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RESEARCH ARTICLE

Assessment of post intervention of geohelminth infection and risk factors among school aged children in the most endemic area of Kano, Nigeria

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ABSTRACT

This study is an initial attempt at determining the prevalence of geohelminth infections among school aged children (SAC) in the most endemic area of Kano State as well as risk factors associated with the infection and the impact of deworming programme in SAC. A retrospective study on the prevalence of geohelminth infection in the 44 Local Government Areas (LGA) of Kano State was conducted. A stratified random sampling technique was used for sample collection. A total of 3000 children were recruited aged 6-15 years. Retrospective study showed that none was of high endemicity. The present status of geohelminth showed that only hookworm was present among SAC with a prevalence of 2.2% and intensity was light (mean: 17 epg). Risk factors that predispose SAC to geohelminth infection like eating outside home, poor hand washing practice, and nail biting were found not to be significantly associated with hookworm infection except risk factor like walking bare footed which was significantly associated with hookworm infection. In conclusion, Prevalence of geohelminth infection in Kabo LGA prior to deworming was 35.1% and post intervention among SAC was generally low (2.2%). The observed low prevalence of geohelminth infection could be attributed to the success of the deworming programme carried out in the district in 2013. Risk factors like poor hand washing practice (2.3%), walking bare footed (2.6%) and eating outside home (2.6%) were pre-dominant among SAC.

Keywords: Geohelminth; Hookworm; Retrospective; Risk factor; Deworming; Post intervention.

INTRODUCTION

Geohelminths are a group of intestinal parasites belonging to the class Nematoda and are transmitted primarily through contaminated soil [1]. The most prevalent geohelminths are roundworms (*Ascaris lumbricoides*), whipworms (*Trichuris trichiura*) and the hookworms (*Ancylostoma duodenale* and *Necator americanus*) [2], each parasitizing hundreds of millions of people [1, 3]. Geohelminth infections are common in tropical and subtropical regions of the developing world especially in Sub-Saharan Africa (SSA), where poor domestic and environmental hygiene prevails [4]. More than 1.2 billion people are infected with *Ascaris* *lumbricoides*; 740 million people with hookworm; 795 million with *Trichuris trichiura* and 300 million with enterobiasis [5, 6]. Nigeria, the most populous country in SSA, is endemic for geohelminth infections due to ascariasis, trichuriasis, and hookworm with estimated cases of 55 million, 34 million, and 38 million, respectively [7-9]. Favourable edaphic and climatic conditions contribute to the development of the geohelminth infection, while inadequate sanitation facilities, lack of safe drinking water source, poor nutrition, and overcrowding are factors aiding their transmission [10, 11]. Infection may be direct or indirect through secondary sources such as food, water, vegetables and fruits since most geohelminth infections are acquired through the faecal-oral route. Ihesiulor et al. [12] found out in their study that, there was repeatedly moderate prevalence of geohelminth infection among apparently healthy children in Kano Municipal.

Like any public health intervention, however, deworming for geohelminth infections must be justified by evidence and judiciously implemented, especially when very young children are targeted for treatment. From the health perspective, there is now ample evidence clearly demonstrating that regular treatment of geohelminth infections produces immediate as well as long-term benefits, significantly contributing to the development of affected individuals, particularly children [13-15]. Geohelminth treatment is also one of the key components of the preventive chemotherapy package concept [16]. School based de-worming has been recommended as a highly cost-effective public health measure in less developed countries [17]. The World Health Organization (WHO) also recommends a baseline survey in school children to determine the prevalence and intensity of infections [13], and develop effective treatment strategies and case management options [18]. Various school-based surveys have been carried out in Nigeria to estimate the current status of geohelminth infections [19-23]. This study therefore aimed at determining the prevalence of geohelminth infections among school aged children in the most endemic areas of Kano State and the impact of deworming programme in school age children.

MATERIAL AND METHODS

Study area

Kano State is located in North Western Nigeria with latitude 11°30′N 8°30′E and longitude 11.500°N 8.500°E. Out of the 44 Local Government Areas (L.G.A) in Kano State, 17 L.G.A. were reported to be endemic for geohelminth infection following the survey conducted by Kano State Ministry of Health (KMoH, 2013). These are: Tofa (24.8%), Bagwai (20.6%), Kabo (35.1%), Kunchi (25.7%), Shanono (23.5%), Kura (24.6%), Madobi (25.3%), Bunkure (22.9%), Rogo (24.3%), Sumaila (20.4%), Takai (20.6%), Karaye (21.8%), Kiru (20%), Rimin Gado (23.4%), Gezawa (30%), Warawa (28.2%), Gabasawa (26%) L.G.As. School aged children study was conducted in the most endemic area (Kabo 35.1%).

Assessment of impact of deworming program among school aged children

The study population was school aged children (6-15 years) in the most endemic area who were present during the study period. The level of geohelminth infection was assessed. The prevalence of geohelminth infection was compared with the prevalence result obtained by the Kano State Ministry of Health.

Retrospective study of geohelminth infection in forty four local governments

Data on the prevalence of geohelminth infection in the forty four (44) local governments was obtained from department of Neglected Tropical Diseases, Kano State Ministry of Health from a pre intervention study conducted in 2011. It was a cross sectional study involving both sexes. Prevalence was compiled and analyzed using simple mean and percentage to obtain prevalence rate for each local government. According to WHO (2012), geohelminth infection endemic areas are classified into three categories in line with application of MDA: i) high transmission (where prevalence is > 50%), ii) moderate transmission (where prevalence is between 20-50%), and iii) low transmission (where prevalence is < 20%). Kano State was categorized base on the criteria using a colour coded map to show level of endemicity.

Ethical clearance

Introductory letter was sought and collected from Department of Biological Sciences. This was submitted to the State Universal Basic Education Board (SUBEB) for approval of the study. Clearance letter collected from SUBEB (Ref no. SUBEB/POL/138) was used as an introductory letter which was shown to Education secretary of the Local Government as well as principals and teachers of the schools.

Determination of prevalence and intensity of geohelminth infection in school aged children

Sample size that was used for the school aged children was 3000. This was obtained using stratified random sampling technique with LGA, WARDS, SCHOOLS and CLASSES used as strata. One (1) L.G.A (the most endemic area) was selected. Five Wards were randomly selected from this L.G.A., while 2 schools were randomly selected from each ward. Lastly, 50 children were selected randomly from each class across classes 1-6 to give a total of 1x 5 x 2x 50 x 6= 3000.

Sample collection in school aged children

Following parental/guardian consent, a labeled vial bottle with a tight fitting lid, an applicator stick and a piece of paper were given to them. They were asked to collect fresh stool sample on a piece of paper and an applicator stick should be used to transfer the specimen into the container. The specimens were examined using formalin-ethyl acetate concentration for presence of parasite eggs in the stool [24].

Stool analysis

About 10 ml of 10% formalin was added to 1 g of feaces and stirred using an applicator stick until a slight cloudy suspension was formed. A gauze filter was fitted into a funnel and placed on top of the centrifuge tube. The faecal suspension was passed through the filter into the centrifuge tube until a mark of 7 ml was reached. The filter was removed and discarded with the lumpy residue. 3 ml of ethyl acetate was added to the faecal suspension and mixed for a minute. The centrifuge tube was transferred into the centrifuge and run for 1 minute at 750-1000 g (approximately 3000 rpm). The fatty plug (debris) was loosened with an applicator stick and the supernatant was poured away quickly by inverting the tube. The tube was placed in its rack to allow all the fluid on the sides of the tube to drain down to the sediment. The sediment was stirred and a drop was transferred to the microscopic slide for examination. The whole area of the sediment was examined using x10 and x40 objectives for ova and larvae. Intensity of the infection was estimated based on number of eggs in 1g of stool i.e. egg per gram (EPG) and it was categorized into light, moderate and heavy [25]. Light intensity infection for *T. trichiura* category was defined as 1-999 EPG and the moderate to heavy intensity infection category was defined as ≥1,000 EPG. For ascariasis, light intensity infection was defined as 1-4,999 EPG and moderate to heavy intensity infection was defined as ≥5,000 EPG. For hookworm, light intensity infection was defined as 1-1,999 EPG and moderate to heavy intensity infection was defined as ≥2,000 EPG. The number of EPG of feaces for each species was recorded.

Determination of risk factors associated with geohelminth infection among school age children

Data were collected using a standardized questionnaire. The questionnaire had 9 questions developed in English which was translated to Hausa versions. It was designed to obtain information on risk factors associated with geohelminth infection. School aged children whose parent/guardian must have signed the consent form were interviewed to obtain information on demographic characteristics and social indicators such as source of water, type of toilet, sanitation, feeding behavior, and type of household were obtained in the questionnaire.

Data analysis

Descriptive statistics was used to analyze the prevalence of the geohelminth infections. Odd ratio was used to test association between the prevalence of geohelminth and risk factors. SPSS version 25.0 was used for analysis of all data and a probability level $P<0.05$ was used to test for significance.

RESULTS

Pre-intervention prevalence of geohelminth infection in 44 local government of Kano State

The prevalence of geohelminth infection in the 44 LGAs of Kano State is presented in Figure 1 in descending order. The highest prevalence rate (35.1%) was recorded in Kabo LGA and the lowest (6.4%) was recorded in Bebeji LGA. Figure 2 illustrate the level of endemicity of geohelminth in Kano State as at 2013. Of 44 LGAs, none was of high endemicity (>50%). Majority (27 LGAs) fell under low endemicity (<20%) with only 17 LGAs being of moderate endemicity (20-50%).

Post-intervention of prevalence of geohelminth infection in school aged children

Table 1 summarizes the demographic characteristics of School Aged Children (SAC) surveyed. A total of 3000 SAC from Kabo Model Primary School, Kabo Central Primary School, Garo Central Primary School, Abdun Garo Primary School, Gammo Central Primary School, Gwaraji Central Primary School, Gude Central Primary School, Mahuta Central Primary School, Godiya Central Primary School and Balan Central Primary School were sampled in the study. Out of the 3000 SAC who were enrolled in this study, 1568 (52.3%) were males and 1432 (47.7%) were females. The mean age of SAC was 10.4. The age range was 6-15 years. Sampled SAC were from classes one to six. Majority of the parent/guardian (71.9%) were not educated and were farmers (59.8%).

Table 2 shows the prevalence rates of geohelminth infection in SAC in Kabo Local Government Area (LGA), 3 years after the deworming programme. Out of 3000 School Aged Children examined, 66 (2.2%) were infected with geohelminths. The only helminth encountered was hookworm. Rate of infection varied across schools ranging from 0.7% in Mahuta Central Primary School to 3.7% in Balan Central Primary School. The prevalence of geohelminth infection in male and female children was 1.3% and 0.9% respectively. The intensity of infection was characterized based on the WHO grouping system of geohelminth infection intensities [13]. All the children had light intensity of geohelminth infection (mean: 17 epg).

A comparison between the findings of the geohelminth infection assessment reported in the present study with those of the reported data of the study carried out in 2013 by the KSMoH as shown in table 3 reveals a drastic reduction in the prevalence rate from 35.1% to 2.2% in Kabo L.G.A of Kano State.

Risk factors associated with geohelminth infection among school aged children

Findings on the assessed risk factors associated with geohelminth infection are prevalent among SAC as shown in Table 4. The result show that, inspite of the low prevalence of infection risk factors associated with geohelminth infection are highly prevalent among the children.

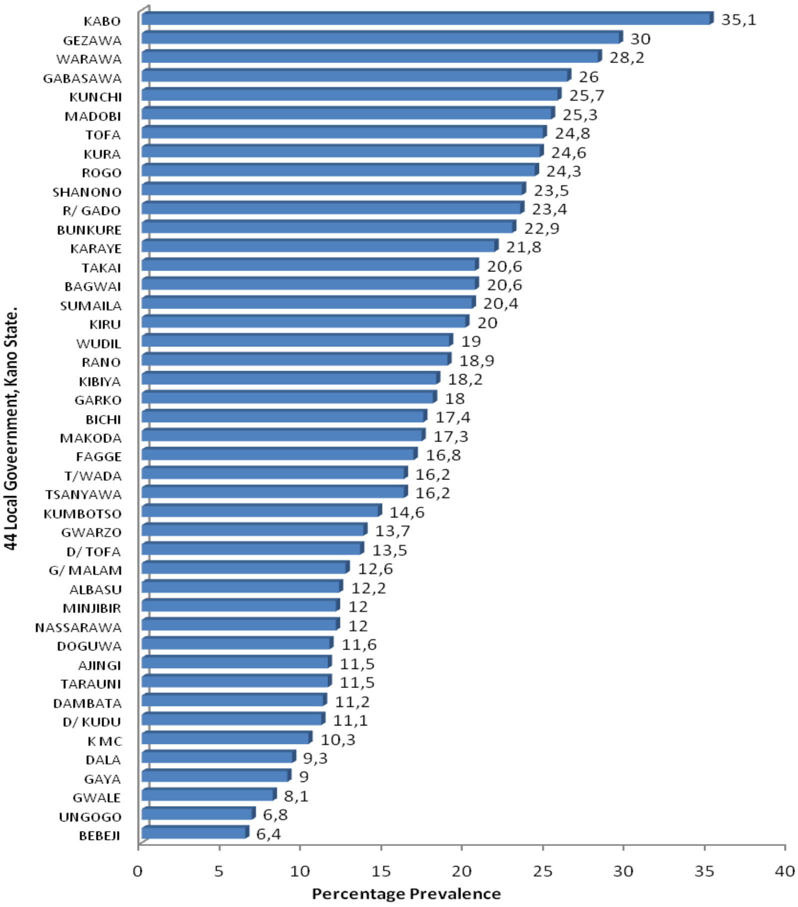

Figure 1. Prevalence of geohelminth infection in descending order in the 44 local government of Kano State.

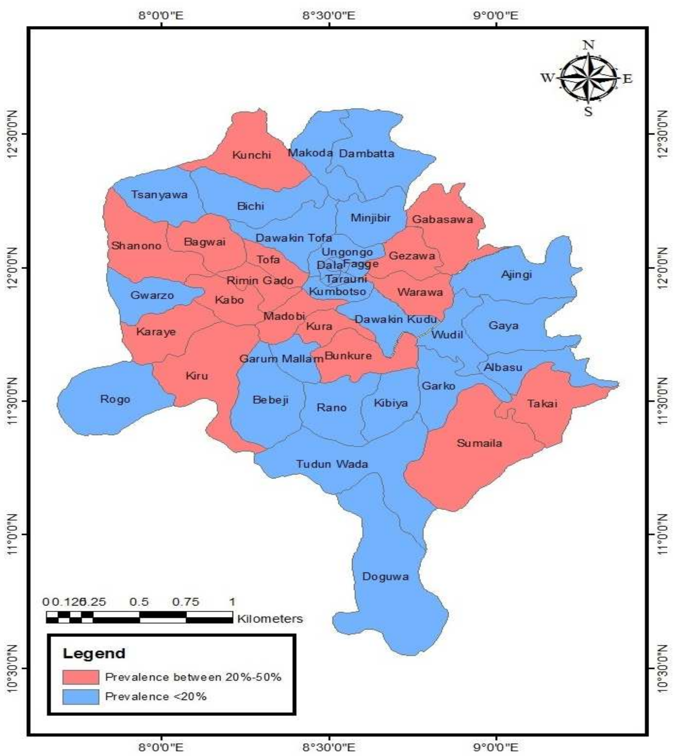

Figure 2. Map of Kano State showing endemicity of geohelminth infection.
Key: High transmission: prevalence >50%. Moderate transmission: prevalence between 20-50%. Low transmission: prevalence <20%.

Factors such as poor housing quality (mud houses) and poor toilet facilities (pit latrines) were recorded for all the participants. Majority of the children walk bare footed (63.7%) and eat outside home (62.7%). Many do not wash hands before meals (46.7%) nor after use of the toilet (46.7%) while an appreciable proportion practice nail biting (26.3%).

Analysis of association of these risk factors with geohelminth infection among the SAC revealed that only two of the assessed risk factors were significantly associated with infection among the SACs. The odds of having infection was almost 2 times higher among participants who walked barefooted than in those who wore shoes (OR=1.8, p=0.04).

Similarly, the odds of being infected was about twice higher among those who ate home cooked meals (OR=1.73, p=0.051). Although only two factors were found to be significantly associated with geohelminth infection in this study, yet infection rate was high among individual where the risk factor were prevalent.

Table 1. Demographic characteristics of school aged children.

Variable	**Total (%)**
Age group (years)	
6-10	1617 (53.9)
11-15	1383 (46.1)
Total	3000
Gender	
Male	1568 (52.3)
Female	1432 (47.7)
Total	3000
Parent/Guardian education	
Not educated	2156 (71.9)
Educated	844 (28.1)
Total	3000
Parent/Guardian occupation	
Farmer	1794 (59.8)
Trader	370 (12.3)
Civil service	696 (23.2)
Others	140 (4.7)
Total	3000

Table 2. Prevalence of geohelminth infection among school aged children.

Schools	**No. examined**	**Hookworm**		**Total infected (%)**	**Mean egg per gram**
		Male (%)	**Female (%)**		
Kabo Model Primary	300	4(1.3)	2(0.7)	6 (2.0)	2
Kabo Central Primary	300	4(1.3)	4(1.3)	8 (2.7)	1
Garo Central Primary	300	6(2)	4(1.3)	10(3.3)	2
Abdun Garo Primary	300	7(2.3)	2(0.7)	9 (3.0)	1
Gammo Central Primary	300	3(1)	0(0)	3 (1)	2
Gwaraji Central Primary	300	2(0.7)	4(1.3)	6 (2)	1
Gude Central Primary	300	4(1.3)	3(1)	7 (2.3)	2
Mahuta Central Primary	300	2(0.7)	0(0)	2 (0.7)	1
Godiya Central Primary	300	4(1.3)	0(0)	4 (1.3)	2
Balan Central Primary	300	4(1.3)	7(2.3)	11 (3.7)	1
Overall	3000	40 (1.3)	26(0.9)	66 (2.2)	17

Table 3. Comparison of data on geohelminth infection in 2013 with data of present study.

Source of information	No. examined	No. infected	% Prevalence
Data from 2013 KSMoH surveyed in Kabo LGA Kano	248	87	35.1
Present surveyed SAC in Kabo LGA Kano	3000	66	2.2

KSMoH - Kano State Ministry of Health, SAC - School Aged Children, LGA - Local Government Area.

Table 4. Risk factors associated with geohelminth infections among school aged children.

Variables	Categories	Frequency n=3000	No. infected (%)	OR	p-value
Eat outside home	Yes	1182	49 (2.6)	1.731	0.051
	No	1118	17 (1.5)		
Do not wash hands before meal and after toilet	Yes	1401	32 (2.3)	0.929	0.769
	No	1599	34 (2.1)		
Do not wear shoes	Yes	1912	50 (2.6)	1.80	0.040
	No	1088	16 (1.5)		
Nail biting	Yes	790	15(1.9)	0.819	0.501
	No	2210	51(2.3)		

OR - Odd Ratio.

DISCUSSION

With regards to mapping of geohelminth infection in Kano State, this study has provided data on the prevalence of geohelminth infection generated from the 44 LGAs of Kano State. The data has been presented in a bar chart (Figure 1) which reflects the level of endemicity in the different local government areas. Endemicity is a measure of disease prevalence in a particular region, while prevalence is the proportion of the people infected at a given point in time. According to WHO, geohelminth infection endemic areas are classified into three categories in line with application of MDA: i) high transmission (where prevalence is >50%), ii) moderate transmission (where prevalence is between 20-50%), and iii) low transmission (where prevalence is <20%) [26]. In the present study, no LGA was above 35%, placing the area in moderate to low transmission zone.

The prevalence of geohelminth infection among school aged children (SAC) was 2.2%. According to WHO [27], if 66 positive children are found, the area is classified as being in the soil transmitted helminth prevalence range of 20% to < 50%. There is reduction in the prevalence of geohelminth infection in the study area compared to the pre-intervention prevalence rate of geohelminth infection (35.1%) recorded by Kano State Ministry of Health (KSMoH) [28]. Reduction in the prevalence was due to the deworming intervention programme taking place in the study area which was distributed by Health and Development Support (HANDS) programme and Christian Blindness Mission (CBM) to the Ministry of health. This shows that the anthelminthic drugs were effective in reducing the prevalence of geohelminth infection. This study is in accordance with a study done by [29] in Kwazulu-Natal South Africa which showed that single dose treatment with albendazole was very effective against hookworm and *A. lumbricoides* with cure rates (CR) of 78.8% and 96.4% and egg reduction rates (ERR) of 93.2% and 97.7%, respectively however it was exceptionally ineffective against *T. trichiura* (CR = 12.7%, ERR = 24.8%). Also, the study is in accordance with a study done by [30] in Nigeria suggested that at baseline, the number of moderate infections was 6.2% and by the end of the follow-up after administration of albendazole the number of moderate infections dropped to 1%. [31-33] supported the use of albendazole for mass chemotherapy because of its effectiveness. School-based deworming also has major externalities for untreated children and the whole community by reducing disease transmission in the community as a whole [34]. Treatment with anthelminthic drugs reduces the transmissibility of the parasite by reducing worm load and shedding of eggs [35], with a single dose of anthelminthics resulting in CR of 88% for *A. lumbricoides* and 78% for hookworm [36]. A study on the efficacy of a mass drug administration programme from South India revealed that periodically administering albendazole reduced the geohelminth infection burden by 77% [37]. On visual examination, all schools visited had pit latrines and majority of the SAC wore shoes. This could partly explain for the observed low prevalence of geohelminth infection among SAC. Prevalence of geohelminth infection in male SAC (1.3%) was an indication that special activities of males such as walking in farm, playing football, walking in flood after rain fall, playing in contaminated soils and molding houses using moist soils could have predisposed them to infections [38]. Sometimes these activities are carried out in the study area while they are bare footed. This was supported by previous studies in Nigeria and India [20, 23, 39, 40] who separately reported high prevalence of geohelminth infection parasites among males than females due to their activities.). Number of eggs per gram counted showed that geohelminth infection (hookworm) was categorized as light. The relatively low prevalence value could be attributed to the inability of the 3rd stage infective larvae to access human skin as penetration of skin which is the major route of infection [41]. Another explanation for the relative low prevalence could be attributed to the survival rate of the larvae in the soil as texture and type of soil markedly influence the viability of the 3rd stage infective larvae [42]. The viability of the larvae is optimal on sandy, warm, humid soil [43].

While low-parasitic burden in a community is an indication of endemicity and chronicity [44, 45], from the public health point of view it is often interpreted as low health impact and therefore low priority [46, 47]. Moreover, in communities where deworming programs are implemented, low intensity infections might be interpreted as a success indicator [48, 49]. The absence of moderate and heavy intensity of infection could be the result of the mass chemotherapy which was done in 2013 [28] and probably some other behavioral and environmental factors that discourage transmission of geohelminth infection among SAC in the district.

A direct comparison of the survey from 2013 with the data of the present study could not be carried out fully because: the 2013 survey was community based while the present study is school based. Secondly, the ages of the children in 2013 survey were not available.

Among associated risk factors, eating outside home (street vended food), poor hand washing habit before meal and after toilet, not wearing shoe and nail biting were the major factor among SAC in the study area; and they were found not to be significantly associated ($p>0.05$) with geohelminth infections except risk factor such as not wearing of shoe and eating outside home (street vended food), which was significantly associated ($p<0.05$) with geohelminth infection. Bearing in mind that only hookworm was detected in this study, this present finding on the risk factors may be connected with the fact that hookworms are transmitted majorly via skin penetration. Therefore not wearing of shoe is a major factor in this instance. All the respondents mentioned mud bricks and pit latrine as the quality of housing and toilet facility both of which provides conducive environments for the geohelminth infection. This finding is accordance with a study conducted in Turkey by [50] who reported that children living in shanty areas had a higher risk of geohelminth infection than those living in towns. Usage of pit latrines in this study were the commonly used sites of sewage disposal which is in accordance with a study conducted by [11] who stated that the use of pit latrine reflects the poor socioeconomic status of the study subjects. Sufiyan et al. [51] in Nigeria concluded that participatory hygiene education to deworming programmes will greatly improve the hemoglobin level of children in areas where there is a high prevalence of hookworm infections. The appropriate mix of interventions for responding to geohelminth infection globally include access to safe water and provision of effective sanitation facilities will help to break the helminth transmission cycle; skills-based education, including life skills that address health and hygiene issues and promotion of positive behaviors; simple, safe, and familiar health and nutrition services that can be delivered cost-effectively in schools (such as deworming).

CONCLUSION

Pre-intervention survey revealed that none was of high endemicity. The highest prevalence (35.1%) was recorded in Kabo LGA and the lowest (6.4%) was recorded in Bebeji LGA. Present status of geohelminth infection in SAC shows an overall prevalence of 2.2%. The drop in the rate of infection from 35.1% to 2.2% (in Kabo) indicates a marked improvement in the health status of SAC in the State. Risk factors that predispose SAC to geohelminth infection like poor hand washing practice (2.3%), walking bare footed (2.6%), eating outside home (2.6%) was pre-dominant among SAC.

AUTHORS' CONTRIBUTIONS

TIO contributed in the conceptualization, data analysis, drafting and proof reading of the manuscript. ZG contributed in the data collection, writing of the manuscript, analysis of the data and final draft of the manuscript. BB was involved in the data collection, statistical analysis and proof reading of the manuscript. All authors read and approved the final manuscript.

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