Science World Journal Vol. 20(No 2) 2025 https://dx.doi.org/10.4314/swj.v20i2.52
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Full Length Research Article

OCCURRENCE AND EFFECTS OF INTESTINAL PARASITIC INFECTIONS ON BODY MASS INDEX OF ALMAJIRI CHILDREN IN ZARIA, KADUNA STATE, NIGERIA

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ABSTRACT
Intestinal parasites are prevalent across tropical and subtropical countries. Almajiri children in search of Islamic education in Nigeria are often left without basic necessities for healthy living and are largely prone to parasitic infections, which adversely affect their body mass index (BMI). This study determined the occurrence and effects of intestinal parasites on BMI of a cross-section of 150 almajiri children in Zaria. Their anthropometric indices were measured to assess malnutrition. Fresh stool samples obtained from the children were subjected to formol-ether concentration technique and examined for intestinal parasites using the light compound microscope. Mean age, height, weight and BMI of the children were 8.03±0.10 years, 1.35±0.0m, 28.76±0.64kg and 15.62±0.28 respectively. Overall occurrence of intestinal parasitic infections was 13.3%. The most occurring parasite was *Entamoeba histolytica* (5.3%). *Ascaris lumbricoides* and hookworms had equal occurrences of 2.7% each. Also, *Hymenolepis nana* and *Schistosoma mansoni* had equal occurrences of 1.3% each, while *Trichuris trichiura* (0.7%) was the least occurring. Children between 5-8 years old had higher occurrence of intestinal parasites (15.1%) than those between 9-12 years old (9.1%, OR=1.778). Almajiri children from Angwan Guava had the highest infections (23.3%), followed by those from Layin Gidan Chairman (20.0%), Layin Bursa (13.3%), Hayin Commada-I (6.7%), but the least was 3.3% among those from Hayin Commada-II. Significant risk factors identified were lack of antihelminthic prophylaxis (P=0.014), lack of regular putting on of footwear (OR=1.500), engagement in farming (OR=1.369), especially on farmlands where untreated night soil was applied (OR=1.138) and lack of regular bath (OR=1.111). Watery stool was significantly associated with parasitic infections (P=0.013). Frequency of malnourished/underweight children was 85.3%, who recorded higher occurrence of intestinal parasites (14.1%; P=0.526) than those with normal BMI (9.1%).These vulnerable children require better education, safe living conditions, health protection and adequate sensitization.

Keywords: Intestinal parasites, Infection, Effects, BMI, Almajri, Underweight.

INTRODUCTION

Intestinal parasites are also known as soil-transmitted helminths (STHs) or geohelminths (Bishop and Yohanna, 2018) because of their inseparable relationship with soil necessary for their transmission and lifecycles. The most common STHs include *Ascaris lumbricoides, Trichuris trichiura, Anyclostoma duodenale, Necator americanus,* and *Strongyloides stercoralis* (Adefioye *et al.*, 2011; Morawski *et al.*, 2017; Zeleke *et al.*, 2021; Yahaya *et al.*, 2024). These parasites affect about half of the world's population; but the most vulnerable group is children (Bishop *et al.*, 2022a). Rural areas suffer a great deal of parasitic infections which severely affect children, by causing malnutrition, anaemia, reduced cognitive ability and poor performance in school (Bishop *et al.*, 2022b). Human infections with intestinal parasites occur through ingestion of parasitic eggs or larval penetration of skin. Infections are often facilitated by consumption of contaminated food/water and negligence of proper hygiene (Idowu *et al.*, 2019).

Almajiri children (also called almajiris) are found across many states in Nigeria in search of Islamic education from mallams (Damen *et al.*, 2011; Shimawua, 2020; Gregory *et al.*, 2023). From Hausa language, the word 'almajiri' was borrowed from Arabic language which refers to someone who has left his home in search of knowledge in Islamic religion in a faraway land or by extension an immigrant child in search of Quranic education (Yahaya *et al.*, 2015; Yunusa *et al.*, 2016). Children sent into the almajiri system may be as young as four years old (Yahaya *et al.*, 2015), and mostly below 6 years old (Gregory *et al.*, 2023).

Almajiri education system is a precolonial system of child education that has persisted and expanded across many states in Nigeria (Muhammad *et al.*, 2023). Parents send their children into this system due to poverty (Teke and Katami, 2023). Such children are commonly found in Nigerian northern states including Kano, Kaduna, Katsina, Sokoto, Kebbi, and Zamfara among others. There are about 1.1 million almajri children in Sokoto state (Yunusa *et al.*, 2016), but an estimated eight million of such children live in different parts of Nigeria. Almajiri children are also found in other African countries like Burkina Faso, Chad, Ghana and Niger (Yahaya *et al.*, 2015).
Children under the almajiri education system have no participation in formal education, and are prone to abuse, poverty, and under development (Muhammad *et al.*, 2023). They are deprived of parental care, food and healthy place to live, and are often seen begging daily to survive. Some of them work on farmlands, or collect recyclable materials from waste dumps (Bature and Bawa, 2013; Iduh *et al.*, 2015; Yunusa *et al.*, 2016; Yandoma and Yohanna, 2019; Gregory *et al.*, 2023). Almajiri schools are characterized by unhygienic conditions, overcrowding and poor water quality (Iduh *et al.*, 2015) which can predispose these children to parasitic infections. These infections cause nutritional impairments, poor cognitive ability and retarded physical growth that can be evidenced by very low BMI (Sheresha *et al.*, 2021; Mohammed *et al.*, 2022; Drake *et al.*, 2022; Bishop *et al.*, 2022b; Nqweniso *et al.*, 2023; De Sousa *et al.*, 2024)

Children are more prone to geohleminthic infections because they love to play with soil, often lick their fingers, eat unwashed fruits and without regular hand washing. They are mostly unaware of the danger of their indiscriminate daily play habits (Bishop *et al.*, 2022b). This informed the choice of this study to ascertain the occurrence of intestinal parasitic infections and their effects on BMI of a more underprivileged group of children called the almajiris.

MATERIALS AND METHODS

Study Area and Population

Zaria is gradually transforming into an urban area, propelled by centralization of several tertiary institutions. Despite infrastructural and human-capital development in the area, many of its communities are still characterized by unsatisfactory level of sanitation. This scenario has triggered and sustained the spread of parasitic infections. The study included 150 randomly selected almajiri children between 5-12 years old who consented verbally. Also, verbal consents from their respective mallams were obtained before commencing the study.

Administration of Questionnaires

In this cross-sectional, descriptive and analytical study, data on demography and risk factors of intestinal parasitic infections among the almajiri children were obtained by means of structured questionnaires. The local language (Hausa) was mainly the medium of communication with the almajiris. Where necessary, assistance of their teachers (or mallams) was required during the interaction. Participation by each of the study subjects was wholly voluntary.

Determination of Body Mass Index (BMI)

The weight (kg) and height (m) of each almajiri child with minimal clothing and without shoes were measured to the nearest whole number. The BMI was calculated as weight divided by the square of height, and categorized based on WHO guideline for BMI-for-Age for boys (WHO, 2025).

Collection of Stool Samples

Sterile, wide-mouth sampling bottle was provided for each consented child and they were guided on how to provide their fresh stool samples for the study. A total of 150 stool samples (one per individual) were obtained from the selected almajiri children. The samples were conveyed immediately to the laboratory for parasitological examination at the Department of Microbiology, Ahmadu Bello University, Zaria.

Detection of Intestinal Parasites

The colour and consistency of each stool sample were observed, and then subjected to formo-ether concentration technique to concentrate parasitic eggs and cysts; which were identified using light compound microscope with the aid of parasitological atlases as described by Cheesbrough (2009) and Bishop *et al.*, (2022a; 2022b).

Statistical analysis

Data obtained together with laboratory findings were subjected to Chi Square (χ^2) and Odds Ratio (OR) analyses on IBM SPSS Version 20 at 95% confidence interval. Factors which had statistical p-value ≤ 0.05 were considered significant.

RESULTS

This study found an overall occurrence of 13.3% of intestinal parasitic infections among almajiri children in Zaria, Kaduna State, Nigeria (Figure 1). There were occurrences of six different types of intestinal parasites that included *Entamoeba histolytica* (5.3%) as the most occurring, followed by equal occurrences of 2.7% each of *Ascaris lumbricoides* and hookworms; *Hymenolepis nana* and *Schistosoma mansoni* had equal occurrences of 1.3% each, while the least occurring parasite was *Trichuris trichiura* (0.7%) as shown in Table 1.

Based on age distribution of intestinal parasitic infections (Table 2), younger almajiri children between 5-8 years old had higher occurrence of 15.1% infections with intestinal parasites than the older children (between 9-12 years old) who had 9.1% of the infections. There was no significant statistical association between age of almajiri children and intestinal parasitic infections (P=0.325); however, higher risk of the infections was recorded among the older children between 9-12 years old (OR=1.778).
Almajiri children from Angwan Guava had the highest occurrence of intestinal parasitic infections of 23.3%, followed by those from Layin Gidan Chairman (20.0%) and Layin Bursa (13.3%). Other almajiri children from Hayin Commada-1 had 6.7% infection, but the least infection was 3.3% found among almajiris from Hayin Commada-2 (Table 3).

Table 4a presents some likely risk factors of intestinal parasitic infections among the study population. Almajiri children that had not received antihelminthic prohylaxis had statistically significant higher occurrence of intestinal parasitic infections (18.9%, P=0.014) than others that had received the antihelminthic intervention (5.0%). Higher occurrence of intestinal parasitic infections was recorded among almajiri children that practiced open defecation (14.0%), did not wash their hands after defecation (19.5%), or used only water in washing hands (13.5%), but these factors were not statistically associated with the infections (P>0.05). However, higher risk of the infection was found among those that claimed to have received mass antihelminthic intervention (OR=4.425), as well as those that used pit latrines (OR=1.239), and claimed to wash hands after defecation (OR=1.960), especially with water and soap (OR=1.246). Also, almajiris that were not frequently on footwear (OR=1.500) or were not on footwear as at the time of the study (OR=1.048) were more at risk of intestinal parasitic infections.

Similarly in Table 4b, almajiri children that did not wear footwear during farm work had higher intestinal parasitic infections (16.5%) than those who wore footwear (9.9%), but it was not a significant factor (P=0.235). Higher risk of the infections were also found among those that engaged in farming (OR=1.369), especially on farmlands where untreated night soil was applied (OR=1.138), as well as those that claimed to be on footwear during farm work (OR=1.801) and did not bathe regularly (OR=1.111).

Based on stool presentation of the Almajiri children, those whose stool samples were brown in colour had higher occurrence of intestinal parasitic infections (13.7%) than others whose stool samples were yellow (10.5%), but it was not a statistically significant difference (P=0.700). However, yellowish stool samples were more likely to contain intestinal parasites (OR=1.354). Based on consistency of the stool samples, the highest occurrence of

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www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
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intestinal parasitic infections was in watery stool samples (25.6%), followed by semi-formed stool samples (13.75), while the least was 5.0% in formed stool samples. The nature of (watery) stool consistency significantly associated with intestinal parasitic infections (P= 0.013) as shown in Table 5.

Table 6 presents the likely effect of intestinal parasitic infections on body mass index (BMI) of the almajiri children. There was higher occurrence of intestinal parasitic infections among those who were underweight (14.1%) than among others who had normal BMI (9.1%); however, it was not found to be statistically significant (P=0.526), and higher risk of the infections was rather found among children with normal BMI (OR=1.636).

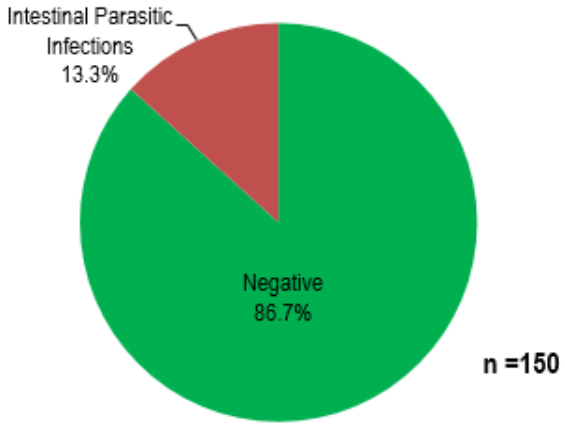

Figure 1: Overall Occurrence of Intestinal Parasitic Infections among Almajiri Children in Zaria, Kaduna State, Nigeria

Table 1: Occurrences of Intestinal Parasites among Almajiri Children in Zaria, Kaduna State

Intestinal parasite	Frequency n = 150	Occurrence (%)
Entamoeba histolytica	8	5.3
Ascaris lumbricoides	4	2.7
Hookworms	4	2.7
Hymenolepis nana	2	1.3
Schistosoma mansoni	2	1.3
Trichuris trichiura	1	0.7

Table 2: Age Distributions of Intestinal Parasitic Infections among the Almajiri Children

Age (Years)	Number examined	Number Positive (%)	χ^2	df	P	OR (95% CI)
5-8	106	16(15.1)	0.970	1	0.325	0.563 (0.177 – 1.789)
9-12	44	4(9.1)				1.778

Table 3: Distribution of Intestinal Parasitic Infections based on Location of the Children in Zaria

Location	Number examined	Number Positive (%)	χ^2	df	P
Angwan Guava	30	7(23.3)			
Layin Gidan Chairman	30	6(20.0)			
Layin Bursa	30	4(13.3)			
Hayin Commada-1	30	2(6.7)	7.500	4	0.112
Hayin Command-2	30	1(3.3)			

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Table 4a: Risk Factors of Intestinal Parasitic Infections among Almajiri Children in Zaria

Risk factor	Number examined	Number Positive (%)	χ^2	df	P	OR (95% CI)
Antihelminthic treatment						
No	90	17(18.9)	6.010	1	0.014	0.226 (0.063 – 0.809)
Yes	60	3(5.0)				4.425
Place for defecation						
Open place	107	15(14.0)	0.152	1	0.697	0.807 (0.274 – 2.377)
Pit latrine	43	5(11.6)				1.239
Washing of hands after defecation						
No	41	8(19.5)	1.864	1	0.172	0.510 (0.192 - 1.357)
Yes	109	12(11.0)				1.960
Materials for washing of hands						
Water and soap	9	1(11.1)	0.041	1	0.840	1.246 (0.147- 10.529)
Water only	141	19(13.5)				0.803
Regularly on footwear						
No	88	10(11.4)	0.715	1	0.398	1.500 (0.584- 3.856)
Yes	62	10(16.1)				0.667
Currently on footwear						
No	69	9(13.0)	0.009	1	0.923	1.048 (0.407 – 2.698)
Yes	81	11(13.6)				0.955

Table 4b: Risk Factors of Intestinal Parasitic Infections among the Almajiri Children (cont'd)

Risk factor	Number examined	Number Positive (%)	χ^2	df	P	OR (95% CI)
Arable farming						
No	37	6(16.2)	0.353	1	0.552	0.731 (0.259 – 2.063)
Yes	113	14(12.4)				1.369
Farming with footwear						
No	79	13(16.5)	1.408	1	0.235	0.555 (0.208 – 1.481)
Yes	71	7(9.9)				1.801
Use of night soil on farms						
No	56	8(14.3)	0.070	1	0.791	0.878 (0.335 – 2.300)
Yes	84	12(12.8)				1.138
Regular bath						
No	115	15(13.0)	0.036	1	0.850	1.111(0.373 – 3.309)
Yes	35	5(14.3)				0.900

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Table 5: Stool Characteristics in Relation to Intestinal Parasitic infections among the Almajiri Children

Stool presentation	Number examined	Number Positive (%)	χ^2	df	P	OR (95% CI)
Colour						
Brown	131	18(13.7)	0.138	1	0.700	0.739 (0.157 – 3.470)
Yellow	19	2(10.5)				1.354
Consistency						
Formed	60	3(5.0)	8.725	2	0.013	not applicable
Semi-formed	51	7(13.7)				
Watery	39	10(25.6)				

Table 6: Effects of Intestinal Parasitic Infections on Body Mass Index of Almajiri Children in Zaria, Kaduna State

Body mass index	N	Number Positive (%)	χ^2	df	P	OR (95% CI)
Normal (18.50– 24.50)	22	2(9.1)	0.402	1	0.526	1.636 (0.352 – 7.607)
Underweight (<18.50)	128	18(14.1)				0.611

DISCUSSION

The almajiri children suffered a burden of intestinal parasitic infections (of 13.3%), which is of significant health concern. Notably, these infected children may serve as repository for spread of parasitic infections in the community, mainly because they engage in open defecation and have poor level of awareness which makes them more vulnerable. These children are also predisposed to parasitic infections due to poor living conditions and close contact with parasites-infested environments. There are various reports of higher prevalence of intestinal parasites among almajiri children that include 80.9% (Damen *et al.*, 2011), 74.5% (Iduh *et al.*, 2015), 83.2% (Yandoma and Yohanna, 2019), and 65.0% (Mohammed *et al.*, 2022). Comparatively, prevalence of 52.0% was reported among school children in Osun State, Nigeria (Adefioye *et al.*, 2011); while 2.5% was reported among children in orphanages across three states in South-eastern Nigeria (Njoku *et al.*, 2022). Intestinal parasites, urinary tract infections, *Neisseria meningitidis* infection, malaria and occupational injuries are the most reported ailments among almajiri children (Muhammad *et al.*, 2023).

Entamoeba histolytica was the most occurring in this study, yet it is not the most prevalently reported intestinal parasite in Nigeria. This infection is likely due to consumption of water from contaminated sources like rivers and streams, in which the children may also swim, which could have resulted in infection with *Schistosoma mansoni.* However, equal occurrences of each of *Ascaris lumbricoides* and hookworms were the next more prevalent parasites. Previous studies had frequently reported *Ascaris lumbricoides* as the most prevalent intestinal parasite in Nigeria (Adefioye *et al.*, 2011; Damen *et al.*, 2011; Mohammed *et al.*, 2022).

The younger children (5-8 years old) had higher occurrence of the intestinal parasites probably because they were more naïve concerning personal hygiene. This observation had been similarly reported by Damen *et al.* (2011). Conversely, Mohammed *et al.* (2022) reported higher infection among children of 9-12 years old. Nevertheless, higher risk (OR>1) of intestinal helminthiasis was mainly among the older children (9-12 years old) who might be more predisposed during activities like fishing and swimming in stagnant water bodies. However, Iduh *et al.* (2015) and Yondama and Yohanna (2019) reported higher occurrences of intestinal parasites among 5-10 and 10-12 years old children respectively. Also, Bishop *et al.* (2022a) had reported higher occurrence of *Ascaris lumbricoides* among school children between 12-13 years old; but others between 6-7 years old had higher hookworm infections (Bishop *et al.*, 2022b). Age-dependent distribution patterns of these parasitic infections between this study and previous ones may be influenced by differences in prevailing exposures to risk factors, sources of water, level of awareness and living conditions across different study areas.

Locations of the almajiri children within the study area did not significantly affect the distribution of parasitic infections among them, mainly because the living conditions and exposure to infections are approximately the same across the area. Many risk factors predisposed the almajiri children to parasitic infections; significant among them included lack of antihelminthic prophylaxis, lack of regular putting of footwear, engagement in farming, especially on farmlands where untreated night soil was applied and lack of regular bath. These factors have been commonly reported across various studies by Iduh *et al.* (2015), Njoku *et al.* (2022) and Bishop *et al.* (2022a; 2022b). Also, open defecation, poor sanitation, and unsafe agricultural practices increase the transmission of geohelminths (Amoah *et al.*, 2018; Muluneh *et al.*, 2020). If these children remain without adequate improvement in the almajiri education system, more infections may occur!

Stool colour was not significantly associated with the infections because it is largely impacted by type of food/diet consumed, and not necessarily due to underlying infection(s). However, stool with watery consistency was significantly associated with intestinal parasitic infections, because these STHs are agents of diarrhoea. Established symptoms of intestinal parasitic infections are notably abdominal pains, diarrhoea, nausea and vomiting (Cheesbrough, 2009; Tiruneh *et al.,* 2020; Bishop *et al.*, 2022b; Njoku *et al.*, 2022). In developing countries, diarrhoeal cases are mostly among young children who live in areas of poor sanitation and drink from unsafe water sources like wells (Bishop and Inabo, 2015a; 2015b; Idowu *et al.*, 2019). These intestinal parasitic infections are neglected tropical diseases (NTDs). Importantly, NTDs thrive in areas marked by poor conditions of housing, poor sanitation, unsafe water, and inadequacy of basic healthcare (Bishop, 2017).

The infected almajiri children had higher incidence of underweight BMI. However, their underweight BMI was not statistically associated with underlying intestinal parasitic infections. Since majority of the children (85.3%) had very low BMI, which was indicative of malnutrition, the effect of underlying parasitic infections may not be obvious or statistically revealing! In general population studies, intestinal parasitic infections have been linked to poor growth indices, especially among children (Haque, 2007; Damen *et al.*, 2008; Cheesbrough, 2009; Lamberton and Jourdan, 2015; Yandoma and Yohanna, 2019; Bishop *et al.*, 2022a; 2022b). Although intestinal parasitic infections may contribute to malnutrition (Omitola *et al.*, 2016), they are not the sole determinant of underweight status in this population; as other factors such as inadequate diet, poor living conditions, and other illnesses could interplay towards the development of low BMI (Ghosh, 2020).

Conclusion

This study found an occurrence of 13.3% of intestinal parasitic infections among almajiri children in Zaria, Kaduna State, Nigeria. The parasites responsible for the infections were *Entamoeba histolytica* (5.3%), *Ascaris lumbricoides* (2.7%), hookworms (2.7%), *Hymenolepis nana* (1.3%), *Schistosoma mansoni* (1.3%), and *Trichuris trichiura* (0.7%). Young almajiri children of 5-8 years were more infected, but higher risk was recorded among those older children of 9-12 years. Occurrence of the infections was not influenced by the locations where the children lived in Zaria. Significant risk factors of intestinal parasitic infections among them included lack of antihelminthic prophylaxis, lack of regular putting on of footwear, engagement in farming, especially on farmlands where untreated night soil was applied and lack of regular bath. Majority of the children (85.3%) had very low BMI, which was indicative of malnutrition. The low BMI was not statistically associated with the underlying intestinal parasitic infections. The health, education and general wellbeing of all children should become a collective and prioritized responsibility!

Acknowledgement

We wish to express appreciation to the mallams who assisted us during conversation with the almajiris. We equally thank all the children that willingly participated in the study.

Conflict of interest

The authors of this article wish to declare that there are no conflicts of interest regarding this study. The study did not receive any funding.

REFERENCES

Adefioye, O.A, Efunshile, A.M, Ojurongbe, O., Akindele, A.A, Adewuyi I.K, Bolaji O.S, Adedokun, S.A. and Adeyeba A.O. (2011). Intestinal helminthiasis among school children in Ilie, Osun State, Southwest, Nigeria. *Sierra Leone Journal Biomedical Research,* 3(1):36-42.

Amoah, I.D., Adegoke, A.A. and Stenström, T.A. (2018). Soil-transmitted helminth infections associated with wastewater and sludge reuse: A review of current evidence. *Tropical Medicine and International Health,* 23(7):692-703. https://doi.org/10.1111/tmi.13076

Bature, J.N. and Bawa, J. (2013).The almajiri educational system in Nigeria: cost and challenges. *Journal of Educations*, 3(1):45-53.

Bishop, H.G. (2017). Menace of Schistosomiasis: Its True Neglected Nature in Nigeria. *MOJ Public Health*, 6(5): 00186. https://doi.org/10.15406/mojph.2017.06.00186

Bishop, H.G. and Inabo, H.I. (2015a). Incidence of *Giardia lamblia* in hand-dug well water in Samaru-Zaria, Nigeria. *International Journal of Extensive Research*, 4:43-47.

Bishop, H.G. and Inabo, H.I. (2015b). Incidence of *Entamoeba histolytica* in well water in Samaru-Zaria, Nigeria. *International Journal of Scientific Research in Environmental Sciences*, 3(1):0016-0022. http://dx.doi.org/10.12983/ijsres-2015-p0016-0022

Bishop, H.G. and Yohanna, A.Z. (2018). Contamination of vegetables with geohelminths: prevalence, intensity and roles of hygiene practices in Samaru-Zaria, Nigeria. *International Journal of Academic and Applied Research*, 2(7):8-13.

Bishop, H.G., Azeez, Z., Ujah A.O., Momoh S.J. and Barwa J. (2022a). *Ascaris lumbricoides*: the risk factors and effects on growth of schoolchildren within Samaru, Zaria, Nigeria. S*cience World Journal*, 17(2):268-290.

Bishop, H.G., Azeez Z.., Momoh S.J., Abdullahi B., Ujah A.O., Barwa J. and Babalola A.R. (2022b). Risk factors and effects of hookworm infections on anthropometric indices of school children in Samaru, Zaria, Nigeria. S*cience World Journal*, 17(2):291-294.

Cheesbrough, M. (2009). District Laboratory Practices in Tropical countries, Part I, 2nd ed. updated, London Cambridge University Press, Cambridge, UK, pp. 191-199.

Damen, J.G., Luka, J., Biwan, E.I., Lugos, M. (2008). Prevalence of intestinal parasites among pupils in rural north eastern, Nigeria. *Nigerian Medical Journal*, 52(1):4-6.

de Sousa, E.B., Silva, V.F., da Silva, A.B.A., Vieira, L.S., Matos, M.F., Saraiva, B.H.d.S., Lima-Maximino, M., Maximino, C. and Pereira, Jr, A. (2024). Soil-transmitted helminthiases negatively impact cognitive development in children: Wechsler Intelligence Scale for Children domains. *Psychology & Neuroscience*, 17(2):122-130. https://doi.org/10.1037/pne0000328

Drake, L., Jukes, M. and Bundy, D. (2022). Geohelminth infections (Ascariasis, Trichuriasis and Hookworm): cognitive and developmental impacts. *Seminars in Pediatric Infectious Diseases*, 11:245-251. https://doi.org/10.1053/spid.2000.9638

Ghosh, S. (2020). Factors responsible for childhood malnutrition: A review of the literature. *Current Research in Nutrition and Food Science Journal*, 8(2); 360-370.

Gregory, D.M, Mohammed, S. and Halilu, S. (2023). Review of almajiri education system in Nigeria. *International Journal of Education and National Development*, 1(3):11-18.

Haque, R. (2007). Human intestinal parasites. *Journal of Health, Population and Nutrition,* 25(4):387-391.

Idowu, E.T., Fagbohun, I.K., Sanyaolu, O.L., Oguntuyi, K.O. and Otubanjo, O.A.J.A.R.I. (2019). Soil-transmitted helminth infections among school aged children in Lagos State, Nigeria. *Animal Research International*, 16(3), 3508–3518.

Iduh, M.U., Isaac, I.Z., and Mustapha, S. (2015). Prevalence of intestinal parasites among the "almajiris" in Sokoto metropolis, Sokoto Nigeria. *International Journal of Novel Research in Life Sciences*, 2(5):11-17.

Lamberton, P.H.L. and Jourdan, P.M. (2015). Human ascariasis: diagnostic update. *Current Tropical Medicine Reports,* 2:180-200.

Mohammed, M., Bala, M.N., Salisu, M.D. and Sani, K.A. (2022). Prevalence of intestinal parasites among children of selected almajiri schools in Kaura Namoda Local Government, Zamfara State, Nigeria. *Journal of Innovative Research in Life Sciences*, 4(1):14-19.

Morawski, B.M., Yunus, M., Kerukadho, E., Turyasingura, G., Barbra, L, Ojok, A.M., DiNardo, A.R., Sowinski, S., Boulware, D.R. and Mejia, R. (2017). Hookwoorm infection is associated with decreased $CD4^+$ T cell counts in HIV-Infected adult Ugandans. *PLoS Neglected Tropical Diseases*, 11(5):e0005634. https://doi.org/10.1371/journal.pntd.0005634

Muhammad, M.I., Abdulsalam, A.H., PetitClair, F., Acquaye, A., Nobles, A., Fleischer, B., Konkwo, C., Ransome, Y. and Paintsil, E. (2023). Almajiri health; a scoping review on disease, health literacy and space for participatory research. *PLOS Global Public Health,* 3(10):e0001641. https://doi.org/10.1371/journal.pgph.0001641

Muluneh, C., Hailu, T. and Alemu, G. (2020). Prevalence and associated factors of soil-transmitted helminth infections among children living with and without open defecation practices in Northwest Ethiopia: a comparative cross-sectional study. *American Journal of Tropical Medicine and Hygyiene*, 103(1); 266-272. https://doi.org/10.4269/ajtmh.19-0704

Njoku, M.O., Iloh, K.K., Okike, C.O., Njoku, G.C. and Ojinnaka, N.C. (2022). The prevalence and intensity of intestinal helminths among institutionalized children in three states of South-East Nigeria. *Nigerian Journal of Clinical Practice,* 25:718-24. https://doi.org/10.4103/njcp.njcp_1880_21

Nqweniso, S., Walter, C., du Randt, R., Adams, L., Beckmann, J., Coulibaly, J.T., Dolley, D., Joubert, N., Long, K.Z., Müller, I., Nienaber, M., Pühse, U., Seelig, H., Steinmann, P., Utzinger, J., Gerber, M. and Lang, C. (2023). Associations between soil-transmitted helminth infections and physical activity, physical fitness, and cardiovascular disease risk in primary schoolchildren from Gqeberha, South Africa. *PLoS Neglected Tropical Diseases*, 17(10):e0011664. https://doi.org/10.1371/journal.pntd.0011664

Omitola, O.O., Mogaji, H.O., Oluwole, A.S., Adeniran, A.A., Alabi, O.M and Ekpo, U.F. (2016). Geohelminth infections and nutritional status of preschool aged children in a periurban settlement of Ogun State. *Scientifica (Cairo)*, 2016:7897351. https://doi.org/10.1155/2016/7897351

Sheresha, B.K., Tumbahangphe, M., Shakya, J., Rai, A., Dhakal, K., Dhugana, K., Ghimire, S., Chauhan, S., Chalise, L. and Ghimire, A. (2021). Prevalence and related risk factors of intestinal parasitosis among private school going pupils in Dharann submetropolitan city, Nepal. *Journal of Parasitology Research*. https://doi/10.org.1155/2021/6632469

Shimawua, D. (2020). Assessment of the implementation of almajirin system of education in Nigeria. *International Journal of Strategic Research in Education, Technology and Humanities*, 8(1): https://doi.org/10.48028/iiprds/ijsreth.v8.i1.10

Teke, A.M. and Katami, N.A. (2023). Assessment of almajiri system of education in Sokoto State, Nigeria. *Rima International Journal of Education,* 2(2):189-206.

Tiruneh, T., Geshere, G and Ketema, T. (2020). Prevalence and determinants of soil-transmitted helminthic infections among school children at goro primary school, south west Shewa, Ethiopia. *International Journal of Pediatrics*, 2020(1):8612054.

WHO (2025). BMI-for-age (5-19 years). Accessed on 15th January 2025 from https://cdn.who.int/media/docs/default-source/child-growth/growth-reference-5-19-years/bmi-for-age-(5-19-years)/cht-bmifa-boys-perc-5-19years.pdf?sfvrsn=5aad7915_4

Yahaya, A., Tyav, Y.B., Idris, A. and Manchanda, P. (2015). Prevalence of intestinal parasitic helminths from fingernails of "almajiris" in Birnin Kudu local government area, Jigawa state, Nigeria. *International Journal of Tropical Diseases and Health*, 8:66-74.

Yahaya, O., Bishop, H.G., Abubakar, H., Jacob, S. and Apata, C.O. (2024). Occurrence and diversity of intestinal parasites on raw vegetables sold in Samaru, Zaria *UMYU Journal of Microbiology Research*, 9(1):158-163. https://doi.org/10.47430/ujmr.2491.017

Yandoma, R.I. and Yohanna, S. (2019). Risk factors for intestinal parasitosis among almajiri pupils in Zaria, North Western Nigeria. *Nigerian Journal of Basic and Clinical Science*, 16:60-3. https://doi.org/10.4103/njbcs.njbcs_47_17

Yunusa, E., Awosan, K., Ibrahim, M. and Isah, B. (2016). Prevalence, epidemiological characteristics and predictors of occurrence of urinary schistosomiasis among Almajiri school children in Sokoto, Nigeria. *International Journal of Medicine and Medical Sciences*, 8(3):22-29.

Zeleke, A.J., Addisu, A., Derso, A., Tegegue, Y., Birhanie, M., Sisay, T. and Aemero, M. (2021). Evaluation of hookworm diagnosis techniques from patients in Debre Elias and Sanja Districts of the Amhara region Ethiopia. *Journal of Parasitology Research*, 2021(Article ID 6682330. https://doi.org/10.1155/2021/6682330