans and civil servants, and the staple food in the State includes rice, maize and guinea corn.

Study design and subject participants:

This was a descriptive cross-sectional study of primary school children in Gombe LGA.

All primary school children whose parents/guardians gave informed consent, and children 7 years and above who gave informed assent in addition to consent were eligible and recruited for the study. Children with history suggestive of chronic illnesses such as HIV, diabetes mellitus and sickle cell anaemia were excluded.

Sample size estimation and sampling procedure:

The sample size of 375 was determined using the Fischer formula (13). A multi-stage random sampling technique was used to select the pupils. In the first stage, from the list of the 11 wards in Gombe LGA, 6 wards were selected by simple random sampling with balloting without replacement. The schools in the selected ward were stratified based on ownership into public and private. Three private and 1 public school were selected in the second stage from each selected ward using simple random sampling by balloting, which gave a total of 24 schools from the 6 selected wards.

In the third stage, the number recruited from each school and class was determined by the proportionate sampling method. After determining the number to be recruited from each class, the class register was used as a sampling frame and the pupils were selected by using systematic sampling technique. The sampling interval was determined by dividing the total number of pupils in each class by the number of pupils selected from the class. Pupils who did not fulfil the inclusion criteria were omitted and the next pupil on the list was selected. Thereafter, the sampling interval was used for selection of subsequent study participants.

Ethical consideration

Ethical approval was obtained from the Federal Teaching Hospital Gombe Research and Ethical Committee (NHREC/25/10/2013). A written permission was sought from the Education Secretary, Gombe State Universal Basic Education Board (SUBEB) and the management of the selected schools. Informed consent was obtained from the parents/guardians and pupils 7 years and above gave assent. The study was at no cost to the participants and all participants received albendazole 400mg stat.

Data and sample collection:

The study was conducted over a period of 7 months (July 2018-January 2019). A pilot study was carried out using 10% of the targeted sample size (38 participants) in a school that was not involved in the main study. This allowed the researcher to pre-test the research tools. No major changes were however made to the research materials following the pre-test study. The questionnaires were filled by the study subjects and their parents/guardians, and each subject was then examined for presence/absence of pallor and oedema. The weight and height of each pupil were subsequently measured.

Measurement of weight, height and calculation of body mass index:

The weight of each pupil was measured using a calibrated standardized digital weighing scale (OMRON BF400), with the accuracy of the scale set to the nearest 0.5 kg, with average of two readings taken. The height was measured using a wooden stadiometer placed on a flat surface to the nearest 0.1 cm at the eye level of the examiner. The BMI was calculated using the formula; BMI (Kg/m^2)=weight (Kg)/height (m^2), and the WHO growth chart was used to interpret the BMI results; with BMI below the 5th percentile classified as underweight, 5th to less than 85th percentile as normal, 85th to less than 95th percentile as overweight, and 95th and above as obesity (14).

Stool sample collection:

Stool samples were collected into clean polythene bag using a spatula (in a well-formed stool) or a spoon (in diarrheal stool) from where a small piece of stool was transferred into a well-labelled universal container containing information on subject age, gender and code number. The samples were transported within one hour of collection to the Research/Teaching Microbiology Laboratory, Gombe State University in a cold box and examined within one hour of collection.

Direct wet mount microscopy:

Direct wet mount was used to examine diarrheal stools. Using an applicator stick, a pinhead size of stool sample was applied to a small area on a clean glass slide and gross fibres and particles were removed immediately. Two drops of saline were added with a pipette and mixed with the tip of the applicator stick specimen was then covered with a cover slip. The cover-slip(s) was sealed using paraffin oil to prevent the preparation from drying out.

The slide was examined under a low-power microscope objective (10x). When a parasite-like object came into view, it was then examined and identified under high power (40x) objective of the microscope for ova or larvae of parasite (13). A total of 10 fields were examined in each slide for 10 minutes before a slide was declared to be negative. The medical microbiologist and the lead author examined the slides and where there was a discordance, a laboratory scientist served as the tie-breaker.

Formol-ether concentration method:

About 3g of faeces were suspended in 10 ml of 10% formol-saline (formalin in saline) solution and mixed with a glass rod. The suspension was sieved (0.5mm mesh sieve) into a centrifuge tube. Then 3ml of ether was added and the mixture was shaken vigorously before centrifuging for 5 minutes at 3,000 rpm, after which the supernatant was discarded leaving the sediment. A drop of the sediment was placed on a glass slide and covered with a cover slip. A drop of iodine added to the side of the cover slip then the deposit examined using 10x and 40x objectives of the microscope for ova or larvae. In each slide, 10 fields were examined for 10 to 15 minutes (15).

Stoll method for counting ova of parasites:

Ova of parasites was counted using the method of Stoll and Hausheer (16). Forty-two millilitres of water were measured into a dish, then a tongue depressor was used to push 3g of faeces through a sieve into the water, then the sieve was lifted above the dish to allow remaining water from the faeces to drip while stirring the water-faeces mixture. The suspension of 0.15ml spread over two slides; each slide was then covered with a long cover slip. Both slides were examined for worm eggs, the total number of eggs counted X 100 represents the number of eggs per gram of faeces. Since 0.15 ml is 1/300 of 45ml (42ml water and 3g faeces), the number of eggs in 0.15ml x 100 is equal to 1/3 of the total number of eggs in the original 3g and thus equal to eggs per gram (EPG).

Data analysis

All data generated were processed and analysed using the IBM Statistical Package for Social Sciences (IBM SPSS) software version 24.0. The means and standard deviations of quantitative variables were calculated while Chi-square test (with Odds ratio and 95% confidence interval) was used to determine association of nutritional status of participants with prevalence of helminthiasis. A $p<0.05$ was considered statistically significant

Results:

Three hundred and seventy-five pupils aged 5-14 years from 24 primary schools were recruited for the study but data of only 350 pupils were used for analysis due to missing and incomplete data. The mean age of the pupils was 9.51±2.20 years, and the male to female ratio was 1 to 1.2. One hundred and forty-seven (42%) are from low socio-economic status, and most of the pupils (233, 66.6%) were from public schools while 117 (33.4%) were from private schools (Table 1).

Prevalence and types of intestinal helminths isolated among the pupils:

Out of the 350 pupils, 83 were infected with helminths, giving a prevalence of 23.7%. Pupils in public schools accounted for 96.4% of the infections. Out of the 83 helminths identified, the most frequent was *Ascaris lumbricoides* (22, 26.5%) while the least frequent was *Trichuris trichuria* (2, 0.6%). Multiple helminths were identified in 15 (18.1%) subjects (Fig 1).

Nutritional status of the participants in Gombe using BMI:

The mean weight of the subjects was 25.6±7.32kg and mean height of 130±11.56 cm. Two hundred and six (58.9%) pupils had normal weight, 100 (28.6%) were underweight, 37 (10.6%) overweight and 7 (2.0%) were obese (Fig 2).

BMI in relation to sociodemographic characteristics of the study subjects

Table 2 shows bivariate analysis of the association between sociodemographic characteristics and body mass index (BMI) of the pupils. There was no significant association of underweight, normal weight, overweight and obesity with age groups, gender, and socio-economic status of the pupils ($p>0.05$), except for pupil in the high socio-economic class who had significantly higher prevalence of overweight (17.1%) than pupils in the middle (12.4%) and low socio-economic class (5.4%) ($p=0.0167$). The was statistically significant association between school types and underweight (OR=0.3943, $p=0.0012$), and school type and overweight (OR = 4.367, $p<0.0001$) (Table 2).

Table 1: Sociodemographic characteristics of the study participants

Characteristics	Frequency (n = 350)	Percentages (%)
School ownership		
Public	233	66.5
Private	117	33.4
Age group (years)		
5 - 9	156	44.6
10 -14	194	55.4
Gender		
Male	164	46.9
Female	186	53.1
Ethnicity/tribe		
Fulani	143	40.9
Hausa	82	23.4
Tera	30	8.6
Others	95	27.1
Socio economic class		
High	82	23.8
Middle	121	34.6
Low	147	42.0
Family type		
Monogamous	189	54
Polygamous	161	46
Number in household		
< 6	99	28.3
≥ 6	251	71.7

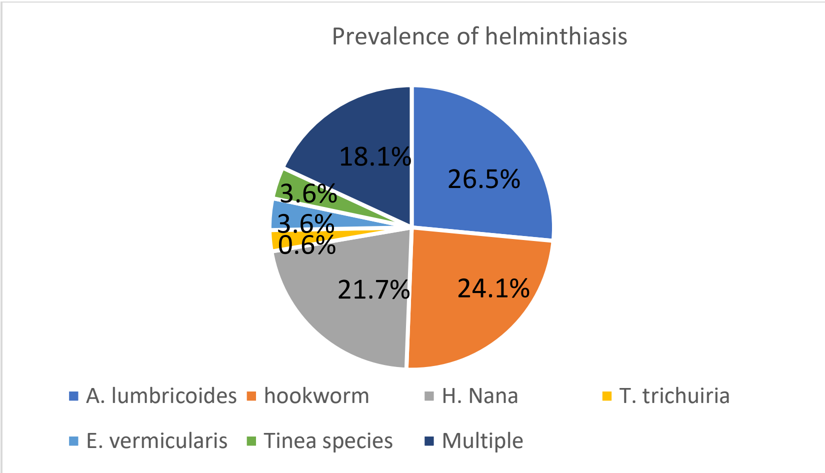

Fig 1: Pie chart showing prevalence and types of intestinal helminths isolated in the subjects

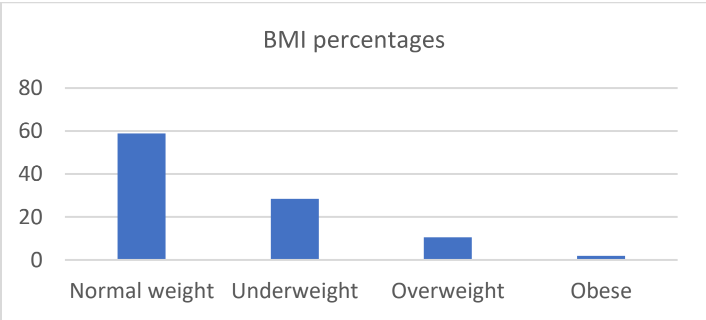

Fig 2: Bar chart showing BMI of the study subjects in percentages

Table 2: Bivariable analysis of sociodemographic characteristics in relation to body mass index of pupils in Gombe local government area, Gombe, Nigeria

Variable	Underweight	Normal weight	Over weight	Obese
Age group (years)				
5-9 years (n=156)	48 (30.8)	89 (57.1)	17 (10.9)	2 (1.3)
10-14 years (n=194)	52 (26.8)	117 (60.3)	20 (10.3)	5 (2.6)
x^2	0.4860	0.2564	$8.987E^{-06}$	0.2268
OR (95% CI)	1.214 (0.76-1.93)	0.8742 (0.57-1.34)	1.064 (0.54-2.11)	0.4909 (0.09-26)
P	0.4857	0.6126	0.9976	0.6339
Gender				
Male (n=164)	47 (28.7)	102 (62.2)	13 (7.9)	2 (1.2)
Female (n=186)	53 (28.5)	104 (55.9)	24 12.9)	5 (2.7)
x^2	0.001147	1.172	1.787	0.3562
OR (95% CI)	1.008 (0.63-1.61)	1.297 (0.85-1.99)	0.5811 (0.29-1.18)	0.4469 (0.09-0.23)
P	0.9730	0.2789	0.1813	0.5506
Socioeconomic class				
High (n=82)	18 (21.9)	47 (57.3)	14 (17.1)	3 (3.7)
Middle (n=121)	34 (28.1)	71 (58.7)	15 (12.4)	1 (0.8)
Low (n=147)	48 (32.7)	88 (59.9)	8 (5.4)	3 (2.0)
x^2	2.974	0.1435	8.184	2.002
p	0.2260	0.9308	0.0167*	0.3675
School type				
Private (n=117)	20 (17.1)	70 (59.8)	24 (20.5)	3 (2.6)
Public (n=233)	80 (34.3)	136 (58.4)	13 (5.6)	4 (1.7)
x^2	10.515	0.02152	16.827	0.01677
OR (95% CI)	0.3943 (0.23-0.69)	1.062 (0.68-1.67)	4.367 (2.13-8.95)	1.507 (0.33-0.69)
P	0.0012*	0.8834	<0.0001*	0.8790

*=statistically significant; OR-Odds ratio; CI-Confidence interval

BMI and adequacy of subject's diet:

Overweight was the only BMI category significantly associated with adequacy of 24-hour dietary intake, with inadequate dietary intake occurring significantly less frequently (24. 3%) among overweight pupils (OR=0.2959, *p*= 0.0025) while there was no significant association of dietary intake with other BMI categories (Table 3).

Association of intestinal helminthic infection and nutritional status of pupils:

The prevalence of helminthiasis was significantly higher (OR=2.113, *p*=0.0065) among underweight pupils (34%) and significantly lower (OR=0.1637, *p*=0.0037) among overweight pupils (5.4%) while the prevalence was not significantly associated with normal weight (*p*= 0.5482) or obesity (*p*=1.000) (Table 4).

Table 3: Bivariate analysis of the relationship of BMI with adequacy of typical 24-hour diet of pupils in Gombe local government area, Gombe, Nigeria

Variable	Inadequate diet n (%)	Adequate diet n (%)	x^2	OR (95% CI)	*p* value
Underweight	55 (55.0)	45 (45.0)	1.608	1.389 (0.8719-2.214)	0.2048
Normal weight	105 (51.0)	101 (49.0)	0.5035	1.195 (0.7799-1.830)	0.4780
Overweight	9 (24.3)	28 (75.7)	9.117	0.2958 (0.13-0.65)	0.0025*
Obese	3 (49.4)	4 (57.1)	0.1129	0.7722 (0.17-3.50)	0.7368
Total	**172 (49.1)**	**178 (50.9)**			

*=statistically significant; OR=Odds ratio; CI=confidence interval; x^2=Chi-square

Table 4: Bivariate analysis of the relationship between intestinal helminths and nutritional status of primary school pupils in Gombe local government area, Gombe, Nigeria

Variable	Infected n (%)	Uninfected n (%)	x^2	OR (95% CI)	*p* value
Underweight	34 (34.0)	66 (66.0)	7.411	2.113 (1.26-3.55)	0.0065*
Normal weight	46 (22.3)	160 (45.7)	0.3606	0.8314 (0.51-1.37)	0.5482
Over weight	2 (5.4)	35 (94.6)	6.577	0.1637 (0.04-0.69)	0.0037*
Obese	1 (14.3)	6 (85.7)	0.02063	0.5305 (0.06-4.47)	1.000
Total	**83 (23.7)**	**267 (76.3)**			

* Significant P value; OR=Odds ratio; CI=confidence interval; x^2=Chi-square

Discussion:

The prevalence of 23.7% for intestinal helminthic infections in primary school children in this study is high and similar to the reports by some researchers (17,18). Body mass index was used for nutritional assessment and underweight was used as a composite indicator to reflect both acute and chronic undernutrition in this study. Pupils with helminthiasis had lower BMI compared to those without helminthiasis, with 34.0% of the underweight pupils being infected while only 5.4% of overweight pupils had infection. This is similar to report by Oninla et al., (19) among infected and uninfected primary school pupils in Osun State, southwest Nigeria. Similar report was also documented from Calabar, south-east Nigeria where Meremikwu et al., (20) reported that greater proportion of underweight, stunted and wasted children had intestinal helminth infection compared to their well-nourished counterparts. Okolo et al., (21) in Vom, Plateau State and Quihui-Cota et al., (22) in Mexico have also reported high prevalence of intestinal helminths among undernourished children.

In contrast to the findings of the current study, Ojurongbe et al., (23) in Ile-Ife and Ajayi et al., (24) in Lagos reported no significant difference in the nutritional status of infected and uninfected primary school children, although the mean weight and BMI of the infected children was lower than uninfected children. The sample size used in the study by Ojurongbe et al., (23) was small and the methodology adopted in arriving at the sample size was not stated. This may have affected the statistical power of their study resulting in false negative findings or type II error. It was difficult to give plausible explanation to the findings by Ajayi et al., (24) as stated by the authors themselves. This was because the findings of the study by Ajayi et al., (24) contrasted many studies and contradicted the theory that proved the known relationship between intestinal helminth and nutrition.

The prevalence of both undernutrition and helminthic infections were significantly higher in pupils from public schools. This is because majority of the pupils were from low socioeconomic families and all the public schools had poor sanitary/toilet facilities, which could lead to contamination of the environment and therefore increasing the risk of helminthic infection. This is similar to the reports by Ogwurike et al., (25) and Obiukwu et al., (26). Undernutrition has been shown to increase susceptibility to helminthic infections, which in turn impair the nutritional status of the host (27). Geographical clustering of helminthic infections, malnutrition and poverty has also been demonstrated similar to the finding of current study (28).

Conclusion:

The prevalence of intestinal helminthic infection among primary school children aged 5-14 years in Gombe LGA, Gombe State, Nigeria in our study was 23.7%, and majority of the infections were in children from public schools who belonged to low socioeconomic class. Under nutrition was significantly associated with intestinal helminthic infection in the pupils especially those in public schools. Therefore, provision of toilet facilities and clean water with regular provision of free antihelminth medications especially in public schools are recommended.

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Contributions of authors:

HBB conceived the study idea and design, led the data collection, conducted analysis, drafted and critically reviewed and revised the manuscript; RA contributed to the study design, manuscript draft, critical review and revision of the manuscript; MMM contributed to the study design, critical review and revision of the manuscript; WSB and UAS contributed to analysis, critical review and revision of the manuscript.

Conflict of interest:

No conflict of interest is declared

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