Assessing the Prevalence of Intestinal Parasitic Infections (IPIs) Among the Children of Geidam Central Primary Yobe State, Nigeria.

ABSTRACT

Background: Intestinal parasitic infections (IPIs) is one of the preventable and avoidable public health problems that affect a significant portion of school-aged children and cause a lot of predominant physical and intellectual health challenges. Despite their significant public health importance attached to IPIs, they remain neglected and this neglect happens due to the fact that most affected people belonging to the poorest communities who have little political voice and this coupled with the nature of the infection, as IPIs are not cause fearsome outbreaks to call emergency public response.

Aims: This research study is aimed at assessing the prevalence of intestinal parasitic infections (IPIs) among the children of Geidam Central primary school Yobe state, Nigeria.

Study Design: A cross-sectional research method was used.

Place and Duration of Study: Laboratory department**,** Yobe State Specialist Hospital (YSSH) Geidam, and the study was conducted within 3 months.

Methodology: A total number of 36 children were randomly collected from primary 1-6 children, and six (6) children were selected from each class. The stool samples were taken to YSSH, Geidam for microscopic examination. The samples were fixed in formalin for 30 minutes and then about 5 grams of the stool were mix thoroughly in the 10% formalin & filtered. The centrifuge was used to read for 2 minutes at 2500 RPM and then discarded the supernatant and leave 1.5 mL of the sediment which eventually formed 4 layers, then 3 layers were decanted carefully and the sediments was left in the test tube and make the smears in saline and iodine wet preparation and then presence of ova or cyst of IPIs were examined under the aid of microscope. The Data were analyzed using SPSS and presented in tables and figures while showing infection's frequency and percentage.

Results: Out of the 36 children that were examined for the prevalence of IPIs in Geidam central primary school, 19 (52.65%) children were infected with different sorts of IPIs.The identified IPIs in the present study were *A. lumbricoides, Hookworm, Giardia, S. stercoralis, T. trichiura,* and *Enterobius vermicularis* (16.63%, 13.86%, 5.54%, 8.31%, 5.54%, *and* 2.77%). Of the 36 selected children, males maintain a high prevalence of IPIs with a total percentage of 36.11% and females hold a lower rate of infection (16.66%). Regarding the age group, children with 10-12 years (class 4-6) have shown a high rate (33.33%) while their counterparts of 6-9 years hold a lower prevalence of (19.44%). Concerning the different classes-, class 1 has 5.5%, class2 has 8.33%, class3 also has 5.55%, in contrast higher rates were detected in class 4, class 5 and class6 (13.88%,11.11%, and 8.33%), respectively.

Conclusions: This research study established that there is a prevalence of IPIs among children of Geidam central primary school. This may have a connection with different potential risk factors such as walking barefoot, poor personal hygiene, inadequate environmental sanitation, lack of portable consumption water, open defection, improper latrine utilization and other several factors.

Keywords: *Assessing, prevalence of IPIs, Children, Central Primary School, Geidam Yobe State, Nigeria.*

1. INTRODUCTION

Intestinal Parasitic Infections (IPIs) are among the most common diseases in Nigeria, especially among children of school-aged. IPIs causing soil-transmitted helminths (STHs), intestinal protozoa are preventable and avoidable public health concern that causes predominant physical and intellectual health problems among school-aged children, the burden of intestinal parasitic infections is primarily related to the impact on health and quality of life. In infancy, this is the consequence of a chronic infection, which may adversely affect growth, nutritional status, and cognitive capacity, and the consequences are not limited to growth retardation, decreased cognitive capacity, protein malnutrition, stomach cramps/pain, weight loss, nausea/vomiting, swollen lymph nodes, persistent diarrhea/gas, constipation, dehydration, bloating, headaches, and skin issues (rashes, eczema, hives, itching), as well as iron deficiency anemia, blindness, and seizure in long term complications among many more others. After the direct percutaneous invasion of infective larvae from contaminated soil, at the end of their life cycle, adult worm parasite inters the upper small intestine and use cutting organs to suck arteriolar and capillary blood of the intestinal mucosa. Alas, despite this huge burden caused by intestinal parasitic infections, IPIs remain prevalent and constitute a public health problem in many parts of developing countries, Africa in particular, and Nigeria is subsumed due to consumption of contaminated water/food, poor personal hygiene, and inadequate sanitation which is highly linked to corruption and poor policy in the health sector of the developing countries. Nonetheless, despite their significant public health importance, they remain largely neglected by the government, medical community, and international health organizations **(1).** This neglect occurs due to several factors- such as the most affected people belonging to the poorest and disadvantaged communities who often live in remote rural areas or urban slums with little political voice and coupled with the nature of the infection as they are not highly visible and do not cause explosive outbreaks that attract public and media attention to take necessary measures**.**

2.0 LITERATURE REVIEW

2.1 Global Prevalence of Intestinal Parasitic Infections (IPIs) and its Associated Risk Factors

"The World Health Organization (WHO) has recognized that STHs are causing IPIs and related it as one of the neglected tropical diseases (NTDs) as it is ubiquitous and persisting exclusively among many worldwide communities" **(2). "**NTDs are a group of infectious diseases, with parasitic infections that occur primarily among regions of poverty and malnourishment" **(4,5). "**Globally, there is an estimation of 895 million people infected with STH, with 447 million people infected with *A. lumbricoides*, 290 million with *T. trichiura*, and 229 million with hookworms" **(6). "**Apart from that, the global prevalence of *S. stercoralis* is estimated to range from 30 million to more than 300 million" **(7). "**Intestinal protozoa, on the other hand, have a lower overall prevalence rate as compared to STHs, with approximately 184 million people infected with *G. lamblia*, 104 million with *E. histolytica*, and 64 million with *Cryptosporidium* spp.," **(8). "**The high prevalence of IPIs is attributed primarily to lower educational levels associated with inadequate knowledge and awareness regarding infection transmission and prevention, as well as limited access to safe drinking water, inadequate personal hygiene, poor environmental sanitation, and widespread food contamination" **(9, 10).** The risk factors of IPI have extensively been discussed by von Huth, Kofoed **(3)**, Terefe, Ross **(12),** and Forson, Arthur **(11),** and hence will not be elaborated in detail in this review. Briefly, demographic factors are closely associated with the high prevalence rate of IPIs **(13).** For example, "having large household members and having inadequate knowledge of health awareness are positively associated with **IPIs" (3, 14). "**Large households are known to have more than seven members in a house, and this may increase the risk of IPIs due to over-crowdedness" **(14, 15). "**The lack of sanitation and health care knowledge increases their risk of disease transmission as most of them may not be aware of the key sources and communal behaviors that exacerbate infection prevalence among the population" **(3, 16). "**Communities who prefer to stay close to

UNDER PEER REVIEW

rivers as their water source for daily chores including bathing, washing, and consumption of untreated water may expose the community to contaminated water harboring different species of protozoa parasites" **(17, 18). "**Furthermore, due to the lack of functioning toilets in most homes, a single pit latrine consisting of a pit that is a few meters deep into the ground to collect human feces is usually shared between several households among IPIs susceptible communities" **(19, 20). "**The need to share latrines coupled with poor maintenance discourages members of the community from using them which thus encourages the practice of open defecation" **(20, 21). "**A previous study has found that pit latrines can be a direct source of water contamination as subterraneous water flows through the soil contaminated with human feces in the pit latrines, which could carry fecal runoffs into water streams" **(22). "**Young age is positively associated with IPI as compared to other age groups of the same population profile" **(2,3,11).** "Children are natural-born explorers; their inquisitive nature propels them to explore their surroundings without proper footwear and supervision from adults" **(17, 20). "**Therefore, STH larvae can penetrate the host's primary protective barrier through direct skin-to-soil contact**.** Additionally, communities that lack veterinary and zoonotic awareness may be in contact with domestic animals that are not dewormed. As these domestic animals often roam freely and defecate in an open environment, contaminating the soil with feces, it may further exacerbate the risks of getting STHs causing IPIs" **(11, 21).** "Due to these risk factors, diseases including anemia, malnutrition, giardiasis, amoebiasis, and cryptosporidiosis caused by IPIs can be developed over time. Thus, the next section will discuss the common diseases associated with IPIs" **(11, 21).**

2.2 Diseases associated with Intestinal parasitic infections (IPIs)

Diseases associated with *T. trichiura, A. lumbricoides, A. duodenale*, and *N. americanus* are *trichuriasis, ascariasis,* ancylostomiasis, and necatoriasis, respectively. Anemia and malnutrition are two intertwined diseases that are strongly associated with IPI **(23-27).** STHs in specific, play a role in inducing intestinal bleeding and red blood cell destruction, leading to anemia **(24,26,28).** Specifically, co-infection of *T. trichiura* and hookworm may have synergistic effects on causing blood loss, impairing re-absorption, and ingesting iron **(28, 29).** As STHs have designed appendages to attach to the host intestinal mucosa, impaired digestion and poor absorption of nutrients may occur in the infected individual with damaged gut epithelium, consequently leading to malnutrition **(25,28,30).** Malnutrition may then lead to underweight as well as stunted growth and development **(27, 28).** Rajoo et al. (2017) stated that the high prevalence rate of stunting (31.7%) is found among rural children infected with STHs in Malaysia, followed by a prevalence rate of 28.6% among those being underweight. STHs-causing IPIs may also lead to intestinal epithelial damage as these STHs can attach to the gut mucosa and disrupt the intestinal barrier, subsequently destroying the cell cytoskeleton and resulting in cell damage **(31).** This is often accompanied by intestinal inflammation as cell damage may enhance the intestinal infiltration of activated neutrophils **(32).** This is supported by a study conducted by Garzón et al. (2017) which showed that the production of fecal S100A12, a protein that regulates inflammatory responses and neutrophil infiltration, was upregulated in IPIs-infected individuals, implying an association between intestinal inflammation IPIs. *Giardiasis, amoebiasis*, and *cryptosporidiosis* are common diseases caused by *G. lamblia, E. histolytica,* and *Cryptosporidium spp*., respectively **(33).** Individuals infected with *E. histolytica* may develop clinical symptoms such as dehydration, dysentery, and acute diarrhea **(34).** However, having been infected with *G. lamblia* will lead to abdominal cramping, bloating, and diarrhea among the populations **(35).** Healthy individuals who are infected with *Cryptosporidium spp.* may have self-limiting diarrhea, but *cryptosporidiosis* may contribute to chronic diarrhea in immunocompromised individuals **(33).** As diarrhea and dysentery are common among individuals infected with intestinal protozoa, weight loss and malnutrition can be observed among the communities **(36).** Persistent diarrhea may result in increased loss of fluids and electrolytes, leading to weight loss and malabsorption of nutrients such as carbohydrates, protein, and fats, resulting in malnutrition **(37).** Reinfection of STHs may occur when there are no improvements in terms of environmental cleanliness and personal hygiene among the communities. STH prevalence often rebounds to the pre-treatment levels in a relatively short time frame of 6 to 12 months **(38, 39).** This showed that the complete elimination of parasites cannot be achieved by relying solely on anti-helminthic treatments. Speich et al. (2016) reported that the reinfection rate in Tanzania for *T. trichiura* was 37.2% (42/113 treated children) after 18 weeks followed by treatment with anti-helminthic drugs. Furthermore, 57 of 165 (34.6%) children were found to be reinfected with *A. lumbricoides*, and 18 of 72 (25.0%) children were reinfected with hookworms. sanitation and personal hygiene may reduce the reintroduction of parasitic agents into the local environment, particularly by actively infected individuals,

UNDER PEER REVIEW

where such methods will be further reviewed in the following section Therefore, anti-helminthic drugs should be administrated alongside sufficient awareness of the importance of hygienic practices in the susceptible community. Improved environmental **(34).** Because of the above stated IPIs burdens was the reason behind this research study was conceived and aimed at assessing the prevalence of IPIs among the children of Central Primary School Geidam, Yobe state Nigeria.

3.MATERIALS AND METHODS

A specimen container, hand globes, and facemasks were used while collecting the stool specimen and the selected children were guided on how to use hand globe, facemasks and how to defecate and insert some portion of the stool in to sample bottle without spoiling the sample bottle and the samples collected were taken to Yobe state specialist hospital (YSSH) Geidam for microscopic examination of the stool specimens to ascertain the presence of IPIs cysts larva or ova. The stool sample were fixed in formalin for 30 minutes and then about 5 grams of the stool were mix thoroughly in the 10% formalin & filtered with the help of wire screen and collected around 3 mL, as well as 12 mL of 0.85% saline was added and mixed thoroughly. The centrifuge is used to read for 2 minutes at 2500 RPM and then discarded the supernatant and leave 1.5 mL of the sediment, the supernatant is normal without any cloudy, then the test tube was capped and shake well for about 30-50 seconds, then tubes were centrifuge for 1 minute at 2000 RPM, which 4 layers were eventually formed and then all the debris were removed with the aid of wooden applicator stick. The 3 layers were decanted carefully and the sediments was left in the test tube. The sides of the tube were cleaned using swab cotton as cyst may stick to the side of the test tube. The drops of the formalin were added and mixed the sediment thoroughly. Finally, we make the smears in saline and iodine wet preparation and then presence of ova or cyst of IPIs were Examined under the aid of microscope. A cross-sectional research method was used, a total number of 36 stool specimens were collected from primary 1-6 children, and six (6) children were randomly selected from each class totaling 36 children and the data were analyzed using statistical package for Social Sciences (SPSS) version 20 statistical software and presented in tables and figures while showing infection's frequency and percentage.

2.1 Aims: This research study is aimed at assessing the prevalence of intestinal parasitic infections (IPIs) among children of Geidam Central primary school Yobe state, Nigeria.

2.2 Objectives: This is to sensitize school-aged children about the causes and risk factors of IPIs through health education at the school level and to develop general public awareness campaigns. The policymakers can utilize the findings of the research in making necessary actions towards eliminating IPIs by providing health education programs at the primary school level and free anthelminthic drugs policy for all school-aged children.

2.3 Study Area: The study was conducted in Geidam local government area of Yobe state Nigeria at the Central primary school Geidam.

2.4 Study population: the study population was children of Geidam central Primary school which comprised all classes ranging from class 1 to 6 and both genders were equally selected, i.e. three males and three males from each class totaling 36 children.

4.RESULTS

Out of the 36 children that were examined for the prevalence of IPIs in Geidam central primary school, 19 (52.65%) children were infected with different sorts of IPIs.The identified IPIs in the present study were *A. lumbricoides, Hookworm, Giardia, S. stercoralis, T. trichiura,* and *Enterobius vermicularis* (16.63%, 13.86%, 5.54%, 8.31%, 5.54%, *and* 2.77%).

Of the 36 selected children, males maintain a high prevalence of IPIs with a total percentage of 36.11% and females hold a lower rate of infection (16.66%). Regarding the age group, children with 10-12 years (class 4-6) have shown a high rate (33.33%) while their counterparts of 6-9 years hold a lower prevalence of (19.44%). Concerning the different classes-, class 1 has 5.5%, class2 has 8.33%, class3 also has 5.55%, in

contrast higher rates were detected in class 4, class 5 and class6 (13.88%,11.11%, and 8.33%), respectively.

Table1: Prevalence of Intestinal Parasitic Infections among the studied samples in relation to sociodemographic data:

Ascaris Lumbricoides		*Hookworm Sp.*		*Giardia*		*Stronglyloides Stercolaris*		*Trichuris Trichiura*		*Enterobius Vermicularis*	
Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
6	16.63%	5	13.86%	2	5.54%	3	8.31%	2	5.54%	1	2.77%

Prevalence of IPIs by Gender		
MALE	Of the 36 selected children 13 males were infected (36.11%) and 6 females were infected (16.66%), totally 19 children with total percentage of (52.65%)	36.11%
FEMALE		16.66%

Prevalence of IPIs by Age		
6-9 Years	Of the 36 selected children 6-9 years 7 children were infected (19.44%) while from 10-12 years 12 children were infected (33.33%), totally 19 children with total percentage of (52.65%)	19.44%
10-12 Years		33.33%

Prevalence of IPIs by Class							
CLASS	Class1	Class2	Class3	Class4	Class5	Class6	19 children
Percent.	5.55%	8.33%	5.55%	11.11%	13.88%	8.33%	**52.65%**

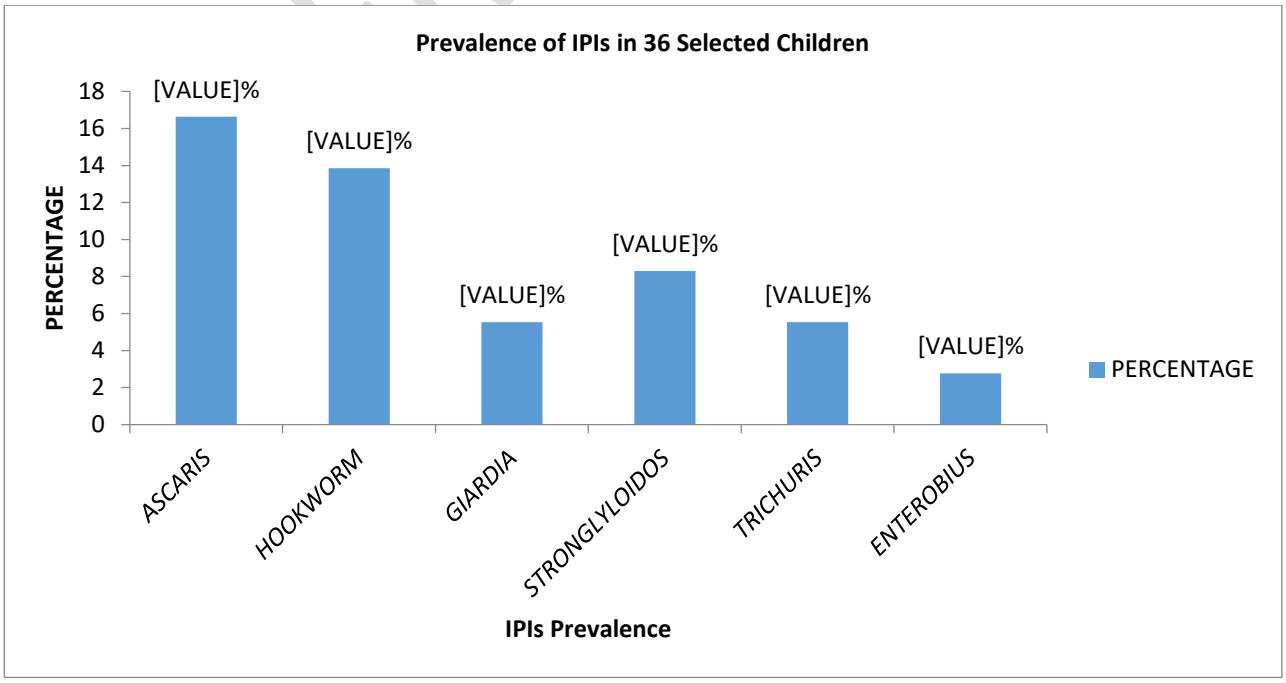

Figure. 1. Shows Prevalence of IPIs Among 36 Selected Children

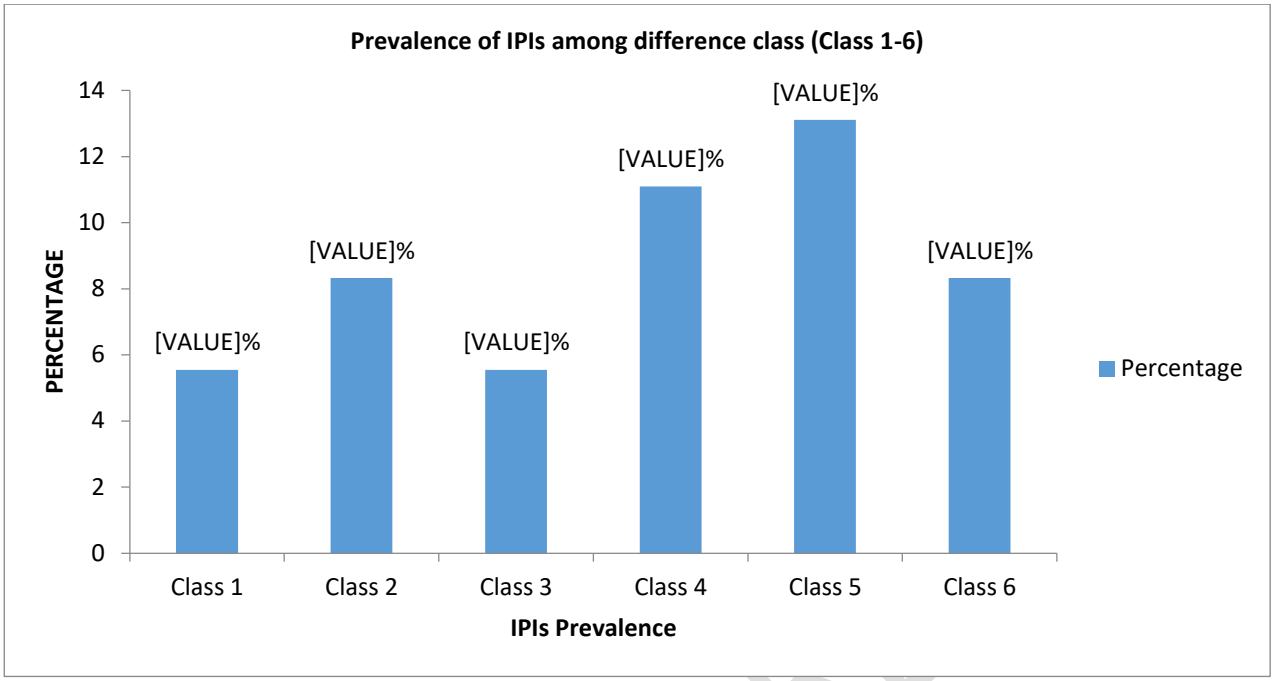

Figure. 2. Shows prevalence of IPIs Among Different Classes

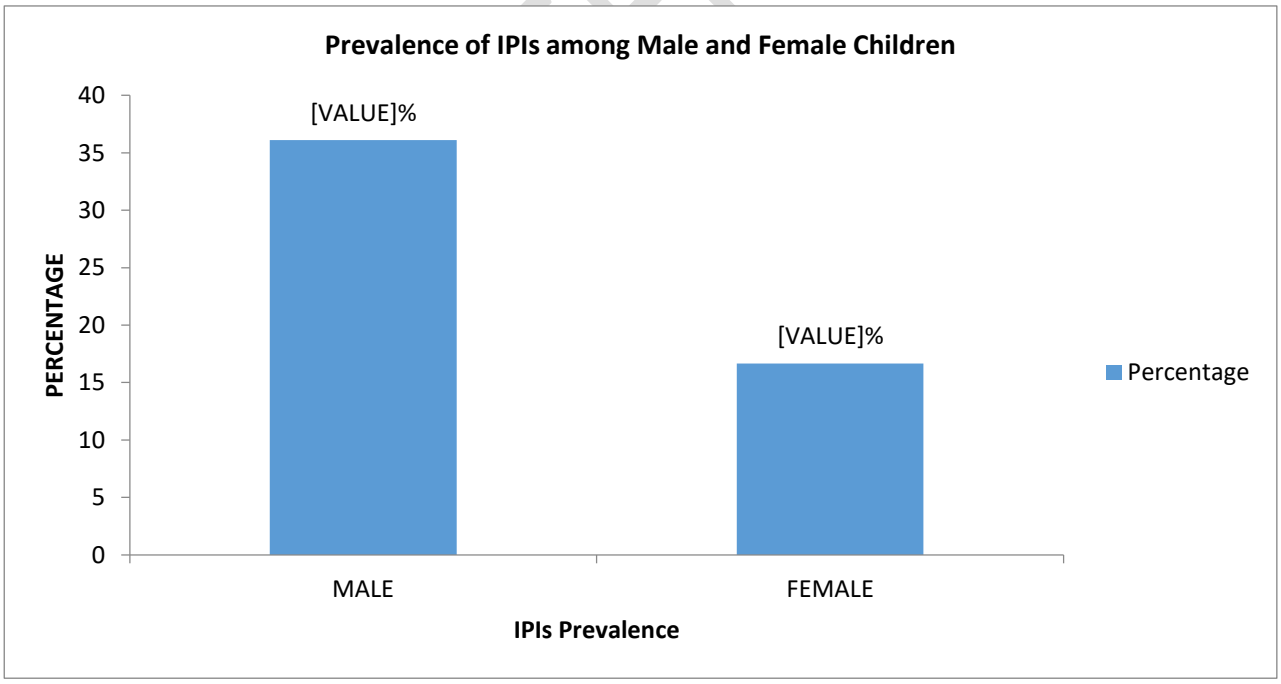

Figure. 3. Shows prevalence of IPIs by Gender (Male and Female).

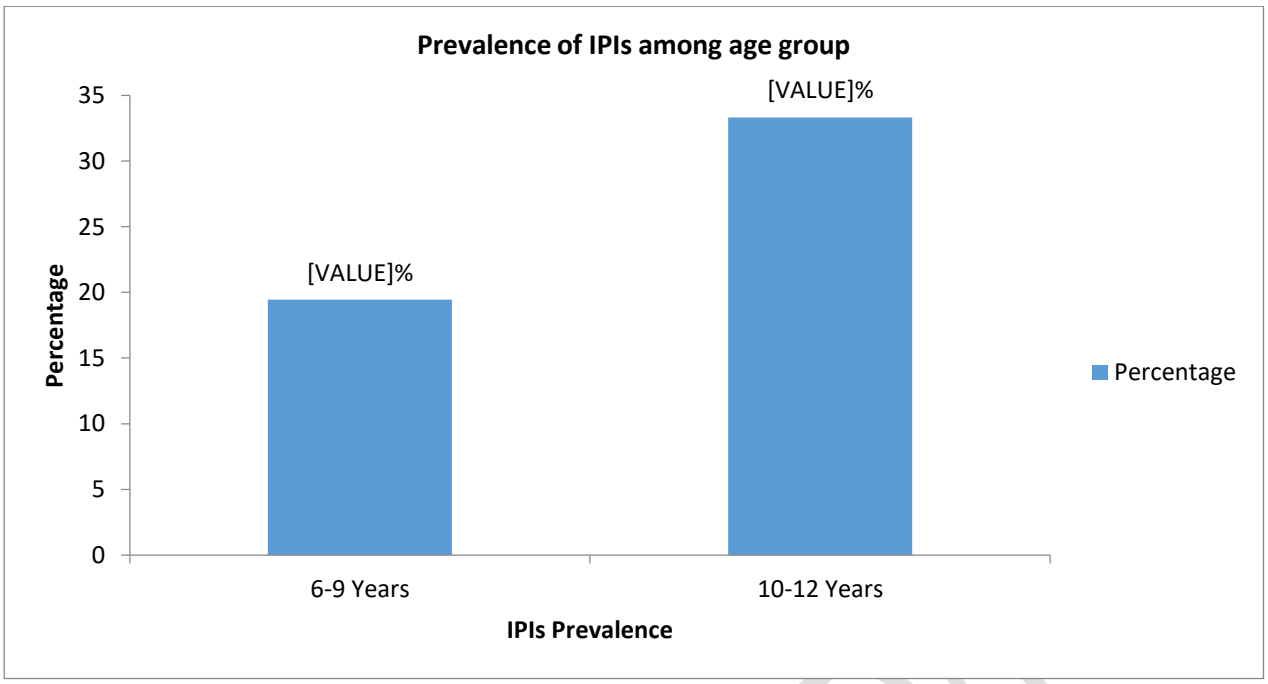

Figure. 4. Shows prevalence of IPIs Among Different Age Groups

DISCUSSION

This finding confirms that IPIs is common in the study area, this may be as a result of hot & humid climate of the region and this unfriendly environmental conditions coupled with poor personal hygiene and environmental sanitation, as well as, low level of literacy and socioeconomic problem. The prevalence of IPIs is higher among the male children than female as well as higher in older children than younger and IPIs is often acquired from contaminated soil, or occasionally through larva-infested waters. Although we cannot be certain of the route of contamination in our findings.

4. CONCLUSIONS

This research study established the prevalence of IPIs among children of Geidam central primary school Geidam. The prevalence is higher in males than in females and older children than the younger ones. This may have a connection that the older males have higher exposure to different potential risk factors such as walking barefoot, poor handwashing habits, open defection, and absence of proper latrine utilization are the major determinant factors for the high prevalence of hookworm infection. Therefore, the government should put more effort to reduce children's morbidity and mortality associated with IPIs through health education at the primary schools level and the development of community awareness campaigns to improve environmental sanitation and personal hygiene, as well as free deworming programs and these three interventions tailored to suit prevention, control and chemotherapy measures of IPIs.

ETHICAL APPROVAL

A letter dated 10th October 2019 was written to the Yobe State Ministry of Health with a detailed explanation of the research aims & objectives seeking ethical clearance to conduct this research study through the Director of research and the Yobe State Ethical Committee (YOHREC) executed a meeting on my research proposal and then clearance letter was issued to me dated, 15th October 2019 with **Ref. No: MOH/GEN/747/VOL.I.** However, the research was not conducted on time due to the insecurity of Boko Haram which necessitated the Geidam's Community to fly the town, until this January 2022 when the insecurity situation subsided. That the clearance letter was presented to Headmaster Geidam Central primary school and he granted permission to collect the stool sample.

RECOMMENDATIONS

Intestinal Parasitic Infections (IPIs) can be controlled and prevented through three main intervention

strategies for controlling and preventing of IPIs, namely: anthelminthic drug treatment, improved sanitation, and health education

(i). Deworming: Deworming can significantly reduce the number of adult worms in the gastrointestinal tract which is also reflected in reduced egg counts. The WHO recommends both albendazole and mebendazole as the drug of choice to be used in the public health program for controlling and preventing of IPIs.

(ii). Sanitation: Improvement of sanitation that is intended at controlling transmission by reducing soil and water contamination is another way for IPIs interventions**.** Sanitation is the only definitive intervention to control IPIs. For this intervention to be fully effective, it should cover a high percentage of the population on a broad scale.

(iii). Health Education: Health education at the school level and public awareness campaign program is another major intervention in controlling IPIs aimed at reducing transmission and re-infections by promoting healthy behaviors such as encouraging the use of latrines, wearing shoes, and hygienic behaviors**.** Without a change in sanitary behaviors**,** regular deworming cannot achieve a significant reduction in IPIs transmission**.** In addition, health education can be offered simply and economically by decreasing cost, increasing levels of knowledge, and decreasing the re-infection rate. Likewise, it does not involve any contraindications or risks. Its benefit goes beyond the control of IPIs infections as it can build trust and engage communities, which are essential aspects of the successfulness of public health initiatives**.** Children should be strictly warned about walking barefoot in areas where hookworm is common and where there may be human fecal contamination of the soil

FUTURE PROSPECTS

Due to financial constraints, I would like to express a final thought on future prospects, which seem to me to be just as interesting to cover all parts of Geidam primary schools and Yobe state at large to ascertained the exact prevalence of IPIs in the case study area, as 1 primary school is too limited to achieves our desired aims and objectives and therefore suggested for other researchers to utilize this opportunity to cover the whole state.

REFERENCES

(1). Udonsi, J. K. (1984). Studies on the occurrence of two species of human Hookworm in a riverine community in Nigeria. Trop. Med. Parasit., 35 (1): 37– 40.

(2). Dudlová A, Juriš P, Jurišová S, et al. Epidemiology and geographical distribution of gastrointestinal parasitic infection in humans in Slovakia. Helminthologia. 2016;53(4):309–317.

(3). von Huth S, Kofoed PE, Holmskov U. Prevalence and potential risk factors for gastrointestinal parasitic infections in children in urban Bissau, Guinea-Bissau. Trans R Soc Trop Med Hyg. 2019;113 (9):545–554. • This paper describes the risk factors for intestinal parasitic infections.

(4). Hotez PJ. Neglected parasitic infections and poverty in the United States. PLoS Negl Trop Dis. 2014 Sep;8(9):1–5.

(5). World Health Organization. Soil-transmitted helminth infections 2019 [cited 2019 Sep 12]. Available from: https://www.who.int/ news-room/fact-sheets/detail/soil-transmitted-helminth-infections.

(6). James SL, Abate D, Abate KH, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018;392(10159):1789–1858. • This paper reports the global prevalence for intestinal parasitic infections.

(7). Bisoffi Z, Buonfrate D, Montresor A, et al. Strongyloides stercoralis: a plea for action. PLoS Negl Trop Dis. 2013;7(5):1–4.

UNDER PEER REVIEW

(8). Kirk MD, Pires SM, Black RE, et al. World Health Organization estimates of the global and regional disease burden of 22 foodborne bacterial, protozoal, and viral diseases, 2010: a data synthesis. PLoS Med. 2015 Dec;12(12):1–21. • This paper describes the how WASH intervention and mass anti-helmintic drugs can be used to control intestinal parasitic infections.

(9). Jia TW, Melville S, Utzinger J, et al. Soil-transmitted helminth reinfection after drug treatment: a systematic review and meta-analysis. PLoS Negl Trop Dis. 2012;6(5):1–11.

(10). Yates T, Allen J, Leandre Joseph M, et al. WASH interventions in disease outbreak response. Oxford: Oxfam GB; 2017. Humanitarian Evidence Programme.

(11). Forson AO, Arthur I, Olu-Taiwo M, et al. Intestinal parasitic infections and risk factors: a cross-sectional survey of some school children in a suburb in Accra, Ghana. BMC Res Notes. 2017;10 (1):1–5.

(12). Terefe Y, Ross K, Whiley H. Strongyloidiasis in Ethiopia: systematic review on risk factors, diagnosis, prevalence and clinical outcomes. Infect Dis Poverty. 2019;8(1):1–11.

(13). Ngui R, Ishak S, Chuen CS, et al. Prevalence and risk factors of intestinal parasitism in rural and remote West Malaysia. PLoS Negl Trop Dis. 2011 Mar 1;5(3):1–7.

(14). Ayuba K, Oti V, Okwoli A, et al. High prevalence of human gastrointestinal parasitic infections in an Internally Displaced Persons (IDPs) Camp in Nasarawa State, Nigeria: a cross-sectional study. South Asian J Parasitol. 2019;3(1):1–8.

(15). Bouwmans MCH, Gaona MA, Chenault MN, et al. Prevalence of intestinal parasitic infections in preschool-children from vulnerable neighborhoods in Bogotá. Rev Univ Ind Santander Salud. 2016;48 (2):178–187.

(16). Anuar TS, Salleh FM, Moktar N. Soil-transmitted helminth infections and associated risk factors in three Orang Asli tribes in Peninsular Malaysia. Sci Rep. 2014 Feb;14(4):1–7.

(17). Al-Delaimy AK, Al-Mekhlafi HM, Lim YAL, et al. Developing and evaluating health education learning package (HELP) to control soil-transmitted helminth infections among Orang asli children in Malaysia. Parasites Vectors. 2014;7(1):1–18.

(18). Al-Delaimy AK, Al-Mekhlafi HM, Nasr NA, et al. Epidemiology of intestinal polyparasitism among Orang Asli school children in rural Malaysia. PLoS Negl Trop Dis. 2014 Aug;8(8):1–12. • This paper describes the risk factors for intestinal parasitic infections.

(19). Graham JP, Polizzotto ML. Pit latrines and their impacts on groundwater quality: a systematic review. Environ Health Perspect. 2013 May;121(5):521–530.

(20). Ngui R, Aziz S, Chua KH, et al. Patterns and risk factors of soil-transmitted helminthiasis among Orang asli subgroups in peninsular Malaysia. Am J Trop Med Hyg. 2015;93(2):361–370.

(21). Muslim A, Mohd Sofian S, Shaari SA, et al. Prevalence, intensity and associated risk factors of soil transmitted helminth infections: a comparison between Negritos (indigenous) in inland jungle and those in resettlement at town peripheries. PLoS Negl Trop Dis. 2019 Apr;13(4):1–22.

(22). Elyana FN, Al-Mekhlafi HM, Ithoi I, et al. A tale of two communities: intestinal polyparasitism among Orang Asli and Malay communities in rural Terengganu, Malaysia. Parasites Vectors. 2016 Jul 16;9 (1):1–17.

(23). Alemu M, Kinfe B, Tadesse D, et al. Intestinal parasitosis and anaemia among patients in a Health Center, North Ethiopia. BMC Res Notes. 2017;10(1):1–7.

(24). Darlan DM, Ananda FR, Sari MI, et al. Correlation between iron deficiency anemia and intestinal

UNDER PEER REVIEW

parasitic infection in school-age children in Medan. IOP Conf Ser Earth Environ Sci. 2018;125:1–6.

(25). Feleke BE. Nutritional status and intestinal parasite in school age children: a comparative cross-sectional study. Int J Pediatr. 2016; 2016:1–8.

(26). Gopalakrishnan S, Eashwar VA, Muthulakshmi M, et al. Intestinal parasitic infestations and anemia among urban female school children in Kancheepuram district, Tamil Nadu. J Fam Med Prim Care. 2018;7(6):1395–1400.

(27). Tulu B, Taye S, Zenebe Y, et al. Intestinal parasitic infections and nutritional status among Primary School Children in Delo-mena District, South Eastern Ethiopia. Iran J Parasitol. 2016;11(4):549–558.

(28). Mahmud MA, Spigt M, Bezabih AM, et al. Efficacy of handwashing with soap and nail clipping on intestinal parasitic infections in school-aged children: a factorial cluster randomized controlled trial. PLoS Med. 2015 Jun;12(6):1–16. • This paper describes the importance and efficacy of personal hygiene behaviour on intestinal parasitic infections.

(29). Rajoo Y, Ambu S, Lim YAL, et al. Neglected intestinal parasites, malnutrition and associated key factors: a population based cross-sectional study among indigenous communities in Sarawak, Malaysia. PLoS One. 2017;12(1):1–17.

(30). Papier K, Williams GM, Luceres-Catubig R, et al. Childhood malnutrition and parasitic helminth interactions. Clin Infect Dis. 2014 Jul 15;59(2):234–243.

(31). Garzón M, Pereira-da-Silva L, Seixas J, et al. Association of enteric parasitic infections with intestinal inflammation and permeability in asymptomatic infants of Sao Tome Island. Pathog Glob Health. 2017 May;111(3):116–127.

(32). Chen TL, Chen S, Wu HW, et al. Persistent gut barrier damage and commensal bacterial influx following eradication of Giardia infection in mice. Gut Pathog. 2013;5(26):1–12.

(33). Tellevik MG, Moyo SJ, Blomberg B, et al. Prevalence of Cryptosporidium parvum/hominis, Entamoeba histolytica and Giardia lamblia among young children with and without diarrhea in Dar es Salaam, Tanzania. PLoS Negl Trop Dis. 2015;9(10):1–16.

(34). Nakada-Tsukui K, Nozaki T. Immune response of amebiasis and immune evasion by Entamoeba histolytica. Front Immunol. 2016;7 (175):1–13.

(35). Halliez MCM, Buret AG. Extra-intestinal and long term consequences of Giardia duodenalis infections. World J Gastroenterol. 2013 Dec 21;19(47):8974–8985.

(36). Ferreira FS, Baptista-Fernandes T, Oliveira D, et al. Giardia duodenalis and soil-transmitted helminths infections in children in Sao Tome and Principe: do we think Giardia when addressing parasite control? J Trop Pediatr. 2015 Apr;61(2):106–112.

(37). Nel ED. Diarrhoea and malnutrition. South Afr J Clin Nutr. 2010;23 (1):15–18.

(38). Speich B, Moser W, Ali SM, et al. Efficacy and reinfection with soil-transmitted helminths 18-weeks post-treatment with albendazole-ivermectin, albendazole-mebendazole, albendazole-oxantel pamoate and mebendazole. Parasite Vector. 2016 Mar 2;9(123):1–10.

(39). Sunish IP, Rajendran R, Munirathinam A, et al. Impact on prevalence of intestinal helminth infection in school children administered with seven annual rounds of diethyl carbamazine (DEC) with albendazole. Indian J Med Res. 2015;141:330–339.

UNDER PEER REVIEW