Prevalence of Intestinal Helminths among Orphanages and Some Almajiri Schools in Sokoto Metropolis, Sokoto State, North-Western Nigeria

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Abstract

Intestinal helminthiasis is still a serious public health problem in under-developed and developing countries like Nigeria. Therefore, local epidemiological data is indispensable to design and monitor prevention and control strategies. This study was carried out to determine the prevalence of intestinal helminths among orphanages and some Almajiri schools in Sokoto Metropolis, Sokoto State, North-Western Nigeria. A descriptive cross-sectional survey was conducted among a total of 400 orphans and Almajiris in the study area. Stool samples were collected and examined for intestinal helminths using standard methods. The overall prevalence of intestinal helminthiasis was found to be 123(30.75%). Four (4) species of intestinal helminths were identified and the highest prevalence rate was seen in Ascaris lumbricoides 55(13.75%), followed by Trichuris trichiura 39(9.75%), hookworms (Ancylostoma duodenale/Necator americanus) 21(5.25%), and Strongyloides stercoralis 08(2.00%). The infection rate was higher in males 85(21.25%) than in females 38(9.50%). The subjects aged 8-10 years were more infected 70(17.50%) than the rest 53(13.25%). The infection rate was greatly higher in the Almajiri schools 113(28.25%) than in the orphanages

10(2.50%). In this study, there was no statistically significant difference (P>0.05) between the prevalence of intestinal helminths among orphanages and Almajiri schools in the study area ($X^2 = 4.124$, P = 0.127). In conclusion, this study revealed the prevalence of intestinal helminth parasites among the subjects in the study area. This study recommends provision of safe food and drinking water, regular deworming exercise, government interventions, health education, improved child/care-giver ratio, reduction of overcrowding, and discouragement of open defecation and walking barefooted.

Keywords: Epidemiology; Intestinal Helminthiasis; Orphanages; Almajiris; Hookworm; Sokoto Metropolis.

1.0 introduction

Helminths are bilaterally symmetrical animals having three germ layers (triploblastic metazoans) (Assafa *et al.*, 2004) and nematodes (roundworms), cestodes (tapeworms) and trematodes (flatworms or flukes) are among the most common helminths that inhabit the human alimentary canal (Daryani *et al.*, 2012). There are five common species of intestinal helminthic parasites, known as geo-helminths or soil transmitted helminths (STHs). They are *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), *Ancylostoma duodenale* (old world hookworm), *Necator americanus* (new world hookworm) (Hotez *et al.*, 2008; Bunza and Abdullahi, 2013; Odugbemi *et al.*, 2015; Taiwo *et al.*, 2017) and *Strongyloides stercoralis* (threadworm) (Keiser and Nutman, 2004).

The health and socio-economic effects associated with intestinal helminths are immense especially in rural communities of the developing countries (Nigeria inclusive) where mal-nutrition and other factors influence the prevalence of the infections (Ogbe and Ado, 1990; WHO, 2002; Ughava and Okon, 2016). They are oftentimes clinically asymptomatic and are mostly neglected until serious complications or chronic clinical manifestations occur. However, they can be associated with eosinophilia as well as prolonged gastrointestinal symptoms (Schulte *et al.*, 2002; Gill *et*

al., 2004; O'Brien *et al.,* 2006; Naidu *et al.,* 2013; Calderaro *et al.,* 2014; Becker *et al.,* 2018). There could be single or multiple infections of these parasites in the body of the affected individuals. Children of school age and immuno-deficient (immuno-compromised or immuno-suppressed) individuals are particularly susceptible to these infections. Heavy infections are associated with cognitive impairment, iron-deficiency anaemia, growth retardation, mal-absorption, and mal-nourishment (Teklemariam *et al.,* 2014). They also cause different levels of tissue damage and illness to humans, but they rarely cause death (Stephenson *et al.,* 2000; Stoltzfus *et al.,* 2004). In addition to their health complications, they also impair physical and mental growth of children, thwart educational achievement, and hinder economic development (Drake *et al.,* 2000; Guyatt, 2000). They negatively affect the health of the infected individuals in several ways which include: impact on digestion and absorption of foods (Crompton and Nesheim, 2002), physical fitness and loss of appetite (Stephenson *et al.,* 1993), cognitive function (Nokes *et al.,* 1992), school performance and attendance (WHO, 2005; Bleakley, 2007). In adults, they are correlated with reduced productivity and work capacity (WHO, 2005).

Intestinal helminths are transmitted by soil contamination of food or drinking water as a result of poor hygienic habits like indiscriminate disposal of human and animal faeces (Bala *et al.,* 2019). They cause human infection through contact with their eggs or larvae that flourish in the warm and moist soils, especially in the tropics where the temperature is very high. They are gotten either by larvae burrowing through intact skin (*Strongyloides stercoralis*, the hookworms *Ancylostoma duodenale* and related spp., and *Necator americanus*) or by the faecal-oral route (*Ascaris lumbricoides* and *Trichuris trichiura*) (Bala *et al.,* 2019). The presence or absence of sanitary facilities at home or office had been established as strong determinants of the prevalence of gastro-intestinal parasites (intestinal helminths inclusive) (De Silva, 2012; Abossie and Seid, 2014; Mathewos *et al.,* 2014).

The global prevalence and number of cases of intestinal helminth infections in school age children have been estimated to be 35% (320 million) roundworm; 25% (233 million) whipworm; 26% (239 million) hookworm; and 14% (128 million) others (Partnership for Child Development, 1999). Threadworm is also prevalent in school age children globally. Other species of intestinal helminths apart from the above-mentioned are not widely prevalent. According to WHO (2014), they are the major health problems in many developing countries (including Nigeria) infecting an estimated one-sixth (1/6) of the global population. Therefore, globally, an estimated 4.5 billion individuals are at risk of getting infected by these infections and more than 2 billion people are already infected, out of which about 450 million suffer from the infections at school-age (WHO, 2014).

Orphanage homes and Almajiri schools form an organized setting which if proper attention is given may add value to the lives of the orphans and Almajiris and ensure proper management of intestinal helminthiasis. Intestinal helminthic infections spread rapidly in such settings due to poverty, poor environmental hygiene and impoverished health services (Crompton and Nesheim, 2002), as well as poor hygienic habits such as indiscriminate disposal of human and animal faeces (Bala *et al.*, 2019) and open defecation.

However, there is to the best of my knowledge, paucity of published epidemiological data on intestinal helminthiasis among orphanage homes and Almajiri schools in Nigeria. Comprehensive epidemiological data on intestinal helminthiasis among orphanages and Almajiri schools are also scanty in the whole North-Western part of Nigeria. Comprehensive epidemiological data are very vital for the successful control of parasitic infections in any locality. These data will help in establishing a suitable scheme for the prevention and control of intestinal helminthiasis among orphanages and Almajiri schools in the study area, hence the need for this research.

Some studies on intestinal helminthic infections were carried out in Sokoto State but there is dearth of information about the infections among orphanages and Almajiri schools in the study area. Most of the studies in Sokoto State were either conducted among the school-age children (Ibrahim *et al.,* 2000; Singh and Idris, 2014; Muhammad *et al.,* 2018; Bala *et al.,* 2019), among the Almajiris (Iduh *et al.,* 2015), or among the infantile geo-helminths (Isyaku *et al.,* 2015).

This study was therefore carried out to determine the prevalence of intestinal helminths among orphanages and some Almajiri schools in Sokoto Metropolis, Sokoto State, North-Western Nigeria.

2.0 MATERIALS AND METHODS

2.1 Study Area/Location

Sokoto is the capital city of Sokoto State, located at the extreme part of North-Western Nigeria between Longitude 5° 13′ 53″ East and Latitude 13° 3′ 5″ North of the Equator near the confluence of the Sokoto River and the Rima River. It shares borders with Niger-Republic to the North, Kebbi State to the South-West and Zamfara State to the East (SSBD, 2007). Sokoto State has an elevation of 450 m (1,476 ft) and is located in dry Sahel. It has a semi-arid climate and its vegetation is largely Sudan Savannah with an annual rainfall between 500 - 1300 mm and temperature ranges between 150 °C and exceeding to over 400 °C during the warm days (SSBD, 2007).

With an annual average rainfall of approximately 629 mm and an annual average temperature of approximately 28.3 °C (82.9 °F), Sokoto is on the whole, a very hot area. The rainy season normally starts from the month of June to the month of October during which showers occur almost daily.

The state covers a total land area of about 32,000 square kilometres and a population of 4,602,298 million people based on the 2013 projection (UNFPA Annual Report, 2013). However, report from the 2006 National Population Commission indicated that the State had a population of 3.6 million people (NPC, 2006).

The people are made up of Hausa and Fulani majority and a minority of Zabarmawa and Tuareg, and other non-indigenous settlers. The main occupation of the people is farming (grain production and animal husbandry). Over eighty percent of the inhabitants of the State are farmers practicing one form of farming or the other. Crops produced include millet, sorghum, beans, rice and maize. Other occupations commonly practiced are dying, blacksmithing, weaving, carving, trading, and cobbling. Sokoto ranks second in livestock production in Nigeria. Modern Sokoto city is a major commercial centre in leather crafts and agricultural products.

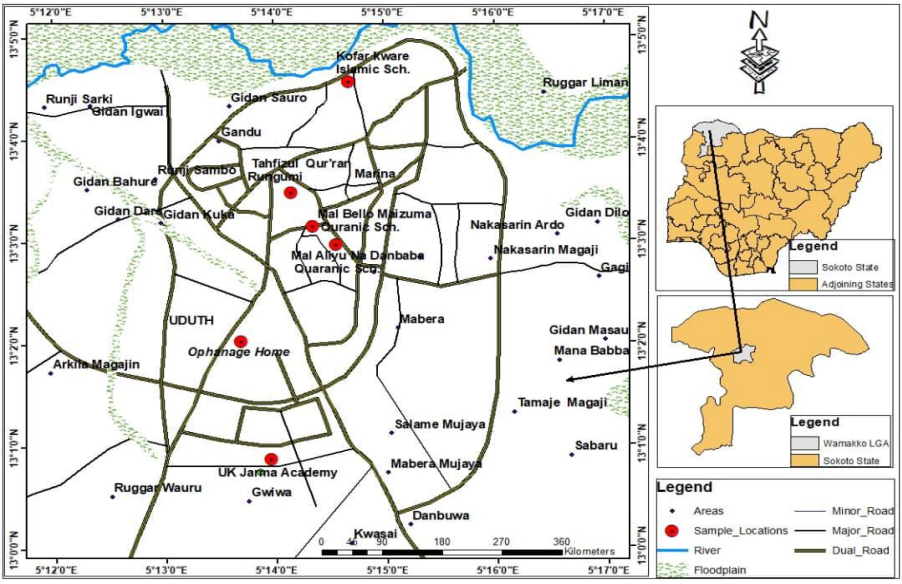

Figure 1: Map of the Study Area (Source: GIS Lab., Department of Geography, UDUS, 2023)

2.2 Study Population

The study was carried out among orphans and Almajiris living within Sokoto Metropolis. The study population comprised both male and female orphans and Almajiris aged 8 - 22 years old randomly selected in the study area.

2.3 Sample Size Estimation

The sample size was achieved by using the Andrew Fisher's Sampling Formula:

$N = Z^2 PQ/d^2$

Where: N = the sample size; Z = the critical value of the standard normal distribution, 1.96 at 95% confidence interval; P = estimated prevalence of intestinal parasitic infections in the locality which was 45.25% (Galamaji *et al.*, 2018); Q = 100-P; and d = absolute precision or sampling error tolerated = 5% (standard value of 0.05).

Therefore, $N = 3.8416 \times 0.4525 \times 0.5475/0.0025$

$= 0.95173239/0.0025$

$= 380.692956$

$= 380.69$ N ≈ 381.

This is the minimum sample size and was rounded off to 400 samples (nearest whole number).

2.4 Study Design

The study design employed was descriptive cross-sectional survey. Two (2) orphanage homes and four (4) Almajiri schools within the Metropolis were used for the study. One hundred and fifty (150) samples were randomly obtained from the orphanages and two hundred and fifty (250) samples were randomly obtained from the Almajiri schools making a total of four hundred (400) samples. A structured questionnaire was developed and administered to every participating candidate from whom sample was collected.

2.5 Ethical Consideration

Before the commencement of the study, ethical clearance was obtained from Research and Ethics Committee of Kebbi State

University of Science and Technology, Aliero, Nigeria. Introduction letter was signed and approved by the Head, Department of Animal and Environmental Biology, Faculty of Life Sciences, Kebbi State University of Science and Technology, Aliero, Nigeria. Upon submission of the introduction letter and other required documents, ethical approval was obtained from Sokoto State Ministry of Health with reference number: SMH/1580/V.IV; Hospital Ethics and Research Committee of Specialist Hospital Sokoto with reference number: SHS/SUB/133/VOL.1; Ministry of Social Welfare, Sports and Culture; the Management of UK Jarma Academy; the Director of Sokoto Orphanage; and the Management of some Almajiri Schools sampled. Permission to conduct the study in the orphanages and Almajiri schools was sought from the orphanage care-givers and Almajiri guardians in the selected orphanages and Almajiri schools from the study area through a written consent. Informed consents of the study subjects were also obtained. Participants' privacy and confidentiality were strictly observed. All data collected in hard copies were kept in a lockable cabinet accessible to the researchers only to maintain confidentiality. Information stored in soft copies were protected from access by unauthorized persons by a password which was changed periodically. All records were coded accordingly by a study identification number.

2.6 Questionnaire Design and Administration

A structured questionnaire was designed and administered to every volunteer/subject from whom samples were collected. The questionnaire was aimed at obtaining information such as candidate's sex, candidate's age, type of facility used, hand-washing before and after a meal, and source of drinking water supply. It served to gather information on markers of socio-economic status, demographic and geographic variables. In a situation whereby participants were not old enough to answer questionnaire, their guardians or care-givers were interviewed. All

these were done with the permission of the orphanage care-givers and Almajiri guardians.

2.7 Inclusion and Exclusion Criteria

Inclusion and exclusion criteria define the characteristics that prospective subjects must have if they are to be included in a study. Therefore, in this study, any participants among orphans and Almajiris aged 8 to 22 years sampled in the study area who met the criteria and who voluntarily agreed to give informed consent for sample collection were included. However, any participants among orphans and Almajiris sampled in the study area who voluntarily disagreed to give informed consent for sample collection and would not be able to provide accurate information during questionnaire administration even with the interpretation and guidance from their guardians or care-givers were excluded.

2.8 Sample Collection

A stool sample was collected per participant in a well-labelled clean and sterile container (sampling bottle) containing applicator after administering the questionnaires. Each container bore an identification number that tallied with the questionnaire. Each subject was given a sample collection bottle bearing serial number assigned to his/her name in the record book in order to ensure accuracy, reliability and validity. The subjects were instructed on how to collect their stool samples into the containers in the morning (between 7 and 10 a.m.).

Collected samples in the sampling bottles were stored in a cool container/cooler according to the Centres for Disease Control and Prevention protocol (CDC, 2019). Collected samples in the cooler were then transported to Microbiology/Parasitology Laboratory, Microbiology and Parasitology Unit, Department of Medical Laboratory Sciences, Specialist Hospital, Sokoto for parasitological analysis.

2.9 Laboratory Analysis of Stool Samples

2.9.1 Macroscopy Method

The stool samples were evaluated macroscopically in terms of colour, consistency, quantity, form, odour, presence of mucus, presence of blood (WHO, 1991; Kasirga, 2019), and presence of adult worm (CDC, 2019).

2.9.2 Microscopy Method

The stool samples were microscopically examined for the presence of intestinal helminths' eggs/ova or larvae by using direct wet-mount and formol-ether concentration methods as described below.

2.9.2.1 Direct Wet-Mount (DWM)

For Direct Wet-Mount (saline and iodine) procedure, an approximately 2 mg of fresh stool sample was put on a slide with a wooden applicator stick. The stool was emulsified with a drop of physiological saline (0.85%) for semi-formed and watery samples (Demeke *et al.*, 2021). For formed stools, iodine was used (Demeke *et al.*, 2021). After emulsification of the stool samples, they were covered with a cover slide and examined under a microscope using 10× objectives and 40× objectives (WHO, 1991; Cheesbrough, 2000; Demeke *et al.*, 2021).

2.9.2.2 Formalin-Ether Concentration Technique (FECT)

The standard operating procedure of Formalin-Ether Concentration Technique (FECT) was employed to detect the eggs/ova or larvae of the intestinal helminths in the faecal samples as described by WHO (1991); National Committee for Clinical Laboratory Standards (1997); Cheesbrough (2000); Arora and Arora (2005); Oyeyipo *et al.* (2013); Demeke *et al.* (2021). An approximately 1.0 g of stool sample was suspended in 10 ml of 10% formaldehyde (formalin) solution and mixed with applicator stick. The suspension was then passed through a funnel which was covered with a wire gauge in order to remove characteristic debris into a bigger tube.

An approximately 3 ml ether solution (diethyl ether) was then measured and added into the tube and then capped. The suspension was then shaken thoroughly to get a mixture that was transferred into a centrifuge tube (15 ml conical centrifuge tube) and then centrifuged for 3 min at 2000 rpm. An applicator stick was used to remove the characteristic layer that appeared in the centrifuge tube. The tube was then inverted quickly and carefully to dispose the content leaving behind the sediments. The sediments were then examined by putting a drop on a clean grease free glass slide covered with a cover slip for the presence of the intestinal helminths' ova with a microscope set at 10× and 40× objectives (Taiwo *et al.,* 2017; Demeke *et al.,* 2021).

2.10 Identification of the Intestinal Helminth Parasites

The intestinal helminth parasites were identified with the aid of World Health Organization Bench Aids for the Diagnosis of Intestinal Parasites – Second Edition (WHO, 2019) and Morphology of Diagnostic Stages of Intestinal Parasites of Humans by Brooke and Melvin (2001).

2.11 Data Analysis

Data generated were entered into a spreadsheet using Microsoft Excel 2013 and then subjected to statistical analysis using SPSS (Statistical Package for the Social Sciences) version 26.0. Simple distribution of study variables and chi-square (X^2) tests were carried out, and $P < 0.05$ was considered to be statistically significant. The prevalence of the intestinal helminths was calculated using the formula: (Number Infected/Number Examined) × 100 and expressed in percentages. Chi-square (X^2) test was used to test the association between the prevalence of infection and institutions as well as the risk factors of infection. Odds Ratio (OR) was used to determine the association between the orphanages/Almajiri Schools, gender/age of the subjects and prevalence of infection.

3.0 Results

3.1 Socio-Demographic Characteristics of the Study Subjects in the Study Area

Among the institutions examined, orphanages were 150 (37.50%) and Almajiri schools were 250 (62.50%), making a total of 400 (100.00%) altogether. Among the orphanages, UK Jarma Academy had 100 (25.00%), and Sokoto Orphanage had 50 (12.50%), respectively. Among the Almajiri schools, Makarantar Malam Bello Mai Zuma had 100 (25.00%), Makarantar Malam Aliyu Na Danbaba had 50 (12.50%), Madrasatu Marhum Abdullahi Li Tahfizil Qur'an had 50 (12.50%), and Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque had 50 (12.50%) as well. Based on gender, out of the 400 subjects examined, 280 (70.00%) were males, and the remaining 120 (30.00%) were females. With respect to age-group, the major age ranges of the subjects were from 8 to 22 years. The subjects aged 8 - 10 years were 172 (43.00%), 11 - 13 years were 163 (40.75%), 14 - 16 years were 54 (13.50%), 17 - 19 years were 9 (2.25%), and 20 - 22 years were 2 (0.50%), respectively. Regarding the educational level of the subjects, illiterates were 140 (35.00%), can read and write only were 60 (16.00%), nursery was 0 (0.00%), primary was 160 (40.00%), and secondary was 40 (10.00%), respectively (Table 1).

Table 1: Socio-Demographic Characteristics of the Study Subjects in the Study Area

Socio-Demographic Data	Category	Number N (%)	Total
Institutions (Orphanages & *Almajiri* Schools)	UK Jarma Academy	100 (25.00)	400 (100.00)
	Sokoto Orphanage	50 (12.50)	
	Makarantar Malam Bello Mai Zuma	100 (25.00)	
	Makarantar Malam Aliyu Na Danbaba	50 (12.50)	
	Madrasatu Marhum Abdullahi Li Tahfizil Qur'an	50 (12.50)	
	Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque	50 (12.50)	
Gender	Male	280 (70.00)	400 (100.00)
	Female	120 (30.00)	
Age-Group	8 – 10 yrs	172 (43.00)	400 (100.00)
	11 – 13 yrs	163 (40.75)	
	14 – 16 yrs	54 (13.50)	
	17 – 19 yrs	9 (2.25)	
	20 – 22 yrs	2 (0.50)	
Level of Education	Illiterates	140 (35.00)	400 (100.00)
	Can Read and Write	60 (15.00)	
	Nursery	0 (0.00)	
	Primary	160 (40.00)	
	Secondary	40 (10.00)	

Key: N = Number of Subjects; **%** = Percentage; yrs = Years

3.2 Stool Macroscopy of the Study Subjects in the Study Area

Based on colour of the stool, out of the 400 stool samples examined, 200 (50.00%) were tawny, 75 (18.75%) were brownish, 44 (11.00%) were yellowish, 55 (13.75%) were greenish, 13 (3.25%) were putty, 08 (2.00%) were black, and 5 (1.25%) were red, respectively. Based on consistency, 140 (35.00%) were formed, 220 (55.00%) were semi-formed, 40 (10.00%) were watery, and 00

(0.00%) were others. With respect to presence of blood in the stool samples, 65 (16.25%) were positive, and 335 (83.75%) were negative. Regarding the presence of mucus in the stool samples, 150 (37.50%) had none, 120 (30.00%) had small, 65 (16.25%) had copious, and 65 (16.25%) had bloody as well. With respect to the presence of adult worm, none 00 (0.00%) was seen (Table 2).

Table 2: Stool Macroscopy of the Study Subjects in the Study Area

Parameter	Category	Number N (%)	Total
Colour	Tawny	200 (50.00)	400 (100.00)
	Brownish	75 (18.75)	
	Yellowish	44 (11.00)	
	Greenish	55 (13.75)	
	Putty	13 (3.25)	
	Black	08 (2.00)	
	Red	05 (1.25)	
Consistency	Formed	140 (35.00)	400 (100.00)
	Semi-formed	220 (55.00)	
	Watery	40 (10.00)	
	Others	00 (0.00)	
Presence of Blood	Yes	65 (16.25)	400 (100.00)
	No	335 (83.75)	
Presence of Mucus	None	150 (37.50)	400 (100.00)
	Small	120 (30.00)	
	Copious	65 (16.25)	
	Bloody	65 (16.25)	
Presence of Adult Worm	*A. lumbricoides*	00 (0.00)	400 (100.00)
	T. trichiura	00 (0.00)	
	Hookworms (*A. duodenale/N. americanus*)	00 (0.00)	
	S. stercoralis	00 (0.00)	

3.3 Prevalence of Intestinal Helminth Species among Orphanages and Almajiri Schools in the Study Area

From Table 3, UK Jarma Academy had an overall prevalence of 02 (0.50%), 01 (0.25%), 00 (0.00%) and 01 (0.25%) for ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Sokoto Orphanage had an overall prevalence of 03 (0.75%), 02 (0.50%), 01 (0.25%) and 00 (0.00%) for ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Makarantar Malam Bello Mai Zuma had an overall prevalence of 10 (2.50%), 08 (2.00%), 04 (1.00%) and 02 (0.50%) for ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Makarantar Malam Aliyu Na Danbaba had an overall prevalence of 05 (1.25%), 03 (0.75%), 01 (0.25%) and 00 (0.00%) for ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Madrasatu Marhum Abdullahi Li Tahfizil Qur'an had an overall prevalence of 15 (3.75%), 10 (2.50%), 05 (1.25%) and 02 (0.50%) for ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque had an overall prevalence of 20 (5.00%), 15 (3.75%), 10 (2.50%) and 03 (0.75%) for ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Ascariasis is more prevalent among orphanages and Almajiri schools in the study area with 55 (13.75%), followed by trichuriasis with 39 (9.75%), hookworm infections with 21 (5.25%) and strongyloidiasis with 08 (2.00%). In addition, Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque were more infected with overall prevalence of 48 (12.00%), followed by Madrasatu Marhum Abdullahi Li Tahfizil Qur'an, Makarantar Malam Bello Mai Zuma, Makarantar Malam Aliyu Na Danbaba, Sokoto Orphanage and UK Jarma Academy with overall prevalence of 32 (8.00%), 24 (6.00%), 09 (2.25%), 06 (1.50%) and 04 (1.00%), respectively. Therefore, the overall prevalence of the intestinal helminths among orphanages and Almajiri schools in the study area was 123 (30.75%). In this study, there was no statistically significant difference ($P > 0.05$) between the prevalence of intestinal helminths among orphanages and Almajiri schools in the study area ($X^2 = 4.124$, $P = 0.127$) (Table 3).

Table 3: Prevalence of Intestinal Helminth Species among Orphanages and Almajiri Schools in the Study Area

Institution	No. Examined (N)	*Ascaris lumbricoides* (%)	*Trichuris trichiura* (%)	Hookworms (*Ancylostoma duodenale/ Necator americanus*) (%)	*Strongyloides stercoralis* (%)	Total Prevalence (%)	X^2	P-Value
UKJA	100	02 (0.50)	01 (0.25)	00 (0.00)	01 (0.25)	04 (1.00)	4.124	0.127
SO	50	03 (0.75)	02 (0.50)	01 (0.25)	00 (0.00)	06 (1.50)		
MMBMZ	100	10 (2.50)	08 (2.00)	04 (1.00)	02 (0.50)	24 (6.00)		
MMAND	50	05 (1.25)	03 (0.75)	01 (0.25)	00 (0.00)	09 (2.25)		
MMALTQ	50	15 (3.75)	10 (2.50)	05 (1.25)	02 (0.50)	32 (8.00)		
KKA	50	20 (5.00)	15 (3.75)	10 (2.50)	03 (0.75)	48 (12.00)		
Total	**400**	**55 (13.75)**	**39 (9.75)**	**21 (5.25)**	**08 (2.00)**	**123 (30.75)**		

Key: UKJA = UK Jarma Academy; SO = Sokoto Orphanage; MMBMZ = Makarantar Malam Bello Mai Zuma; MMAND = Makarantar Malam Aliyu Na Danbaba; MMALTQ = Madrasatu Marhum Abdullahi Li Tahfizil Qur'an; KKA = Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque; N = Number Examined; % = Percentage; X^2 = Chi-Square; P-Value = Probability Value

3.4 Overall Prevalence of Intestinal Helminth Species among Orphanages and Almajiri Schools in the Study Area

From Table 4, the overall prevalence of ascariasis, trichuriasis, hookworm infections and strongyloidiasis was 55 (13.75%), 39 (9.75%), 21 (5.25%) and 08 (2.00%), respectively. The overall prevalence of the intestinal helminths among orphanages and Almajiri schools in the study area was 123 (30.75%).

Table 4: Overall Prevalence of Intestinal Helminth Species among Orphanages and Almajiri Schools in the Study Area

Ascaris lumbricoides	*Trichuris trichiura*	Hookworms (*Ancylostoma duodenale/ Necator americanus*)	*Strongyloides Stercoralis*
55 (13.75%)	39 (9.75%)	21 (5.25%)	08 (2.00%)

3.5 Mean Intensity of Intestinal Helminths among Orphanages and Almajiri Schools in the Study Area

From Table 5, out of the 400 samples examined, 123 were infected with the intestinal helminths among the orphanages and Almajiri schools in the study area. The total prevalence of the intestinal helminths was 30.75%. The number of parasites recorded was 160. The total mean intensity of the parasites recorded among the orphanages and Almajiri schools in the study area was 10.02. The institution with the highest prevalence was Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque with 96.00%. The institution with the lowest prevalence was UK Jarma Academy with 4.00%. The institution with the highest mean intensity was Sokoto Orphanage (2.50) and the one with the lowest was Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque (1.02).

Table 5: Mean Intensity of Intestinal Helminths among Orphanages and Almajiri Schools in the Study Area

Institution	No. Examined (N)	No. Infected	Prevalence (%)	No. of Parasites	Mean Intensity
UKJA	100	04	4.00	08	2.00
SO	50	06	12.00	15	2.50
MMBMZ	100	24	24.00	30	1.25
MMAND	50	09	18.00	18	2.00
MMALTQ	50	32	64.00	40	1.25
KKA	50	48	96.00	49	1.02
Total	**400**	**123**	**30.75**	**160**	**10.02**

Key: UKJA = UK Jarma Academy; SO = Sokoto Orphanage; MMBMZ = Makarantar Malam Bello Mai Zuma; MMAND = Makarantar Malam Aliyu Na Danbaba; MMALTQ = Madrasatu Marhum Abdullahi Li Tahfizil Qur'an; KKA = Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque; N = Number Examined; % = Percentage

3.6 Prevalence of Intestinal Helminths in Relation to Gender among Orphanages and Almajiri Schools in the Study Area

From Table 6, based on gender, out of the 280 males examined, 39 (9.75%), 29 (7.25%), 12 (3.00%) and 05 (1.25%); and out of the 120 females examined, 16 (4.00%), 10 (2.50%), 09 (2.25%) and 03 (0.75%) were infected with ascariasis, trichuriasis, hookworm infections and strongyloidiasis among orphanages and Almajiri schools in the study area, respectively.

Table 6: Prevalence of Intestinal Helminths in Relation to Gender among Orphanages and Almajiri Schools in the Study Area

Key: UKJA = UK Jarma Academy; SO = Sokoto Orphanage; MMBMZ = Makarantar Malam Bello Mai Zuma; MMAND = Makarantar Malam Aliyu Na Danbaba; MMALTQ = Madrasatu Marhum Abdullahi Li Tahfizil Qur'an; KKA = Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque; M = Male; F = Female; N = Number Examined; % = Percentage; OR = Odds Ratio; CI = Confidence Interval; P-Value = Probability Value

Institution	Gender	No. Examined (N)	*A. lumbricoides* (%)	*T. trichiura* (%)	Hookworms (*A. duodenale*/*N. americanus*) (%)	*S. stercoralis* (%)	OR (95% CI)	P-Value
UKJA	M	70	01 (0.25)	01 (0.25)	00 (0.00)	00 (0.00)	1.23 (0.83, 1.81)	0.307
	F	30	01 (0.25)	00 (0.00)	00 (0.00)	01 (0.25)		
SO	M	20	01 (0.25)	01 (0.25)	00 (0.00)	00 (0.00)	1.43 (0.82, 2.49)	0.207
	F	30	02 (0.50)	01 (0.25)	01 (0.25)	00 (0.00)		
MMBMZ	M	100	10 (2.50)	08 (2.00)	04 (1.00)	02 (0.50)	1.21 (0.79, 1.85)	0.376
	F	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
MMAND	M	25	03 (0.75)	02 (0.50)	00 (0.00)	00 (0.00)	1.10 (0.75, 1.59)	0.636
	F	25	02 (0.50)	01 (0.25)	01 (0.25)	00 (0.00)		
MMALTQ	M	40	12 (3.00)	07 (1.75)	03 (0.75)	01 (0.25)	1.09 (0.75, 1.59)	0.660
	F	10	03 (0.75)	03 (0.75)	02 (0.50)	01 (0.25)		
KKA	M	25	12 (3.00)	10 (2.50)	05 (1.25)	02 (0.50)	1.19 (0.82, 1.72)	0.375
	F	25	08 (2.00)	05 (1.25)	05 (1.25)	01 (0.25)		
Total	**M**	**280**	**39 (9.75)**	**29 (7.25)**	**12 (3.00)**	**05 (1.25)**		
	F	**120**	**16 (4.00)**	**10 (2.50)**	**09 (2.25)**	**03 (0.75)**		

3.7 Prevalence of Intestinal Helminths in Relation to Age among Orphanages and Almajiri Schools in the Study Area

From Table 7, out of the 172 subjects aged 8 - 10 years, 31 (7.75%), 23 (5.75%), 11 (2.75%) and 05 (1.25%) were infected with ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Out of the 163 subjects aged 11 - 13 years, 13 (3.25%), 09 (2.25%), 06 (1.50%) and 03 (0.75%) were infected with ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Out of the 54 subjects aged 14 - 16 years, 08 (2.00%), 05 (1.25%), 04 (1.00%) and 00 (0.00%) were infected with ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Out of the 09 subjects aged 17 - 19 years, 02 (0.50%), 01 (0.25%), 00 (0.00%) and 00 (0.00%) were infected with ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively. Lastly, out of the 02 subjects aged 20 - 22 years, 01 (0.25%), 01 (0.25%), 00 (0.00%) and 00 (0.00%) were infected with ascariasis, trichuriasis, hookworm infections and strongyloidiasis, respectively.

Table 7: Prevalence of Intestinal Helminths in Relation to Age among Orphanages and Almajiri Schools in the Study Area

Institution	Age-group (years)	No. Examined (N)	*A. lumbricoides* (%)	*T. trichiura* (%)	Hookworms (*A. duodenale*/*N. americanus*) (%)	*S. stercoralis* (%)	OR (95% CI)	P-Value
UKJA	8 - 10	26	01 (0.25)	00 (0.00)	00 (0.00)	00 (0.00)	1.12 (0.63, 1.98)	0.708
	11 - 13	48	01 (0.25)	01 (0.25)	00 (0.00)	01 (0.25)		
	14 - 16	26	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
	17 - 19	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
	20 - 22	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
SO	8 - 10	25	02 (0.50)	02 (0.50)	01 (0.25)	00 (0.00)	0.73 (0.49, 1.09)	0.120
	11 - 13	15	01 (0.25)	00 (0.00)	00 (0.00)	00 (0.00)		
	14 - 16	06	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
	17 - 19	04	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
	20 - 22	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
MMBMZ	8 - 10	16	03 (0.75)	02 (0.50)	01 (0.25)	00 (0.00)	0.85 (0.58, 1.26)	0.429
	11 - 13	78	04 (1.00)	04 (1.00)	02 (0.50)	02 (0.50)		
	14 - 16	04	02 (0.50)	01 (0.25)	01 (0.25)	00 (0.00)		
	17 - 19	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
	20 - 22	02	01 (0.25)	01 (0.25)	00 (0.00)	00 (0.00)		
MMAND	8 - 10	35	02 (0.50)	03 (0.75)	01 (0.25)	00 (0.00)	0.74 (0.29, 1.87)	0.523
	11 - 13	07	01 (0.25)	00 (0.00)	00 (0.00)	00 (0.00)		
	14 - 16	05	01 (0.25)	00 (0.00)	00 (0.00)	00 (0.00)		
	17 - 19	03	01 (0.25)	00 (0.00)	00 (0.00)	00 (0.00)		
	20 - 22	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
MMALTQ	8 – 10	35	10 (2.50)	05 (1.25)	03 (0.75)	02 (0.50)	1.31 (0.84, 2.03)	0.231
	11 – 13	08	03 (0.75)	02 (0.50)	02 (0.50)	00 (0.00)		
	14 – 16	05	01 (0.25)	02 (0.50)	00 (0.00)	00 (0.00)		
	17 – 19	02	01 (0.25)	01 (0.25)	00 (0.00)	00 (0.00)		
	20 – 22	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
KKA	8 – 10	35	13 (3.25)	11 (2.75)	05 (1.25)	03 (0.75)	1.31 (0.84, 2.03)	0.231
	11 – 13	07	03 (0.75)	02 (0.50)	02 (0.50)	00 (0.00)		
	14 – 16	08	04 (1.00)	02 (0.50)	03 (0.75)	00 (0.00)		
	17 – 19	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
	20 – 22	00	00 (0.00)	00 (0.00)	00 (0.00)	00 (0.00)		
Total	**8 – 10**	**172**	**31 (7.75)**	**23 (5.75)**	**11 (2.75)**	**05 (1.25)**		
	11 – 13	**163**	**13 (3.25)**	**09 (2.25)**	**06 (1.50)**	**03 (0.75)**		
	14 – 16	**54**	**08 (2.00)**	**05 (1.25)**	**04 (1.00)**	**00 (0.00)**		
	17 – 19	**09**	**02 (0.50)**	**01 (0.25)**	**00 (0.00)**	**00 (0.00)**		
	20 – 22	**02**	**01 (0.25)**	**01 (0.25)**	**00 (0.00)**	**00 (0.00)**		

Key: UKJA = UK Jarma Academy; SO = Sokoto Orphanage; MMBMZ = Makarantar Malam Bello Mai Zuma; MMAND = Makarantar Malam Aliyu Na Danbaba; MMALTQ = Madrasatu Marhum Abdullahi Li Tahfizil Qur'an; KKA = Kofar Kware Almajiris Nearest Aliyu Magatakarda Wamakko Jumu'at Mosque; M = Male; F = Female; N = Number Examined; % = Percentage; OR = Odds Ratio; CI = Confidence Interval; P-Value = Probability Value

4.0 Discussion

The current study revealed overall prevalence of the intestinal helminths among orphanages and Almajiri schools in Sokoto Metropolis to be 30.75% which is low. This result confirms the prevalence of the intestinal helminthiasis among the study subjects in the study area.

The finding in this study is similar to the result obtained by Muhammad *et al.* (2018), who reported 33.50% in Sokoto State, Nigeria and Okolie (2008), who reported the prevalence of 32.40%.

This finding is higher than the overall prevalence of infantile geo-helminths infections (1.40%) in Sokoto State reported by Isyaku *et al.* (2015); the overall prevalence of intestinal helminthiasis (9.00%) among prison inmates in Jos, Nigeria reported by Ughava and Okon (2016); and the overall prevalence of intestinal helminthiasis (20.70%) among children living in orphanages in Benin City, Nigeria reported by Nwaneri and Omuemu (2012), respectively. Also, it is higher than the overall prevalence of helminthic parasites (3.20%) reported by Abbaszadeh Afshar *et al.* (2020) in the southeast of Kerman province, southeastern Iran; the overall prevalence of soil-transmitted helminth infections (14.30%) among rural communities of Chachoengsao province, Thailand reported by Suntaravitun and Dokmaikaw (2018); and the overall prevalence of intestinal helminths infestation (17.33%) reported by Mirisho *et al.* (2017) among children attending Princess Marie Louise Children's Hospital in Accra, Ghana, respectively. In consonance to this, Campbell *et al.* (2017) reported 6.30% in Cameroon, Colman *et al.* (2013) reported 22.89% and Sah *et al.* (2013) reported 13.00%, respectively.

However, this finding is lower than a recent study conducted by Bala *et al.* (2019), who reported an overall STH prevalence of 60.00% among students in Sokoto State, Nigeria; the result obtained by Iduh *et al.* (2015), who reported 74.50% among the "Almajiris" in Sokoto Metropolis, Sokoto Nigeria; the finding of Ibrahim *et al.* (2000), who reported 74.80% among primary school children in Sokoto; and the finding of Singh and Idris (2014), who reported

74.00% among boarding school children in Sokoto, Nigeria, respectively. Also, it is lower than the overall helminth prevalence of 78.00% at Mawuko and 71.00% at Isolu for intervention and non-intervention communities respectively, in Abeokuta, Nigeria reported by Taiwo *et al.* (2017).

The variations in the findings among the various studies conducted on intestinal helminthic parasites in Nigeria and abroad could be due to the number of stool samples analysed, methods employed for stool collection and examination, diversity of health condition, level of education, water supply, feeding habit, cultural practices in the different study areas, the study period, age variations, and geographical differences (Belete *et al.,* 2021).

Four (4) species of intestinal helminths were identified and the highest prevalence was seen in *Ascaris lumbricoides* 55 (13.75%), followed by *Trichuris trichiura* 39 (9.75%), hookworms (*Ancylostoma duodenale/Necator americanus*) 21 (5.25%) and *Strongyloides stercoralis* 08 (2.00%). Previous studies had shown that *A. lumbricoides* is the most prevalent, followed by hookworms *(A. duodenale* and *N. americanus), T. trichiura* and *S. stercoralis* (Sam-Wobo and Mafiana, 2006; Samaila *et al.,* 2016). However, *T. trichiura* had been reported as the most prevalent in parts of Lagos and Oyo (Sam-Wobo *et al.,* 2012; Samaila *et al.,* 2016). Furthermore, in some parts of Nigeria, hookworm has been reported as the most prevalent (Anosike *et al.,* 2006; Azoro *et al.,* 2015).

The overall mean intensity result (10.02) reported in this study is higher than the total intensity of 3.11 reported by Nnatuanya *et al.* (2023). Additionally, Mergo and Crites (1986) also reported a lower mean intensity result of 2.16 for *Lintaxine cokeri*.

Based on gender, the infection rate was higher in males 85 (21.25%) than in females 38 (9.50%). The above finding corroborates that of Taiwo *et al.* (2017), who reported that significantly more cases of infections were observed in male (46%) at the intervention community than female (31%). However, it disagrees with the result obtained by Taiwo *et al.* (2017) in non-intervention community where

females (39%) were significantly more infected than their male counterparts (32%).

With respect to age-group, the subjects aged 8 - 10 years were more infected 70 (17.50%) than the rest 53 (13.25%). This could be attributed to the fact that children of school-age are more infected with intestinal helminthic parasites (Ibrahim *et al.,* 2000; Merid *et al.,* 2001; Crompton and Nesheim, 2002; WHO, 2010; Singh and Idris, 2014; Teklemariam *et al.*, 2014; Adedoyin *et al.*, 2015; Iduh *et al.,* 2015; Isyaku *et al.,* 2015; Muhammad *et al.,* 2018; Bala *et al.,* 2019; Belete *et al.,* 2021).

Also, based on institutions, the infection rate was greatly higher in the Almajiri schools 113 (28.25%) than in the orphanages 10 (2.50%). This could be attributed to the fact that most of the children in the orphanages received anthelminthic drugs every 3 - 6 months (Bethony *et al.,* 2006; Nwaneri and Omuemu, 2012; Bieri, 2013), had an improved child/care-giver ratio, potable water supply, clean latrine/toilet, and hygienic environment, and were not overcrowded (WHO, 2002; Bethony *et al.,* 2006; De Silva, 2012; Bieri, 2013; Mathewos *et al.,* 2014; Abossie and Seid, 2014; Bala *et al.,* 2019; Belete *et al.,* 2021). While, in most of the Almajiri schools, the above-mentioned medications and sanitary facilities were lacking. In addition, low level of education (Yimam *et al.,* 2014; Kang *et al.,* 1998) was more predominant among the Almajiris. Again, majority of the children in the Almajiri schools were found to be walking barefooted and engaging in open defecation (WHO, 2002; Bethony *et al.,* 2006; De Silva, 2012; Bieri, 2013; Mathewos *et al.,* 2014; Abossie and Seid, 2014; Bala *et al.,* 2019; Belete *et al.,* 2021).

5.0 Conclusion

The Almajiri schools were more prevalent and had the highest mean intensity of intestinal helminths in the study area than the orphanages. The infection rate was higher in males than in females and the subjects aged 8-10 years were more infected than the rest (the infection decreases with age). *Ascaris lumbricoides* had the

highest prevalence than other species of intestinal helminths among the subjects in the study area. In this study, there was no statistically significant difference between the prevalence of intestinal helminths among orphanages and Almajiri schools in the study area. Therefore, improved child/care-giver ratio reduces worm burden in the orphanages within Sokoto Metropolis. Regular deworming exercise (at least every 3-6 months) reduces the prevalence of intestinal helminthiasis among Almajiris in Sokoto Metropolis. Provision of safe food and drinking water, regular deworming exercise, government interventions, health education, improved child/care-giver ratio, reduction of overcrowding, and discouragement of open defecation and walking barefooted are recommended.

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Conflict of Interest
Authors have declared that no competing interests exist.

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