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Original Article

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Prevalence and associated risk factors of gasrointestinal parasitic infections among school-aged children in urban and rural health districts of Bamenda, North West region of Cameroon

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Abstract

Introduction: This study was conducted in two health districts of Bamenda: Ntambag representing the urban setting and Santa representing the rural area. Gastrointestinal parasitic infections remain a major public health concern in sub-Saharan Africa, particularly among school-aged children. They contribute to malnutrition, impaired cognitive development, and reduced academic performance. Intestinal parasitic infections remain a significant public health concern among school-aged children in Cameroon. Although several studies have been conducted in different regions of the country, recent comparative data on the prevalence and risk factors of these infections in both urban and rural settings of Bamenda are scarce. The aim of this study was to investigate the prevalence, and associated risk factors of gastrointestinal parasitic infections among school-aged children in four schools in Bamenda Urban and Rural Health Districts.

Materials and methods: A cross-sectional study was conducted from March to May 2025 among 181 school-aged children (5–15 years) selected by stratified random sampling from four schools in Ntambag (urban) and Santa (rural) health districts of Bamenda. Data on sociodemographic, hygiene, and environmental factors were collected using a structured questionnaire, and stool samples were examined microscopically using the formol-ether concentration technique. Associations between infection and risk factors were analyzed using Chi-square tests, with $p < 0.05$ considered statistically significant.

Results: Out of 181 stool samples examined, 46 (25.4%) were positive for at least one gastrointestinal parasite. Protozoan infections predominated (35/46;
intestinal. Les infections à protozoaires prédominaient (35/46 ; 76,1 %) par 76.1%) compared with helminthic infections (11/46; 23.9%). The most common species identified were *"Entamoeba histolytica (13/46; 28.2%), Entamoeba coli (11/46; 23.9%), and Blastocystis hominis"*. (7/46; 15.2%). Infections were significantly higher in rural areas (27.5%) than in urban settings (23.3%; $p < 0.05$), and were due to factors such as lack of proper sanitation, poor handwashing habits, and walking barefoot. Infection rates were significantly associated with risk factors such as hygiene practices, toilet type, pet ownership, and water source ($p < 0.0001$).

Conclusion: Gastrointestinal parasitic infections remain common among school-aged children in Bamenda, with protozoa predominating over helminths. The higher prevalence in rural settings reflects the influence of poor sanitation and hygiene practices. Strengthened school-based health education, regular deworming, and improved water and sanitation facilities are recommended to further reduce infection rates.

Keywords: gastrointestinal parasites, prevalence, risk factors, school-aged children, Bamenda, Cameroon, rural, urban

Résumé

Prévalence et facteurs de risque associés aux infections parasitaires gastro-intestinales chez les enfants d'âge scolaire dans les districts de santé urbains et ruraux de Bamenda, région du Nord-Ouest du Cameroun

Introduction: Cette étude a été menée dans deux districts de santé de Bamenda: Ntambag, représentant la zone urbaine, et Santa, représentant la zone rurale. Les infections parasitaires gastro-intestinales demeurent un problème majeur de santé publique en Afrique subsaharienne, en particulier chez les enfants d'âge scolaire, car elles contribuent à la malnutrition, à la baisse du développement cognitif et à de faibles performances scolaires. Bien que plusieurs études aient été réalisées dans différentes régions du Cameroun, les données récentes comparant la prévalence et les facteurs de risque de ces infections dans les zones urbaines et rurales de Bamenda restent rares. Cette étude visait donc à évaluer la prévalence et les facteurs de risque associés aux infections parasitaires gastro-intestinales chez les enfants d'âge scolaire de quatre écoles sélectionnées dans les districts de santé urbains et ruraux de Bamenda.

Matériels et méthodes: Une étude transversale a été menée de mars à mai 2025 auprès de 181 enfants d'âge scolaire (5–15 ans) sélectionnés par échantillonnage aléatoire stratifié dans quatre écoles situées à Ntambag (urbain) et à Santa (rural). Les données sociodémographiques, hygiéniques et environnementales ont été recueillies à l'aide d'un questionnaire structuré, et les échantillons de selles ont été examinés microscopiquement selon la technique de concentration au formol-éther. Les associations entre l'infection et les facteurs de risque potentiels ont été analysées à l'aide du test du Chi carré (χ^2), avec un seuil de signification fixé à $p < 0,05$.

Résultats: Sur les 181 échantillons de selles examinés, 46 (25,4 %) étaient positifs pour au moins un parasite gastro-
rapport aux infections helminthiques (11/46 ; 23,9 %). Les principales espèces identifiées étaient *Entamoeba histolytic*a (13/46 ; 28,2 %), *Entamoeba coli* (11/46 ; 23,9 %) et *Blastocystis hominis* (7/46 ; 15,2 %). La prévalence était légèrement plus élevée en zone rurale (27,5 %) qu'en zone urbaine (23,3 %), et les infections étaient significativement associées à une mauvaise hygiène, l'absence d'assainissement adéquat, la possession d'animaux domestiques et l'utilisation d'eau non potable ($p < 0,0001$).

Conclusion: Les infections parasitaires gastro-intestinales demeurent fréquentes chez les enfants d'âge scolaire à Bamenda, avec une prédominance des protozoaires sur les helminthes. La plus forte prévalence observée en milieu rural reflète l'influence des conditions d'hygiène et d'assainissement insuffisantes. Le renforcement de l'éducation sanitaire en milieu scolaire, la vermifugation régulière et l'amélioration des infrastructures d'eau et d'assainissement sont recommandés pour réduire davantage les taux d'infection.

Mots clés: parasites gastro-intestinaux, prévalence, facteurs de risque, enfants d'âge scolaire, Bamenda, Cameroun, rural, urbain

What is known on this topic

- Gastrointestinal parasitic infections are common in sub-Saharan Africa and disproportionately affect school-aged children.
- They contribute to malnutrition, anemia, poor cognitive development, and reduced school performance.
- Periodic deworming campaigns have been implemented as a preventive measure in many endemic regions.

What this study adds

- The study provides updated prevalence data of gastrointestinal parasites in Bamenda, Cameroon, showing protozoa are now more prevalent than helminths.
- It identifies key sociodemographic and environmental risk factors, including parental education, water source, and sanitation type.
- It underscores the urgent need for integrated control strategies that go beyond mass deworming to include hygiene education and sanitation improvements.

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1 | INTRODUCTION

Gastrointestinal parasites (GIPs) are microorganisms that colonize the human intestine, with some causing disease while others remain asymptomatic [1]. Intestinal parasitic infections (IPIs) represent a significant global public health concern, disproportionately affecting children in low- and middle-income countries [2]. These infections, caused by protozoa and helminths, contribute to malnutrition, anemia, stunted growth, impaired cognitive development, and poor academic performance [2]. Although distributed worldwide, they are most prevalent in tropical and subtropical regions, particularly in rural areas with poor sanitation and limited access to clean water [3].

The World Health Organization (WHO) recommends periodic deworming of school-aged children in endemic regions as a preventive measure [4]. Intestinal parasitic infections are among the most neglected tropical diseases, accounting for more than 3.5 billion infections globally and significant morbidity in approximately 450 million people [5]. Gastrointestinal parasites (GIPs) are broadly classified into protozoans, such as "*Entamoeba histolytica, Giardia duodenalis*, and *Balantidium coli*, and helminths, such as *Ascaris lumbricoides, Trichuris trichiura,* and *Necator americanus*" [1]. These parasites thrive in environments characterized by warm temperatures, high humidity, poor sanitation, contaminated water, and overcrowded housing [1]. Globally, over 1.5 billion people are infected with soil-transmitted helminths (STHs), including *"Ascaris lumbricoides, Trichuris trichiura"*, and hookworms [6]. Each year, more than 267 million preschool-aged children and 568 million school-aged children require preventive chemotherapy [6]. In sub-Saharan Africa, intestinal parasites affect up to 50% of the population in some regions [7]. Protozoal infections such as *Giardia lamblia, E. histolytica*, and Cryptosporidium are common in developing countries, while in industrialized nations protozoal are more prevalent than helminthic infections [7].

In Cameroon, intestinal parasitic infections remain endemic, with regional prevalence rates among school-aged children ranging from 25% to 75%, depending on geographical location and environ - mental conditions [12,13]. Rural commun -ities are disproportionately affected due to inadequate sanitation and limited access to healthcare services [13]. A 2018 study by Sama et al. in the Northwest Region of

Cameroon reported a higher prevalence (35.6%) of intestinal parasitic infections among school-aged children compared to the 25.4% observed in the present study. This variation may be attributed to differences in study period, environmental sanitation, and the intensity of ongoing deworming and hygiene education programmes in Bamenda [13]. *Common helminths* included *"Ascaris lumbricoides, Trichuris trichiura,* and hookworms, while *Giardia lamblia"* being the most frequently detected protozoan [14].

This study was designed to determine the prevalence and associated risk factors of gastrointestinal parasitic infections among school-aged children in two health districts of Bamenda: Ntambag representing the urban setting and Santa representing the rural area. Findings are expected to contribute to the existing body of knowledge on the epidemiology of intestinal parasites in Cameroon and provide evidence for school- and community-based control interventions.

2 | MATERIALS AND METHODS

Study design and setting

This was a cross-sectional descriptive study carried out from March to May 2025 among school-aged children in Bamenda.

Study population and sampling

The study population comprised school-aged children (5–15 years) enrolled in primary schools within Bamenda. Four schools were purposively selected to represent the two health districts: Ntambag (urban) and Santa (rural). In each district, two schools were randomly chosen from the list provided by the District Education. The total sample size of 181 pupils was obtained using Cochran's formula, assuming an expected prevalence of 13%, a 95% confidence level, and a 5% margin of error [22].

$n = (Z^2 \times p (1 - p)) / d^2$

where:

n = required sample size

Z = standard normal deviate corresponding to a 95% confidence level (1.96)

p = expected prevalence of gastrointestinal parasitic infections (0.13) based on a previous study in the Northwest Region

d = desired margin of error (0.05)

Substituting the values:

$n = (1.96)^2 \times 0.13 \times (1 - 0.13) / (0.05)^2 = 174.3$

Adjusting for a 5% non-response rate, the final sample size was:

$174.3 + (0.05 \times 174.3)$ 181.0

Therefore, 181 participants were included in the study.

Within each school, participants were selected by stratified random sampling, with strata defined by class levels. Class registers were used as sampling frames, and pupils were selected proportionally to class size. Only children whose parents or guardians provided written consent and who were present during data collection were included in the study

Data collection

After obtaining informed consent, a structured closed-ended questionnaire adapted from Ebai et al was administered to collect information on sociodemographic characteristics, hygiene practices, water sources, sanitation facilities, and health-related behaviors [22]. Each participant was then provided with a clean, dry, and leak-proof container labeled with a unique identification number for stool collection and participants were told how to collect this sample.

Macroscopic examination: Each stool sample was first examined visually to assess consistency (formed, semi-formed, or loose), color, and presence of mucus, blood, or visible worms.

Microscopic examination: Stool specimens were examined using two complementary techniques the direct wet mount and the formol-ether concentration technique as described in standard parasitology manuals (WHO, 2010).

Direct wet mount examination

Approximately 0.25 g of stool (about a matchstick-head portion) was taken using a sterile applicator stick and emulsified in a drop of normal saline on a clean glass slide and examined under x10 and 40x objectives. The quantity of stool was visually approximated using a standard parasitology scoop, corresponding to about one-quarter gram, as described in WHO (2010) guidelines for stool microscopy. A second preparation was stained with Lugol's iodine to enhance identification of cysts and trophozoites [23].

Formol-ether concentration technique

For concentration, 1–1.5 g of stool was emulsified in 10 mL of 10% buffered formalin in a screw-cap tube. The suspension was strained through a double layer of sterile gauze into another tube to remove large debris and undigested food particles. 3mL of ether were then added, and the tube was tightly stoppered and shaken vigorously for about 30 seconds. The mixture was centrifuged at 3000 rpm for 3 minutes, after which four layers were observed: Top ether layer (containing fat and debris), second layer Plug of debris (just below the ether), Formalin layer, and Sediment (containing concentrated parasitic elements).

The top three layers were gently decanted, and the sediment was examined microscopically under 10× and 40× objectives for helminth eggs, larvae, and protozoan cysts.

Parasite detection was qualitative rather than quantitative; therefore, results were recorded as either positive or negative for the presence of any parasite species. Identified organisms were recorded according to morphological features and classified into protozoa or helminths.

Quality control

To ensure diagnostic accuracy, known positive stool samples containing identifiable cysts and ova were processed in parallel with test samples at the beginning of each session. In addition, negative samples were re-examined by a second qualified microscopist to confirm results and minimize observer bias.

Statistical analysis

Data from questionnaires and laboratory results were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 22.0.

Descriptive statistics such as frequencies and percentages were used to summarize sociodemographic variables, hygiene practices, and prevalence of intestinal parasitic infections.

Associations between infection status (positive or negative) and potential risk factors (such as water source, handwashing habit, and type of toilet facility) were tested using the Chi-square (χ^2) test. Variables with p-values < 0.05 were considered statistically significant.

Ethical Considerations

Ethical clearance was obtained from the Institutional Review Board of the Catholic University of Cameroon (Ref: 067/CATUC-IRB/WFM/LKN/25). Authorization was also granted by school administrations and local health authorities. Participation was voluntary, confidentiality was maintained, and children found positive for parasites were referred for treatment.

3 | RESULT

Sociodemographic Characteristics and Infection

Table I below shows the association of socio-demographic characteristics with gastro-intestinal parasites. It's evident that, the various factors such as age group, gender, residence, family size and parental educational level is highly associated with gastro-intestinal parasites ($p < 0.001$). The findings indicated that parasitic infections were more prevalent among females, with 60.9% (28/46) affected, compared to 39.1% (18/46) of males.

General prevalence of gastrointestinal parasites

Out of 181 stool samples examined, 46 were positive for gastrointestinal parasites, giving an overall prevalence of 25.4% (Table II).

Environmental and behavioral factors such as access to clean drinking water, frequency of handwash before meal, walking bare feted regularly by child etc as seen below were significantly associated with infection ($p < 0.0001$) (Table III)

Prevalence of single and mixed infections

Most infected children (91.3%) had single-species infections, while 8.7% had co-infections (Figure 1) .

Prevalence of specific parasites

The most frequently identified parasite was Entamoeba histolytica (28.2%), followed by *E. coli* (23.9%), *Blastocystis hominis* (15.2%), *Giardia lamblia* (13.0%), *Ascaris lumbricoides* (10.9%), and *Taenia saginata* (8.7%) (Figure 2).

Table I: Association between sociodemographicfactors and gastrointestinal parasitic infections

Sociodemographic characteristics	Intestinal parasites (N=181)			X^2	P- Value
	Positive (%)	Negative (%)	Total n (%)		
Age groups (years)					
0-4	0 (0)	0 (0)	0 (0)	67.5	<0.0001
5-10	15 (32.6)	47 (34.8)	62 (34.3)		
11-15	31 (67.4)	88 (65.2)	119 (65.7)		
Gender					
Female	28 (60.9)	83 (61.5)	111 (61.3)	31.4	<0.0001
Male	18 (39.1)	52 (38.5)	70 (38.7)		
Residence					
Urban	21(45.6)	69 (51.1)	90 (49.7)	31.4	<0.0001
Rural	25 (54.4)	66 (48.9)	91 (50.3)		
Family size					
1 -3	11 (23.9)	17 (12.6)	28 (15.5)	67.5	<0.0001
4 -6	17 (36.9)	68 (50.4)	85 (46.9)		
> 6	18 (39.2)	50 (37.0)	68 (37.6)		
Parental educational level					
Non formal	9 (19.6)	13 (9.6)	22 (12.2)	67.5	<0.0001
Primary	17 (36.9)	24 (17.8)	41 (22.7)		
Secondary	15 (32.6)	62 (45.9)	77 (42.5)		
Tertiary	5 (10.9)	36 (26.7)	41 (22.7)		

N= Study population, n= frequency, %= Percentage, X^2= Chi square, p -value=Level of significance

Table II: General prevalence of gastrointestinal parasites among study participants

Stool results	Frequency	Percentage (%)
Negative	135	74.6
Positive	46	25.4
Total	**181**	**100**

Table III. Association between selected risk icfactors and gastrointestinal parasitic infections

Risk factors	Intestinal parasites			X^2	P- Value
	Positive n (%)	Negative n (%)	Total n (%)		
Access to clean drinking water					
Yes	41 (89.1)	133 (98.5)	174 (96.1)	31.4	< 0.0001
No	5 (10.9)	2 (1.5)	7 (3.9)		
Primary source of drinking water					
	0 (0)	4 (2.9)	4 (2.2)	43.8	< 0.0001
Borehole	3 (6.5)	8 (5.9)	11 (6.1)		
Spring	43 (93.5)	123 (91.2)	166 (91.7)		
Tap					
Frequency of handwash before meal	4 (8.7)	38 (28.1)	42 (23.2)	43.7	< 0.0001
Always	40 (86.9)	94 (69.6)	134 (74.0)		
Sometimes	2 (4.4)	3 (2.2)	5 (2.8)		
Rarely					
Walk bare footed regularly by child Yes	13 (28.3)	94 (69.6)	107 (59.1)	9.4	< 0.0001
No	33 (71.7)	41 (30.4)	74 (40.9)		
Symptoms recently experienced by child	12 (26.1)	40 (29.6)	52 (28.7)	101.8	< 0.0001
Abdominal pain	4 (8.9)	17 (12.6)	21 (11.6)		
Fatigue					
Diarrhea	12 (26.1)	33 (24.4)	45 (24.8)		
Vomiting	12 (26.1)	45 (33.3)	57 (31.5)		
Loss of appetite					
Dewormchild	29 (63.0)	80 (59.3)	109 (60.2)	28.8	< 0.0001
Yes	17 (37,0)	55 (40.7)	72 (39.3)		
No					
Gastrointestinal parasite history	10 (21.7)	56 (41.5)	66 (36.5)	31.4	< 0.0001
Yes	36 (78.3)	79 (58.5)	115 (63.5)		
No					
Pets at home	14 (30.4)	77 (57.0)	91 (50.3)	31.4	< 0.0001
No	32 (69.6)	58 (43.0)	90 (49.7)		
Yes					
Toilet type available in child's school	4 (8.7)	36 (26.7)	40 (22.1)	43.7	< 0.0001
Pit	42 (91.3)	99 (73.3)	141 (77.9)		

N= Study population, n= frequency, %= Percentage, X^2= Chi square, p -value=Level of significance

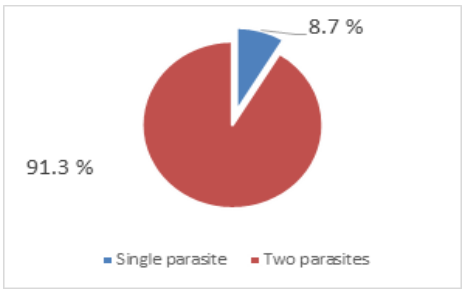

Figure 1. Distribution of single vs. Mixed infections (Single infections: 91.3% (42/46); Co-infections: 8.7% (4/46)

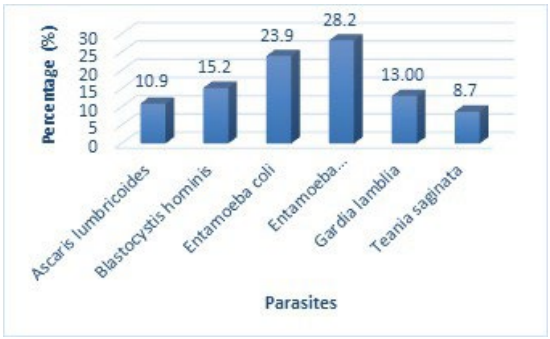

Figure 2. Specific prevalence of gastrointestinal parasites (n=46 positive cases)

4 DISCUSSION

This study revealed a prevalence of 25.4% for gastrointestinal parasitic infections among school-aged children in Bamenda. The observed prevalence is lower than findings reported in Ethiopia (43.5%) [24] and Nigeria (35.6%) [25], but comparable to recent studies in Cameroon which reported rates between 23% and 30% [26,27]. The relatively lower prevalence observed may reflect the impact of ongoing regular deworming campaigns using albendazole and mebendazole significantly reducing the worm burden in communities, thereby lowering the overall prevalence of helminth infections. Improved health awareness programs in the study area; In recent years, the Ministry of Public Health in Cameroon, in collaboration with partners such as the World Health Organization, has implemented mass drug administration (MDA) programs targeting school-aged children and at-risk populations. In addition, health education and awareness programs focusing on hygiene and sanitation have been strengthened, especially in schools and community health centers. Campaigns promoting handwashing, safe disposal of faeces, proper washing of fruits and vegetables, and consistent use of footwear have likely contributed to breaking the cycle of transmission of soil-transmitted helminths.

Urban areas of Bamenda, in particular, benefit

Risk factors

from better access to healthcare services, improved water supply, and sanitation infrastructure compared to rural areas, which may partly explain the lower prevalence recorded.The growing involvement of non-governmental organizations in community sensitization has also raised awareness of the risks associated with poor hygiene and the consumption of contaminated food and water.

Furthermore, the increasing availability of antiparasitic drugs in pharmacies and health facilities, coupled with improved healthcare-seeking behavior among residents, may have contributed to early treatment and reduced parasite carriage in the population.

Taken together, these interventions suggest that sustained public health measures particularly regular deworming and community-based health education are having a measurable impact on reducing the prevalence of gastrointestinal parasitic infections in Bamenda. However, continuous monitoring is necessary to maintain these gains and address residual transmission in high-risk groups.

Protozoan infections were more common than helminthic infections, with *Entamoeba histolytica* being the predominant parasite. This is consistent with reports from Yaoundé [28] and Kenya [29], where protozoa were found to be the major intestinal pathogens. The low prevalence of soil-transmitted helminths in this study may be attributed to periodic mass drug administration with albendazole or mebendazole, as recommended by the World Health Organization [4].Intestinal Parasitic Infections among School Children in Bamenda

Sociodemographic factors such as age, parental education, and family size showed significant associations with infection. Children aged 11–15 years were more affected, a finding similar to studies in Nigeria and Ghana [25,30]. Larger family size was linked with higher prevalence, probably due to overcrowding and shared sanitation facilities. Moreover, low parental education has consistently been associated with poor hygiene practices and increased risk of parasitic infections [31].

Environmental and behavioral factors also played an important role. Children from rural areas, those who walked barefoot, consumed untreated water, or had pets at home were more likely to be infected. These risk factors mirror findings from other African studies [24,32], underscoring the importance of water, sanitation, and hygiene (WASH) interventions.

The findings suggest that while deworming campaigns are beneficial, they may not be sufficient in the absence of improved sanitation and hygiene education. Integrated approaches, including health education, provision of safe water, and better waste disposal systems, are essential to break the cycle of transmission.

This study had some limitations. First, only direct wet mount and formol-ether concentration methods were used; more sensitive molecular techniques such as PCR were not available, which may have underestimated the true prevalence. Second, the cross-sectional design does not allow causal inferences. Lastly, the study was limited to two districts, and findings may not be generalizable to the entire region.

5 | CONCLUSION

This study demonstrates that gastrointestinal parasitic infections remain a significant public health problem among school-aged children in Bamenda, with an overall prevalence of 25.4%. Protozoa were more frequently detected than helminths, with *Entamoeba histolytica* being the most common parasite. Infection was significantly associated with sociodemographic, environmental, and behavioral risk factors such as parental education, family size, water source, hygiene practices, and rural residence.

These findings highlight the need for integrated interventions combining periodic deworming, hygiene education, provision of safe water, and improved sanitation. Strengthening community awareness and targeting high-risk groups, especially in rural areas, are crucial steps toward reducing the burden of gastrointestinal parasitic infections

► Abbreviations

GIPIs: Gastrointestinal parasitic infections
IPIs: Intestinal parasitic infections
WHO: World Health Organization.
STHs: Soil-transmitted helminths
WASH: Water, Sanitation, and Hygiene

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► Author contributions

1. Ndeyenou Shousgha Sylvie: Conceptualization, data collection, laboratory analysis, and drafting of the manuscript.
2. Seba Francis: Study supervision, critical review, and final approval of the manuscript.

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► Conflict of interest

The authors declare no conflict of interest.

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