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ORIGINAL ARTICLE

High prevalence of intestinal helminthic infection among children under 5 years in a rural Ghanaian community: an urgent call for attention

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Abstract Intestinal parasitic infections presents a significant public health concern in developing countries. The study determined the prevalence of intestinal parasitic infection of children under 5 years. A cross-sectional prospective study was conducted at Dodi Papase, a town in the Kadjebi district of the Oti region of Ghana. Stool samples were collected from 152 children under 5 years and examined for the presence of intestinal parasites using Kato–Katz technique. Additionally, venous blood samples were collected from participants into EDTA tubes and analyzed for their hemoglobin concentration using the Sysmex XS-500i automated hematology analyzer All laboratory analyses were done at the Ho Teaching Hospital Laboratory. Overall prevalence of intestinal helminthic infections was 44.08% (67/152). *Ascaris lumbricoides*, *Trichuris trichiura* and Hookworm recorded 20.39%, 10.53% and 13.16% prevalence respectively. Children aged 4 years recorded the highest prevalence of intestinal parasitic infections vis-à-vis 50.00% *A. lumbricoides* and 37.50% Hookworm while children below age 2 years recorded the lowest. *T. trichiura* infection was highest among children below age 2 years (44.44%) and lowest among children aged 4 years. This study recorded an overall parasitic infections of 44.08%. This therefore calls for periodic screening, anti-helminthic treatment of these children as well as intensified education on attitudinal/behavioral change on improved personal and environmental hygiene in order to help control the menace of intestinal parasitic infections.

Keywords Intestinal parasitic infection · Children · Rural Ghanaian community

Introduction

Intestinal parasitic infections are of high endemicity and reckoned among the world's leading cause of morbidity (Alwabr and Al-Moayed 2016). They have been described as one of the greatest causes of illness and regarded as major public health problems globally infecting about 3.5 billion people in the world and causing illness in about 450 million children (Hassen Amer et al. 2016; Taheri et al. 2011). According to studies, distribution and prevalence of various intestinal parasite species are influenced by social, geographical, economical and inhabitant customs (Yadav and Prakash 2016). In less developed countries, poor environmental and personal hygiene, poor nutrition, overcrowding, lack of access to potable water and tropical climatic conditions that favor the development and survival of these parasites all contribute to high transmission of intestinal parasites (Opara et al. 2012). Children below 5 years carry the heaviest burden of related morbidities due to their habits of playing in infected soils, eating with soiled hands, unhygienic toilet practices, and oral intake of contaminated water and food (Opara et al. 2012). Morbidities from the commonest infectious intestinal helminthes including *Ascaris lumbricoides*, Hookworm and

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Trichuris trichiura (collectively referred to as soil-transmitted helminths, STHs) (Yadav and Prakash 2016) result in complications such as stunted growth (usually in children), loss of weight, chronic blood loss, iron deficiency anaemia, diarrhoea, and vitamin A deficiency (Opara et al. 2012; Taheri et al. 2011). Enteric helminthiasis among children below 5 years has been linked to complications such as severe anaemia and stunted growth (Ayeh-Kumi et al. 2016). Malnutrition has also been a crucial factor favoring intestinal helminth infections among children under 5 years and pregnant women; a condition highly associated with developing countries like Ghana (Walana et al. 2014a). Resulting consequences of these intestinal helminth infections among children particularly include malnutrition, poor physical and mental development as well as cognitive and behavioral deficiencies (Walana et al. 2014b). In Ghana, varying prevalent rates of intestinal parasitic infections has been reported vis-à-vis a 15.1% overall prevalence of intestinal parasites of which 10% were *Giardia lamblia* among children aged 2–8 years in a suburb of the Greater Accra region of Ghana and an overall 17.3% among children aged 0–10 years, the preponderant of which was hookworm followed by *A. lumbricoides* in Princess Marie Louise Children's Hospital in the Greater Accra Region of Ghana (Mirisho et al. 2017; Obeng et al. 2017). Elsewhere in a tertiary care hospital in Karachi, a rather high prevalence of 68.8% intestinal parasite infection was reported with *G. lamblia* documented as the most prevalent, 25.3% (Mumtaz et al. 2009). The mode of transmission of most intestinal helminthes varies. However, the most common mode of transmission is the faeco-oral route (Opara et al. 2012; Walana et al. 2014b). Children are a category of the vulnerable population that could suffer greatly from the menace of these infectious agents due to their weak immunity as well as lack of knowledge with regards to these infections and their inability to differentiate between hygienic and unhealthy environment. In spite of the numerous works that have been carried out in Ghana, only a few have been carried out among children under 5 years in the rural community considered for this study.

This study therefore aims to fill this gap in knowledge by determining the prevalence of intestinal helminth infections among children less than 5 years in one of the most deprived communities in Ghana.

Material and methods

Study site and eligibility criteria

A cross sectional study was conducted among 152 conveniently sampled children from the general population in Dodi Papase from November 2018 to February 2019. Dodi Papase is a major town in the Kadjebi District formally part of the Volta Region of Ghana but now in the Oti Region of Ghana owing to the recent creation of new Regions in the country. The town lies within latitude 5° 33′ 35.5″ (5.5599°) North and longitude 0° 12′ 45.7″ (0.2127°) North holding a number of schools and a healthcare facility. The details of the study were thoroughly explained to the parents and/or legal guardian of the children prior to the study. Additionally, children under 5 years whose parents or legal guardian consented to partake in this study by signing the child ascent form provided them were included in the study. Visibly sick children and children on anti-helminthic medication (indicated by their parents or guardian) were also excluded from partaking in the study.

Sample size

At 95% confidence level with an estimated prevalence (p) of 11% (Ayeh-Kumi et al. 2009) and allowable margin of error (e) of 5%, minimum sample size (n) of 150 was determined using the Cochran formula, $n = \frac{z^2(p)(1-p)}{e^2}$ however, a total of 152 children were recruited for this study.

Sample collection and laboratory analysis

Parents and/or guardian of the study participants were educated on how to collect and handle specimens to avoid contamination before being provided with sample containers. A sterile plastic container with a spatula attached, a sealable transparent plastic bag and sterile gloves were used in the sample collection. Items were provided to parents or legal guardian of the children based on the child's age and ability to follow given instructions. For children below 2 years of age, a well labelled sterile plastic container with a spatula attached, sterile gloves and a clean collecting bag was provided. These category of parents or guardian were then instructed to wash their hands thoroughly with soap and water, put on the gloves and then lay the clean collecting bag into a chamber pot halfway where the collecting bag could only cover the child's anus but not the urinary outlet in order to prevent the mixture of urine with the stool. After the production of the stool, the parent or guardian using the spatula attached to the sterile stool container given were instructed to pick a spatula full of the stool (equivalent to two grams of the stool) into the stool container, tighten it appropriately and then given to the researcher immediately.

For children aged 2–4 years, a sterile plastic container with a spatula attached, sterile gloves were provided the parents or guardian. These category of parents were instructed to provide a clean chamber pot to the child and instruct the child to void urine outside before producing the stool into the chamber pot. Then after the parent or guardian collected a spatula full of the stool onto the sterile container while in gloves and immediately given to the researcher. Collection of stool samples were done between 7:00 a.m. and 11:00 a.m. each day.

Each successful collection of stool sample was accompanied by the collection of a venous blood sample from the child by the researcher. This was done by collecting 3 ml of venous blood sample using sterile 23 gauge needle from the median cubital vein or the cephalic vein where appropriate from the antecubital fossa of the arm with the most prominent and easily visible or palpable vein into EDTA tubes applying aseptic techniques employed in phlebotomy. The EDTA tube was swirled thoroughly to ensure even mixture of the blood with the anticoagulant in the tube. Upon successful collection, the tube were then labelled with same sample ID as the stool.

The stool samples after each collection in a day were then assembled, kept in tight fitting leakproof cold boxes with ice packs together with blood samples in a shock proof container and then transported to the Ho Teaching Hospital (HTH) laboratory within two hours, forty-five minutes (2 h 45 min) for immediate analysis.

Laboratory analysis

In this study, a laboratory parasitosis diagnostic technique; the Kato–Katz strongly recommended by the WHO (1994) for surveillance and epidemiological field survey of STH infections due to ease of its use in the field and relatively low cost and also identified as the best method of choice for the detection of STH infection in studies conducted in the rural environments with poor infrastructure (Tarafder et al. 2010) was employed in the laboratory analysis of stool samples obtained from the study participants.

Kato–Katz technique procedure

A cardboard template from a commercial disposable Kato kit (HelmR test kits: from Brazil AK Industriae Commercio Ltd., Belo Horizonte, Brazil) with a diameter of 0.2 mm central hole was placed on a glass slide and then marked with the corresponding sample number of the study participants. A wooden applicator was used to pick a portion of the fecal sample and placed on a Pergamon paper on a scrap paper. A piece of nylon fabric was then used as a screen and the sample pressed on it. A wooden applicator was used to scrape the surface of the nylon fabric to remove the sieved fecal material. A sizable portion of the sieved fecal material was then used to fill the template. The template was carefully lifted and discarded into a carrier bag used to collect the waste. An unwetable cellophane tape of size 25 mm × 30 mm with thickness 40 µm soaked in methylene blue glycerol solution for 24 h was placed directly on the sieved fecal material on the microscope glass slide. A clean glass slide was picked and pressed directly against the slide with the sieved fecal sample for the sample to spread evenly in a circular manner. The slide was left for 20 min and subsequently examined (Cheesbrough 2006).

Hemoglobin concentration estimation

Hemoglobin concentrations of study participants were estimated using the Sysmex xs-500i automated hematology analyzer for the determination and classification of anaemia among the study participants.

Data analysis

Data obtained were compiled into Microsoft Excel 2016 and checked for completeness. Descriptive method of analysis such as tables and graphs were used to illustrate the occurrence of the various factors in the study. Categorical data was analyzed using Chi square (χ^2) for statistical significance using GraphPad Prism version 6.00 for windows (GraphPad software, San Diego USA). A p value less than 0.05 was considered to be statistically significant.

Ethical consideration

Ethical clearance for the study [UHAS-REC A.4 [181] 18-19] was obtained from the University of Health and Allied Sciences Research Ethics Committee (UHAS-REC). Written approval was also sought from Kadjebi District Assembly prior to commencement of the study. Also, a written permission was sought from the administration of Ho Teaching Hospital (HTH). Parents or legal guardian of all participants who agreed for their wards to partake in the study after they were thoroughly informed and sensitized about the study were asked to sign the child ascent form provided them by the researcher. Confidentiality of participants' information and data obtained from the study was ensured.

Results

Prevalence of intestinal parasitic infection

The overall prevalence of intestinal parasitic infections was 44.08% (67/152). *Ascaris lumbricoides, Trichuris trichiura* and Hookworm recorded 20.39%, 10.53% and 13.16% prevalence respectively (Fig. 1).

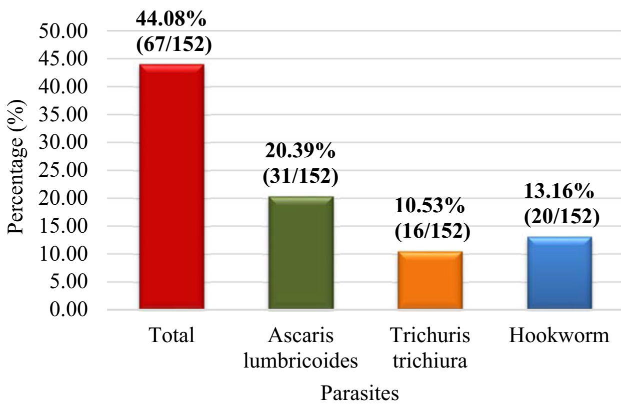

Fig. 1 Prevalence of intestinal parasites among studied children

Socio-demographic characteristics of study participants

This study recruited a total of 152 children under 5 years. Out of the total, 65 (42.76%) were males while 87 (57.24%) were females. Majority of parents to these children could only make it up to their basic education level [92 (60.53%) mothers and 75 (49.34%) fathers] and were informally employed [124 (81.58%) mothers and 134 (88.16%) fathers]. The greater proportion 93 (61.18%) of the parents belonged to the Christian Religion whereas 59 (38.82) were Muslims. Religion of study participants was statistically associated with parasitic infection ($p < 0.012$) (Table 1).

Age distribution of parasitic infections among study participants

This study recorded variations in intestinal parasitic infections in relation to age in the studied children. Children aged 4 years recorded the highest prevalence of intestinal parasitic infection vis-à-vis 50.00% *A. lumbricoides* and 37.50% Hookworm whiles children below age 2 years recorded the lowest. *T. trichiura* infection was highest among children below age 2 years (44.44%) and lowest among children aged 4 years. It can be observed that prevalence of *A. lumbricoides* and Hookworm infections increased with advancement in age as opposed to *T. trichiura* infection, which decreased with advancement in age (Fig. 2).

Gender based distribution of intestinal parasitic infection among studied children

Prevalence rate of intestinal parasitic infection was insignificantly higher in males than females. Of the 87 males recruited, 36 (41.38%) were infected whereas 46.27% (31/65) females were infected with intestinal parasites. The highest parasitic infection was *A. lumbricoides* with a prevalence rate of 18.39% (16/87) and 23.08% (15/65) in males and females correspondingly. The lowest infection recorded was *T. trichiura*, 10.34% (9/87) and 10.77% (7/65) in males and females respectively. None of the parasitic infections was significantly associated with gender (Table 2).

Intestinal parasitic infection stratified by community

Analysis based on the communities from which the children lived indicated that children who lived in the Muslim dominated community (Zongo community) were the highest infected, 50.00% (38/76) as against children who lived in the non-Muslim dominated community, 38.16% (29/76). Majority of children who were infected with *A. lumbricoides*, 64.52% (20/31) live in the Zongo community as against 37.93% (11/29) of both *A. lumbricoides* and Hookworm among children who lived in the non-Muslim dominated community (Table 3).

Relationship between intestinal parasitic infection and degree of anaemia

The overall prevalence of anaemia per this study is 35.53% (54/152). Not all the studied children who were diagnosed with intestinal parasitic infection presented with anaemia. In this study, 26 children representing 17.11% (26/152) of the total study population and 48.15% (26/54) of the total number of children who presented with anaemia were diagnosed with parasitic infection. Of those who were diagnosed with *A. lumbricoides* infection, 1 (100.00%) presented with severe anaemia followed by 12 (60.00%) who presented with mild anaemia. Majority of children diagnosed of *T. trichiura* infection, 5 (25.00%) presented with mild anaemia while those diagnosed with Hookworm infection, 2 (40.00%) were moderately anaemic. In this study, anaemia was not significantly associated with parasitic infection ($p = 0.666$) (Table 4).

Discussion

Knowledge on the distribution and magnitude of intestinal parasitic infection in a given community is essential for planning and evaluating intervention programs vital for combating of these infections. This cross-sectional study realized an overall prevalence rate of 44.08%. Higher prevalence of 60% in Chad (Bechir et al. 2012) and 68.8% in Karachi (Mumtaz et al. 2009), both among similar population had been documented. Elsewhere in Senegal and Southeastern Iraq, overall prevalence of 26.2% and 37.5% were documented respectively (Sarkari et al. 2016;

Table 1 Socio-demographic details associated with parasitic infection in studied children

Parameters	Sub-categories	Total	Positive	*p* value
		152 (100.00)	67 (44.08)	
Age	< 2 years	26 (17.11)	9 (34.62)	0.159
	2–3 years	83 (54.61)	34 (40.96)	
	4 years	43 (28.29)	24 (55.81)	
Gender	Male	87 (57.24)	36 (41.38)	0.510
	Female	65 (42.76)	31 (47.69)	
Father's education	Illiterate	36 (23.68)	18 (50.00)	0.619
	Basic	75 (49.34)	32 (42.67)	
	Secondary	33 (21.71)	15 (45.45)	
	Tertiary	8 (5.26)	2 (25.00)	
Father's occupation	Unemployed	6 (3.95)	3 (50.00)	0.945
	Informal	134 (88.16)	59 (44.03)	
	Formal	12 (7.89)	5 (41.67)	
Mother's education	Illiterate	56 (36.84)	27 (48.21)	0.581
	Basic	92 (60.53)	39 (42.39)	
	Secondary	4 (2.63)	1 (25.00)	
Mother's occupation	Unemployed	26 (17.11)	14 (53.85)	0.531
	Informal	124 (81.58)	52 (41.94)	
	Formal	2 (1.32)	1 (50.00)	
Religion	Christian	93 (61.18)	33 (35.48)	**0.012**
	Muslim	59 (38.82)	34 (57.63)	

Data is presented as frequency and percentages. *p* value significant at < 0.05

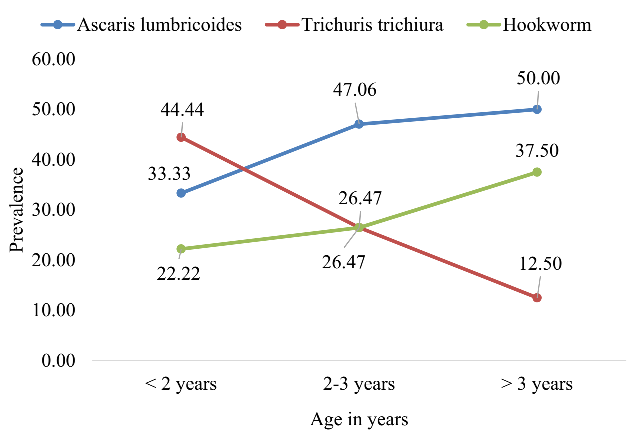

Fig. 2 Distribution of parasitic infection of children stratified by age

Tine et al. 2013) all in similar study groups. The relatively high prevalence observed in this study could be due to poor sanitary practices among caretakers of the children vis-à-vis consumption of unsafe drinking water as well as indiscriminate disposal of faecal matter due to lack of appropriate toilet facilities. Other likely predisposing factors could be unfavorable climatic conditions and ignorance of caregivers and children about the mode of transmission of parasitic infections (Nyantekyi et al. 2010; Opara et al. 2012). Again, poor parental monitoring or control of the playing habits of these children most especially with sand which may be infected could also account for the high prevalence recorded in this study (Nyantekyi et al. 2010; Walana et al. 2014b).

Parasites predominantly responsible for intestinal infections have been found to vary from one country to another with unique geographical peculiarities. In this study, *A. lumbricoides* 20.39% (31/152) was the most prevalent intestinal parasite identified, followed by Hookworm 13.53% (20/152). *T. trichiura* 10.53% (16/152) was the least prevalent IP recorded in this study. However, compared to other findings elsewhere, *T. trichiura* was the most common intestinal parasite identified with a prevalence of 89.5% in the Ashanti Akim North Municipal Hospital of Ghana (Nkrumah and Nguah 2011). As established in this study, *A. lumbricoides* recorded the highest prevalence in Southern Angola but observed *T. trichiura* as the second most common intestinal parasite contrary to the findings of this study (Oliveira et al. 2015). In this study, infection with *A. lumbricoides* and Hookworm increased with advancement in age unlike *T. trichiura* which decreased with increasing age. *A. lumbricoides* (50.00%) and Hookworm (37.50%) infections were highest among

Table 2 The overall distribution of intestinal parasitic infection by sex

Intestinal parasite	Number infected (%)		p value
	Males = 87 (57.24%)	Females = 65 (42.76%)	
Total	36 (41.38)	31 (47.69)	0.510
A. lumbricoides	16 (18.39)	15 (23.08)	0.544
T. trichiura	9 (10.34)	7 (10.77)	0.999
Hookworm	11 (12.64)	9 (13.85)	0.999

Data is presented as frequency and percentages in parenthesis. p value is significant at < 0.05

Table 3 Microscopically identified intestinal parasites from the stool samples of children from the two communities

Intestinal Parasite	Total	Community	
		Zongo community	Non-Zongo community
	67 (40.08)	38 (50.00)	29 (38.00)
A. lumbricoides	31 (46.27)	20 (64.52)	11 (35.48)
T. trichiura	16 (23.88)	9 (56.25)	7 (43.75)
Hookworm	20 (29.85)	9 (45.00)	11 (55.00)

Data is presented as figure and percentages in parenthesis. Zongo community = Muslim dominated community

Table 4 Intestinal parasitic infection versus degree of anaemia in studied children

	Hemoglobin reference range (g/dl) for anaemia classification	Intestinal parasitic infection		
		A. lumbricoides	*T. trichiura*	Hookworm
Total		15 (57.69)	6 (23.08)	5 (19.23)
Degree of anaemia				
Mild anaemia	(10.0–10.9)	12 (60.00)	5 (25.00)	3 (15.00)
Moderate anaemia	(7.0–9.9)	2 (40.00)	1 (20.00)	2 (40.00)
Severe anaemia	(less than 7.0)	1 (100.00)	0 (0.00)	0 (0.00)

Data is presented as frequency and percentage in parenthesis for categorical data. p value = 0.666. p value is significant at < 0.05

children aged 4 years while *T. trichiura* was highest among children below 2 years of age. However, infection with these three parasites generally was high across all age groups among the children studied. Despite the fact that data was not compiled to this effect, a good number of inhabitants of Dodi Papase rear animals such as sheep and goat. Therefore the unsupervised roaming of these animals and their contact with children may be a contributing factor to the observed prevalence. Also, the explanation to high prevalence of *A. lumbricoides* recorded in both males and females in this study is not immediately apparent. Also, negligence of parents on getting their children screened regularly for these infections can be a reason for the high prevalence of *A. lumbricoides*. These children are mostly sent to the hospital when the situation becomes critical.

Children who lived in Zongo communities (Muslim dominated community) recorded the highest parasitic infection 38 (50.00%) compared to those who lived in non-Zongo communities 29 (38.16%). Infection with *A. lumbricoides* was relatively high among children from the Zongo communities (64.52%) compared to those from the non-Zongo communities (56.35%). Muslim dominated communities popularly referred to as zongo communities in Ghana as captured in this study is generally characterized by activities such as intensive animal rearing including primarily cattle, goats and sheep. Except for a select few who treat the feed given these animals, fresh green grasses or silage probably contaminated with the parasitic agents are fed to these animals on daily bases. Training of children in these communities begin at ages as young as 6 years were the child is taught how to feed the animals and even sometimes collect milk in the case of cattle. By about 12 years, the child starts going on the fields with the animals for purposes of grazing by the animals. In this study, the elevated IPI infection rate documented in the Zongo communities could be accounted for by the intensive animal keeping and rearing characteristics by parents of these children as much attention is seldom paid to the hygienic status of the animal farming system. In another division, Muslim children often mimic their parents or guardian in praying in the sand mostly concentrating on the prostrating and sitting stage of the prayer. Consequently, the direct contact with infected animals or human faecal matter in the sand could also contribute the high parasitosis observed in the Zongo communities than seen among children from the non-zongo communities. Religious affiliation of study participants was statistically associated with infection with intestinal parasites ($p = 0.012$) in this study. Thus, the probability of Muslim children being infected was relatively higher (57.63%) compared to Christian children (35.48%).

Severe anemia is known to affect children especially those under the age of 5 years in the tropics; intestinal parasites are a main cause of anaemia aside malnutrition in these children (Mumtaz et al. 2009; Yadav and Prakash 2016). The overall prevalence of anaemia in this study was 35.53% (54/152). However, anaemia was not significantly associated with the presence of intestinal parasitic infection, contrary to a similar study carried out in a tertiary hospital in Karachi (Mumtaz et al. 2009). The dissimilarity in findings could be due to a delay in the occurrence of anaemia in this study as a result of early infection of the children by the parasite and/or an erythropoietic compensation of blood loss in response to the anaemia.

Conclusions

A high intestinal parasitic infection prevalence (44.08%) among children under 5 years at Dodi Papase was documented in this study indicating that intestinal parasitic infection still remains a major health concern in Ghana since the frequency of intestinal parasitic infection was found to be high among the current studied population. Parents/guardian of children living in these rural communities, especially the Zongo communities could greatly use intensified public health education on intestinal parasite infection emphasizing on its devastating effect on children to help lessen the prevalence as well as alleviate the devastating burden of these infections on the children and the overall human race at large. More so, intensified screening and anti-helminthic treatment exercise by Ghana Health Service should be carried out to help improve upon the health status quo of these children as well as their families at large.

Limitation

The study did not interview parents of participants on environmental and hygienic practices which could have given extra information on the possible risk factors of the infection. Additionally, the study did not investigate the HIV status of the participant which could explain their susceptibility to intestinal helminthic infections.

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Compliance with ethical standards

Conflict of interest The authors declare no conflict of interest.

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