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ORIGINAL RESEARCH

A 10-Year Trend Analysis of Intestinal Parasitic Infections at Grarigy Health Center, Northwest Ethiopia: Implication for Epidemic Preparedness

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Background: Intestinal parasitic infections (IPI) are one of the most significant health issues around the world. Their burden is significant in Ethiopia with an estimated five million cases reported annually. This study aimed to evaluate the 10-year trend of IPIs at the Grarigy Health Center in northwest Ethiopia.

Methods: A retrospective analysis was done at Grarigy Health Center to determine the 10-year (2011–2020) trend of IPIs by reviewing stool examination reports from a laboratory logbook. The data was collected by laboratory personnel using data extraction sheets. Then, entered into EpiData, cleaned and analyzed using SPSS-20 software. The chi-square test was used to test for significant differences between variables.

Results: A total of 9541 stool samples were examined over a 10-year period, of which, 5599 (58.7%) were from male participants and 3942 (41.3%) were from female participants. Participants in the study had an average age of 26.11 years. Infection with intestinal parasites was seen in 58.8% of people (n = 5612) (CI: 57.8–59.8). A significant fluctuating pattern of IPIs was observed from 2011 to 2020 ($P < 0.05$). The highest peak of IPIs was recorded in 2020 (61.9%; 767 cases) and the lowest peak was observed in 2011 (49%; 99 cases). A total of 10 different genera of intestinal parasites were reported, of which, *A. lumbricoides* was the predominant (23.5%) followed by *E. histolytica/dispar* (16.6%). The highest cases of all intestinal parasites were reported between the ages of 5 and 14 years except *H. nana* (highest case reported in < 5 years).

Conclusion: Prevalence of IPIs is substantial at the Grarigy Health Centre. A fluctuating trend was noticed in the past 10 years. A surveillance system should be in place to bring the burden of IPI down to a level where it has no public health effect.

Keywords: intestinal parasite infection, trend analysis, Grarigy Health Center, Ethiopia, IPI

Introduction

Intestinal parasitic infections (IPI) are a set of illnesses brought by one or more species of protozoa, cestode, trematode or nematode. In order to thrive, parasites live inside their hosts. Some barely have an impact on their hosts. Others spread, proliferate, or infiltrate organ systems, making their hosts ill and infecting them with parasites.[1] They have an oral-faecal and direct skin penetration mode of transmission among people, and a direct life cycle. Parasitic infections are among the most prevalent and ignored tropical infectious diseases in the world, with long-lasting repercussions on humanity.[2] About 450 million schoolchildren are infected due to IPIs in sub-Saharan Africa, where Ethiopia is second only to Nigeria in prevalence.[3] According to the WHO report; there were around 4300 deaths of ascariasis, 45,000 deaths of hookworm infection, and 54,000 deaths of amoebiasis each year globally. Multiple infections with hookworm, roundworm, and amoeba are also common and their serious effect is aggravated by lack of micronutrient.[4,5]

Similar to this, 200–500 million people in sub-Saharan African nations are afflicted by at least one type of these intestinal parasites.[6] Amoebiasis, giardiasis, ascariasis, hookworm infection, and *trichuriasis* are among the most prevalent parasitic infections in Ethiopia.[7] The Ethiopian Ministry of Health reported that both urban and rural areas have high rates of various illnesses and a prevalence of IPIs of up to 70%.[8,9]

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Although parasitic infections can be avoided, they are widespread in areas with low socioeconomic level and tropical climates.[10,11] Overcrowding, poor sanitation, contaminated food and water, under-nutrition, reduced immunity, lack of awareness, and other aspects of poverty are strongly linked to morbidity and mortality from IPIs.[12] In addition to morbidity and mortality, IPI's have serious negative effect on public health including nutritional deficiencies (vitamin A, vitamin B_{12}, iron, copper, magnesium and zinc), weight loss, growth retardation, chronic blood loss, general health and performance (productivity), and psychological and social well-being.[13–15] Moreover, IPIs make people more susceptible to Human Immunodeficiency Virus (HIV), and other infectious disorders.[2,16]

Ethiopia has conducted schistosomiasis and soil transmitted helminth (STH) nationwide mapping surveys from 2013–2015 in all regions of the country. These coordinated, large-scale maps showed that 741 districts are known to be endemic for schistosomiasis and STH. About 476 districts need treatment against STH. Furthermore, 279 districts need treatment twice a year. According to estimates, 37.3 million people lived in areas where schistosomiasis was prevalent and 79 million people did so in places where STH was endemic.[8]

There are only a few institutional-based studies on the prevalence and trend analysis of intestinal parasites in Ethiopia, despite the fact that the disease is extremely common and causes numerous unrecognized health issues. The goal of the current study is to evaluate the 10-year trend of IPI prevalence. Taking these findings into account, stakeholders may prioritize the prevention and control of IPIs through the district's health sector's budget allocation and effective resource mobilization.

Methods and Materials

Study Area

The investigation was carried out at the Grarigy Health Centre in the northwest Ethiopian province of Dembia. Dembia District is located 747 kilometers North of Addis Ababa (the capital city of Ethiopia) and 28 kilometers to the west of the historic city of Gondar.[17] Grarigy town is one of the small towns in Dembia District in Central Gondar. The town has approximately a total population of about 28,471. Among these 14,179 are males and 14,292 are females (Source: Dembia Health Bureau Personal Communication). The majority of the population works in mixed agriculture, farming maize, teff, and wheat, and they live in rural communities where adequate safe drinking water, good hygienic conditions, and proper waste disposal system are unavailable. The health centre has seven nurses, three midwives, two laboratory professionals, two health officers, and 12 health extension workers rendering service to the surrounding inhabitants, and one government primary hospital providing service to the population of the catchment.

Study Design and Sampling Method

In order to evaluate the 10-year (2011–2020) trend of IPI prevalence, a retrospective study was conducted by reviewing stool examination reports at Grarigy health centre laboratory logbook. The whole stool direct wet mount results reported over 10 years in the Health Center and contained sex of patient, age of patient, year of examination, and microscopy results were included and recorded. Records with incomplete sociodemographic data and/or no reported stool examination results were excluded.

Data Collection and Parasitological Analysis

Ten-year data regarding age, sex, and IPI status were collected from Grarigy Health Centre laboratory logbook from August 02/2021 to September 30/2021. The Ethiopian Federal Ministry of Health (FMoH) recommends using stool direct wet mount as a standard test to determine IPIs.[18] In this method, a fecal smear is prepared on a microscopic slide using 0.85% normal saline. The smear was then covered with a 22 by 22 mm coverslip and examined microscopically using a 10 times and 40 times objective lens for the presence of ova/larva stage of helminthic parasites and cyst/trophozoite stage of protozoan parasites. Laboratory personnel used a checklist created for this study to gather information about the patient's age, sex, examination year, stool examination results, and parasite species detected after removing any personal information.

Data Management and Analysis

Data were first cleaned, updated and entered into EpiData and then imported to SPSS 20 software, verified as complete, and analyzed. Descriptive statistics (frequency, percentage, mean, and range) were utilized to present the data and to evaluate intestinal parasite trends over the years. The Chi-square test was used to test a statistically significant difference between variables. P-value <0.05 was considered as statistically significant.

Results

Socio-Demographic Characteristics and Annual Prevalence of IPIs

Over a ten-year period (2011–2020), 9541 stool wet mounts were requested for the identification of intestinal parasites at Grarigy Health Centre, of whom 5599 (58.7%) were from male and 3942 (41.3%) were from females. About 42.1% (n = 4015) of the participants were in the age group of 5–14 years. The mean age of participants was 26.11 years (range 01–95 years). The highest (1585; 16.6%) and lowest (202; 2.1%) numbers of stool samples were examined in 2015 and 2011 respectively. IPI prevalence was 58.8% (n = 5612) (CI: 57.8–59.8), with males making up 35.8% (3421/9541) and females making up 23% (2191/9541). Males had a significantly higher prevalence of IPI than females (X^2= 28.86; P < 0.05). The mean annual case of intestinal parasites was 561.2 (range 99–904) and the mean annual prevalence was 57.79% (range 49–61.9%). The highest and lowest prevalence of IPIs were recorded in 2020 (61.9%) and 2011 (49%) respectively (Table 1).

Annual Prevalence Trend of Intestinal Parasitic Infections

The findings of this study revealed a significant (X^2= 24.76; P = 0.003) fluctuating trend of IPIs from 2011 to 2020. Despite variations over a 10-year period, intestinal parasite occurrences happened all year long. The highest peak of IPIs was observed in 2020 (767 cases; 61.9%) and the lowest peak was observed in 2011 (99 cases; 49%) (Table 1).

A total of 10 different genera of intestinal parasites (two intestinal protozoans and eight intestinal helminths) were detected. Protozoa to helminth ratio was approximately 1:1.4 (24.6% versus 34.2%). *Ascaris lumbricoides* was the most common parasite among the 10 intestinal parasites identified (23.5%, 2245/9541), followed by *Entamoeba histolytica/dispar* (16.6%, 1587/9541). Other intestinal parasites identified were *Giardia lamblia, Schistosoma mansoni*, Hookworm, *Hymenolepis nana, Strongyloides stercoralis, Taenia species, Trichuris trichiura*, and *Enterobius vermicularis* with a prevalence of 8%, 4.7%, 3.2%, 1.4%, 0.5%, 0.4%, 0.3%, and 0.2% respectively. Of the total samples, 5.7% (540/9541) were mixed, of which, 5.6% (533/9541) were double and 0.1% (7/9541) were triple infections (Table 2).

Table 1 Annual Prevalence of Intestinal Parasite Infections at Grarigy Health Centre Northwest Ethiopia, 2011–2020

Year	Total Samples Tested	Total Positive Samples n (%)	Total Negative Samples n (%)	*P*-value
2011	202	99(49.0)	103(51.0)	0.003
2012	263	148(56.3)	115(43.7)	
2013	373	215(57.6)	158(42.4)	
2014	1059	608(57.4)	157(42.6)	
2015	1585	904(57.0)	681(43.0)	
2016	1180	690(58.5)	490(41.5)	
2017	1324	758(57.3)	566(42.7)	
2018	1235	757(61.3)	478(38.7)	
2019	1081	666(61.6)	415(38.4)	
2020	1239	767(61.9)	472(38.1)	
Total	9541	5612(58.8)	3929(41.2)	

Table 2 Intestinal Parasite Species Detected at Grarigy Health Centre Northwest Ethiopia, 2011–2020

	Species Name	Frequency	Percentage
Protozoa	*E. histolytica/dispar*	1587	16.6
	G. lamblia	759	8.0
Helminth	*A. lumbricoides*	2245	23.5
	S mansoni	444	4.7
	Hookworm	308	3.2
	H. nana	135	1.4
	S. stercoralis	49	0.5
	Taenia Spp	37	0.4
	T. trichiura	27	0.3
	E. vermicularis	21	0.2
Overall positive		5612	58.8
Overall negative		3929	41.2

Annual Species Trend of Intestinal Parasites

Ten intestinal parasites were reported over the 10-year period. A fluctuating trend was observed in six intestinal parasites over the 10-year period. The highest peak for *A. lumbricoides, E. histolytica/dispar, G. lamblia, S. mansoni*, Hookworm, and *H. nana*, was observed in 2016 (322 cases), 2015 (301 cases), 2015 (138 cases), 2015 (76 cases), 2015 (63 cases), and 2014 (55 cases) respectively whereas, the lowest peak was observed in 2011 (28 cases), 2013 (35 cases), 2012 (0 case), 2012 (1 case), 2012 (1 case), and 2012 (1 case) respectively. No substantial fluctuations were observed for the rest of the four intestinal parasites (*S. stercoralis*, T*aenia species, T. trichiura*, and *E. vermicularis*) (Figure 1).

Age Distribution of Intestinal Parasites

Intestinal parasites were reported in all age groups though the difference is statistically significant (X^2= 89.48; P < 0.05). The highest prevalence (42.6%) was observed in the age group 5–14 years and the least prevalence (4.7%) was recorded in the age group ≥65 years. The highest case of each intestinal parasites was reported at the age group of 5–14 years except *H. nana* (highest case reported at the age group < 5 years) and *S. stercoralis* (equal number of cases reported at the

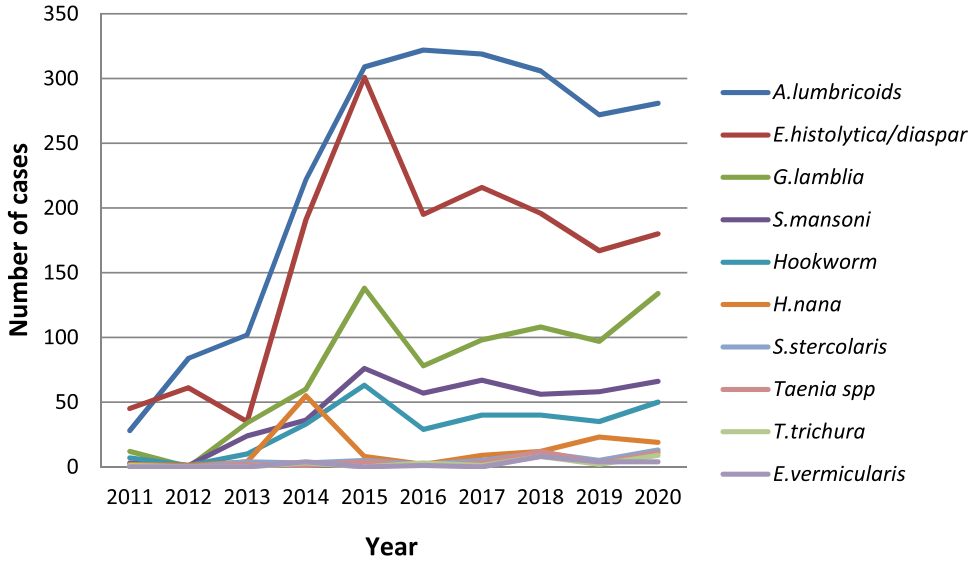

Figure 1 Species trends of intestinal parasites at Grarigy Health Centre, Northwest Ethiopia, 2011–2020.

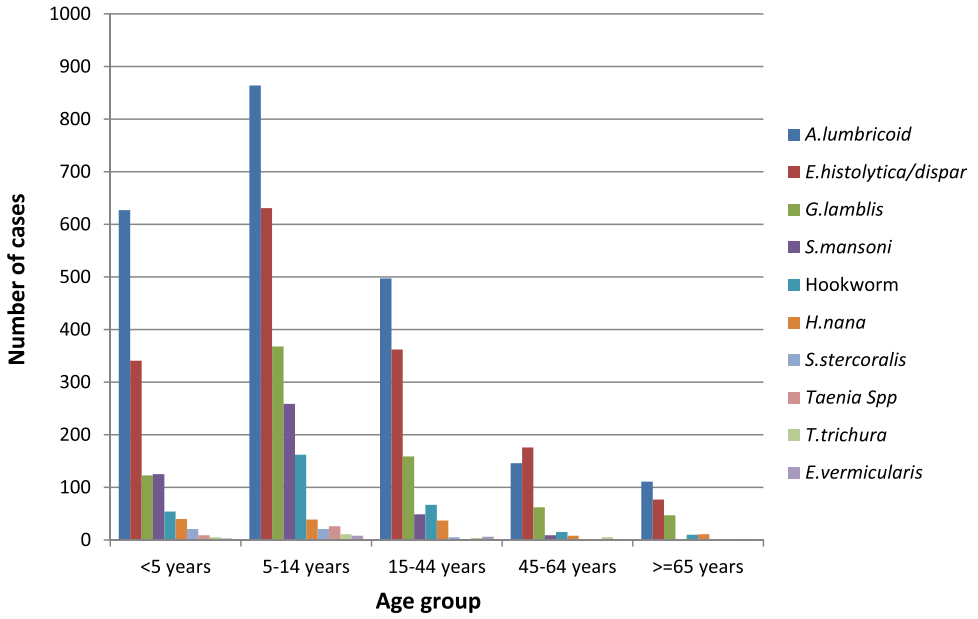

Figure 2 Age distribution of intestinal parasites at Grarigy Health Centre, Northwest Ethiopia, 2011–2020.

age groups of < 5 years and 5–14 years). *Ascaris lumbricoides* is the predominant intestinal parasite recorded in each age group, followed by *E. histolytica/dispar*. However, it was vice versa at the age group of 45–64 years. No *Taenia species* was reported at the age group of 15–44 years (Figure 2).

Discussion

IPI continues to pose a severe public health threat for developing nations. Planning and evaluating the current intervention program requires monitoring and observing the prevalent trend of IPI in a particular locality. The overall prevalence of IPI was 58.8% (CI: 57.8–59.8) even if the used diagnostic tool was only direct wet mount, which might compromise the sensitivity in detecting light intensity infections. The present finding is higher than earlier retrospective studies conducted in different parts of Ethiopia; Dembia district (53.3%),[19] Yabelo General Hospital (48%),[20] Gondar Poly Health Centre (41.3%),[21] Mizan-Tepi University Teaching Hospital (33.33%),[22] Debre Tabor Comprehensive Specialized Hospital (27.3%),[23] University Gondar student's Clinic (45.6%),[24] Bale Robe Health Centre (6.23%),[25] Mojo Health Centre (9.3%),[26] and West Dembia district (53.3%).[19] This variation in prevalence might be due to differences in local endemicity of particular intestinal parasites across different countries. In addition, possible factors like unavailability of safe drinking water, difference in socio-economic status, poor personal or environmental hygienic conditions, poor sanitary disposal of feces, lack of awareness about the transmission of parasites, and different cultural activities might lead to the high prevalence of IPIs.

The prevalence of IPIs in the present study was significantly higher in males than in females ($P < 0.05$). Similar findings were reported from studies conducted at University Gondar students' clinic, Northwest Ethiopia[24] and Debre Tabor Comprehensive Specialized Hospital, Northwest Ethiopia[23] which reported that males were infected at a higher rate than females. This could be due to the fact that males are more engaged in farming activities like digging, crop cultivation, weeding, and fishing than females. The overall proportion of intestinal parasites was higher among females than males according to a research finding reported by Gondar Poly Health Centre, Northwest Ethiopia[21] and Yabelo General Hospital, Southern Ethiopia.[20]

The present study finding showed a significant ($P = 0.003$) fluctuating trend of intestinal parasite prevalence over a 10-year period. This is supported by studies conducted at University of Gondar students' clinic, Northwest Ethiopia,[24] and Gondar Poly Health Center, Northwest Ethiopia[21] which reported a fluctuating trend of IPIs. However, studies conducted in Bale-Robe Health Centre, Ethiopia,[25] and Istanbul, Turkey[27] reported a gradual increasing trend of IPIs. Studies done in Yabelo General Hospital, Southern Ethiopia,[20] Mojo Health Center, Central Ethiopia,[26] University of

Parma, Italy,[28] and North Central Iran[29] reported a decreasing trend in IPIs. Cyclic pattern of fluctuation in IPIs was also reported from a previous study conducted in Debre Tabor Comprehensive Specialized Hospital, Northwest Ethiopia.[23] The possible reason for the fluctuating trend of parasite prevalence might be due to lack of safe water supply in some seasons for routine use like personal and environmental hygiene and differences in preventive measures taken by the community each year. Occurrence of other new epidemics like COVID-19 might divert the concern of health care providers and could be a reason for the highest cases of IPI recorded in 2020 in the current study. Moreover, it might also be due to different prevention and control measures applied which might be unsatisfactory in our study area.

A total of 10 different genera of intestinal parasites (two intestinal protozoans and eight intestinal helminths) were detected. The ratio of protozoa to helminth infection was approximately 1:1.4 (24.6%; 34.2%). Of the 10 intestinal parasites identified, *A. lumbricoides* was the predominant parasite and *E. histolytica/dispar* was the second intestinal parasite identified. *Giardia lamblia, S. mansoni*, and Hookworm ranked third, fourth and fifth respectively. *Strongyloides stercoralis, Taenia species, T. trichiura*, and *E. vermicularis* comprised < 1%. Double and triple infections were also reported. Insufficient access to clean water supply and open field defecation practice in the society might contribute to a higher diversity and prevalence of intestinal parasites in and around Grarigy town (a small town in Dembia District). The studies conducted at University of Gondar student's clinic, Northwest Ethiopia,[24] Debre Tabor Comprehensive Specialized Hospital, Northwest Ethiopia,[23] Gondar Poly Health Centre, Northwest Ethiopia,[21] and Yabelo General Hospital, Southern Ethiopia[20] reported that *E. histolytica/dispar* was the predominant intestinal protozoa followed by *G. lamblia* and *A. lumbricoides* was the leading intestinal helminth detected. Another study done in West Dembia district, Northwest, Ethiopia reported *A. lumbricoides* and hookworm as the most frequently diagnosed soil-transmitted helminths and *E. histolytica/dispar* and *G. lamblia* as the most frequently diagnosed protozoa.[19] In contrast, previous reports from different studies reported that *S. stercoralis, T. trichiura, and E. vermicularis* were the least intestinal parasites, consisting <1%.[19–24,26] Local endemicity and difference in health-seeking behavior of society might be a reason for varied frequency of the identified intestinal parasite species.

In the current study, a fluctuating trend was observed in *A. lumbricoides, E. histolytica/dispar, G. lamblia, S. mansoni*, Hookworm and *H. nana* over the 10-year period. However, no substantial fluctuations were observed for *S. stercoralis*, T*aenia species, T. trichiura*, and *E. vermicularis*. A sharp increasing trend of *E. histolytica* and *A. lumbricoides* infections was reported by Bale Robe Health Center, Southeastern Ethiopia.[25] Varied frequency of *A. lumbricoides* and hookworm, steadily increased trend of *G. lamblia*[17] and varied frequency of *E. histolytica* and *G. lamblia*[26] were reported.

Though the difference is statistically significant ($P < 0.05$), intestinal parasites were reported in all age groups. The highest and the lowest cases were reported in age groups of 5–14 and ≥65 years respectively. The high prevalence of IPI in the age group 5–14 years supports the fact that school-age children are highly vulnerable to IPIs. The highest case of *H. nana* among under-five children supports the fact that this parasite is frequently encountered in preschool-aged children. According to earlier reports, the highest and lowest prevalence of IPIs were reported in age groups of 20–29 years and 40–49 years respectively,[21] and in the age groups of > 14 years and < 5 years respectively.[21] Other findings revealed that the majority of intestinal parasites were detected among the age group of ≥15 years rather than 0–4 and 5–14 years.[25,26]

Strength and Limitations of the Study

This study manipulated a large amount of data from Grarigy Health Centre laboratory, Northwest Ethiopia and allowed us to evaluate the long-term trend of intestinal parasitic infections. However, a single stool sample analyzed by direct wet mount is inadequate and might under estimate the prevalence. This study might not represent the accurate prevalence and trends of IPIs because the majority of asymptomatic patients might have been overlooked. Moreover, due to the nature of the study, we were unable to illustrate the possible risk factors that could have been predisposing to IPIs.

Conclusion

Intestinal Parasitic infections are highly prevalent in the Grarigy Health Centre and have a fluctuating trend in the past 10 years. *E. histolytica/dispar* and *A. lumbricoides* were the predominant protozoan and helminthic parasites respectively. This conclusion raises concerns about developing effective infection prevention methods by taking into account various

contributing factors. Therefore, there should be a strong surveillance system in the study area to lower the burden of IPIs in the community to a level that has no longer an impact on public health. Regular health education on personal cleanliness and environmental protection, as well as awareness creation regarding intestinal parasite prevention and control methods, are all strongly advised.

Data Sharing Statement

The data sets used and/or analyzed during this study are available from the corresponding author upon a reasonable request.

Ethics Approval and Consent to Participate

Ethical clearance (Dated 29 Jul 2021; Ref. No. SBLS/2035/2021) was obtained from the School of Biomedical and Laboratory Science research ethical review committee, University of Gondar. A letter of consent was obtained from the head of Grarigy Health Centre after a brief explanation regarding the objectives of the study. A verbal consent was also obtained from the focal person of the laboratory. The data accessed complied with relevant data protection and privacy regulations. Patient informed consent was waived because all data were collected and analyzed retrospectively from laboratory record. The names and other personal identifiers of the study participants were anonymized and kept confidential.

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Author Contributions

All authors made a significant contribution to the work reported, whether in the conception, study design, execution, acquisition of data, analysis, and interpretation, or all these areas, took part in drafting, revising, or critically reviewing the article, gave final approval to the version to be published, have agreed on the journal to which the article has been submitted, and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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