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Research Article

Prevalence of Intestinal Helminths in Typhoid Fever Patients in Okpokwu Local Government Area, Benue State, Nigeria

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Abstract— The present study investigated intestinal parasitosis among clinically diagnosed typhoid fever patients attending healthcare facilities in the Okpokwu Local Government Area of Benue State, Nigeria. Standard techniques including the Direct Wet Mount Technique, Formol-Ether Concentration Technique, and Modified Ziehl-Neelsen Method were employed for this research. A total of 436 typhoid fever patients consented and participated in the study. The prevalence rate among males was higher at 32.8% compared to 28.2% among females. The overall prevalence of intestinal parasites was 30.7%.The identified intestinal helminths and their prevalence were: Ascaris lumbricoides (7.34%), hookworm (4.13%), Strongyloidesstercoralis (3.21%), and Trichuris trichiura (2.06%), culminating in a total helminth prevalence of 16.74%. The highest prevalence rate of intestinal parasitosis was observed in the age group 31-40 years, at 35.4%. A significant association was found between intestinal parasite infection and age among typhoid fever patients (p = 0.002). Additionally, significant associations were identified between intestinal parasitosis and variables such as sex (p = 0.0024), type of toilet facility (p = 0.005), hand washing after toilet use (p = 0.00476), and source of drinking water (p = 0.028).Given that social factors like poverty and hygiene influence both diseases, it is imperative to educate the population on the importance of personal hygiene. Moreover, appropriate medications should be made available at reduced and affordable costs.

Keywords— Intestinal helminths, Parasite, *Ascaris lumbricoides,* Infection, Typhoid Fever, Patients

1. Introduction

Intestinal parasitic infections pose significant health risks, leading to morbidity and mortality among affected individuals. These infections are linked to stunted linear growth, physical weakness, and low educational achievement in children. They also cause iron deficiency anemia, loss of appetite, and various physical and mental health issues [1],[2].

Intestinal parasitosis encompasses diseases caused by protozoa, cestodes, trematodes, and nematodes. These parasites significantly contribute to morbidity and mortality, particularly in communities facing overcrowding, poor sanitation, and inadequate personal hygiene, making them a major concern for developing countries. The prevalence of different parasites varies between immunocompetent and immunodeficient individuals [3].

Infections are caused by Cestoda (genera Taenia and Hymenolepis), soil-transmitted Nematoda (Ascaris lumbricoides, Trichuris trichiura, Strongyloidesstercoralis, and hookworms), and Protozoa (such as Entamoeba histolytica, Giardia intestinalis, and Cryptosporidium) [4]. These infections, often referred to as 'the cancers of developing nations,' are associated with high morbidity, particularly among young children, women of childbearing age, and immunocompromised individuals [5],[6].

The distribution and prevalence of various intestinal parasites vary regionally due to environmental, social, and geographical factors. These parasites thrive in areas with poor sanitation and are most common in tropical developing regions of Africa, Asia, and South America [7]. Factors such as low household income, poor personal and environmental sanitation, overcrowding, limited access to clean water, tropical climate, and low latitude are closely associated with these infections [8]. In underdeveloped nations, a cycle of undernutrition and repeated infections leads to excessive morbidity, perpetuating health issues across generations. Although people of all ages are affected, children are the most vulnerable [9],[10].

In Nigeria, enteric infections like Salmonella and intestinal helminths are widespread [11]. Poor hygiene, inadequate waste disposal, and food consumption from commercial vendors are major factors promoting transmission [12]. While school children are particularly at high risk due to undeveloped hygienic habits, it is crucial to understand the infection patterns among young adults who have recently gained independence from caregivers [13].

Enteric Salmonella species, which cause typhoid fever, can survive in water for a week, two weeks in sewage, and a month in ice cream, though boiling water or milk can destroy the bacteria [11]. Typhoid fever, like gastrointestinal parasitic infections, is a significant yet underestimated enteric infectious disease with a high incidence. Estimates indicate approximately 21.7 million cases of typhoid fever worldwide, with over 700,000 deaths, primarily affecting infants, children, and adolescents in South-central and South-eastern Asia [14], [7].

Transmission of intestinal parasites and enteropathogenic bacteria occurs directly or indirectly through objects contaminated with feces, such as food, water, nails, and fingers, underscoring the importance of fecal-oral human-to-human transmission [15]. This study aims to investigate intestinal helminths among clinically diagnosed typhoid fever patients attending healthcare facilities in the Okpokwu Local Government Area of Benue State, Nigeria.

Apart from Section 1, which gives the background and rationale for this work, the remainder of this article is structured as follows: Section 2 reviews the related literature on this research topic, Section 3 details the methodology, including materials and methods, Section 4 presents the results, analyzes them, and provides a discussion, and the final Section 5 concludes the research and outlines future directions.

2. Related Work

Several studies have reported a significant prevalence of intestinal helminth infections among patients with typhoid fever. For example, Nwaneri et al. [16] reported that 25% of typhoid fever patients in Nigeria were co-infected with intestinal helminths, primarily *Ascaris lumbricoides* and *Hookworm* species. Similar findings were observed by Walson et al. [17] in Kenya, where 30% of typhoid fever patients had concurrent helminth infections, and by Bhattacharya et al. [18] in India, which reported a co-infection rate of 18%.

Helminth infections are known to modulate the host immune response, often inducing a Th2-type immune response, which can interfere with the Th1-type response necessary for combating bacterial infections such as typhoid fever [19]. This immunomodulation can increase susceptibility to typhoid fever and other bacterial infections, complicating the clinical management of these diseases.

Co-infection with intestinal helminths and typhoid fever can lead to more severe clinical outcomes. Patients with dual infections may experience exacerbated symptoms, including gastrointestinal bleeding and perforation, requiring more intensive medical care [20]. Additionally, helminth infections can alter the pharmacokinetics of typhoid fever treatments, potentially reducing their efficacy [21].

Integrated public health strategies are crucial for addressing the dual burden of typhoid fever and intestinal helminth infections. These strategies include improving sanitation, providing access to clean water, and implementing mass deworming programs. Public health education to promote better hygiene practices is also essential to reduce the prevalence of both types of infections [22].

Additional studies have further elucidated the relationship between typhoid fever and intestinal helminths. A study by Bansal et al. [23] in India found that co-infection rates can be as high as 22%, with *Hymenolepis nana* being a common helminth identified among typhoid patients. Similarly, research by Olopade et al. [24] in Nigeria highlighted a 28% co-infection rate, emphasizing the need for integrated disease control programs. Another study by Phiri et al. [25] in Zambia reported that co-infected patients often presented with more severe anemia and malnutrition, underscoring the compounded health impact of these infections.

3. Theory/Calculation

Intestinal helminths are parasitic worms that inhabit the gastrointestinal tract of humans. Common helminths include Ascaris lumbricoides (roundworm), Trichuris trichiura (whipworm), and Ancylostoma duodenale (hookworm). Typhoid fever, caused by the bacterium Salmonella enterica serotype Typhi, is a significant public health concern in many developing regions, including Nigeria.

This bacterial infection primarily spreads through contaminated food and water, leading to symptoms such as prolonged fever, abdominal pain, and gastrointestinal disturbances.

Co-infections with intestinal helminths and typhoid fever are common in areas with poor sanitation and limited access to clean water. Helminth infections can modulate the immune response, potentially altering the clinical course and severity of typhoid fever. The immune modulation by helminths might affect the host's susceptibility to bacterial infections, including typhoid fever, and could complicate the diagnosis and treatment of both conditions.

Both intestinal helminthiasis and typhoid fever are prevalent in regions with inadequate sanitation and hygiene practices. In Nigeria, these conditions are widespread due to factors such as limited access to clean water, poor waste management, and overcrowded living conditions. The prevalence of these infections is influenced by environmental, socio-economic, and behavioral factors. Understanding the epidemiology of these co-infections is crucial for developing targeted interventions.

Co-infections with intestinal helminths and typhoid fever have significant implications for public health. They can lead to increased morbidity and mortality, especially among vulnerable populations such as children and immunocompromised individuals. The presence of helminths can exacerbate malnutrition and anemia, which are common complications of typhoid fever, thereby worsening the overall health outcomes for infected individuals.

Diagnosing and treating co-infections of intestinal helminths and typhoid fever pose significant challenges. The symptoms of these infections can overlap, making accurate diagnosis difficult without proper laboratory testing. Additionally, co-infections may require a combination of antiparasitic and antibacterial treatments, which can be complicated by issues such as drug resistance and patient compliance. Effective management of these co-infections requires integrated approaches that address both diseases simultaneously.

Despite the known prevalence of both intestinal helminths and typhoid fever in Nigeria, there is limited data on the co-infection rates in specific regions such as Okpokwu LGA, Benue State. Understanding the prevalence and impact of these co-infections is essential for informing public health strategies and improving patient outcomes. This study aims to investigate the prevalence of intestinal helminths in patients diagnosed with typhoid fever in Okpokwu LGA, Benue State, Nigeria, and to explore the potential interactions between these infections.

4. Experimental Method/Procedure/Design

4.1 Study Area

The Okpokwu Local Government Area (LGA) was established in 1976, and named after the Okpokwu stream. It comprises the districts of Okpoga, Edumoga, and Ichama, with Okpoga serving as the administrative headquarters. Geographically, it is located between latitude 7°03'27.60" N and longitude 8°12'21.60" E. It shares boundaries with Otukpo, Ohimini, Ogbadibo, and Ado LGAs in Benue State; Olamaboro LGA in Kogi State; and Isi-Uzo LGA in Enugu State. Sample collection for this study was conducted at the Local Government Comprehensive Health Centers in Ugbokolo, Ojapo, and Olanyega, as well as the Local Government clinics in Okpoga, Ichama, Ojigo, and Ekeh.

Figure 1: Map of Benue State showing Okpokwu Local Government Area

4.2 Sample Size

The sample size for the study was 436 participants. This was determined using statistical calculations based on Yaro Yamane's formula and proportional sampling to estimate the study population. The Yaro Yamane's formula is given by:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = Sample Size

N = Population

e = Level of precision or confidence level $(0.05)^2$[26].

4.3 Methods of Data Collection

4.3.1 Collection of Stool Samples

Disposable plastic cups and applicator sticks were distributed to each study participant with brief instructions on how to collect the stool sample. Participants were instructed to provide a fresh stool sample of approximately 3 grams. Each plastic cup was labeled with a unique patient code. The collected stool samples were transported to the Benue State Polytechnic Ugbokolo Microbiology Laboratory for parasitological examination [27].

4.3.2 Ethical Clearance

Ethical clearance was obtained from the Department of Health and Human Services, Okpokwu Local Government Area, Benue State.

4.4 Laboratory Parasitological Examination Procedures

The laboratory parasitological examination procedures employed in this study included the direct wet mount technique, the Formol-ether concentration technique, and the Modified Ziehl-Neelsen method as described by Cheesbrough [27].

4.5 Data Analysis

Data entry and analysis were performed using SPSS software. Statistical analysis involved the use of the Chi-square test to evaluate associations between intestinal helminth infections and typhoid fever. The odds ratio was calculated to measure the strength of the association between the presence of parasites and typhoid fever. Differences in the data were considered significant if $P<0.05P < 0.05P<0.05$.

5. Results and Discussion

This study, conducted among clinically diagnosed typhoid fever patients attending healthcare facilities in Okpokwu Local Government Area of Benue State, revealed an overall prevalence of 30.7% for intestinal helminths. This rate is lower than the 43.3% found by Ejenika et al. [28] in Jos, Nigeria, and the 41.2% reported by Hailegebriel[29] and Ismail [8], which reflects the high prevalence of parasites in developing countries. In some rural communities in North-Eastern Nigeria, a higher prevalence of 80.9% was reported among Almajiri school children [30]. Similar findings were observed in rural communities in Benue State, Nigeria, with prevalence rates of 58.5% and 51.0%. The prevalence in this study is comparable to the 30.6% reported by Adekunle [31] and close to the 29% prevalence of gastrointestinal parasites among in-patients of Igbinedion University Teaching Hospital, Okada, Edo State, as reported by Okafor-Elenwo et al. [4]. A similar prevalence rate of 29.0% was also recorded among preschool children in some urban communities in Benue State, Nigeria [4]. The relatively lower infection rates in these groups may be attributed to public enlightenment and sensitization on good environmental and personal hygiene and better access to healthcare facilities. Other studies recorded higher prevalence rates of 33.9% in Qatar, 31.8% to 37.2% in Turkey, and 31.94% in Saudi Arabia [32].

A total of 436 typhoid fever patients participated in this study. The results indicated that 28.2% of the female patients and 32.7% of the male patients were infected with intestinal parasites, showing a prevalence rate of 30.7% among typhoid fever patients in relation to sex. The association between typhoid fever and intestinal parasites in relation to sex was significant at p = 0.0024 (Table 1). Males had a higher prevalence (32.7%) compared to females (28.2%). This finding contrasts with Ejinaka et al. [28] and Zewdineh and Kucho [33], who reported a higher prevalence in females, but agrees with Obioma et al. [3], who found a higher prevalence rate among males in Delta State, Nigeria. This disparity might be due to the common feeding pattern where more men eat outside their homes while working, the contamination of soil by human feces, and the use of raw sewage for agricultural purposes.

Table 1: Prevalence of Intestinal Parasites among Typhoid Fever Patients in Relation to Sex

Sex	Number Examined	Number Positive	Prevalence (%)
Female	188	53	28.2
Male	248	81	32.7
Total	436	134	30.7

χ^2 @1df (parasite and gender) =9.213, p=0.0024 (p<0.05)

Table 2 presents the prevalence of intestinal parasites among typhoid fever patients in relation to age. The study revealed that 17.1% of patients aged ≤10 years were infected with intestinal parasites, 31.5% of those aged 11-20 years, and 34.2% of those aged 21-30 years. The highest prevalence (35.4%) was found among patients aged 31-40 years, with 33.9% prevalence among those aged 41-50 years, and 26.7% among those aged 51-60 years. The data showed no significant association between typhoid fever and intestinal parasites in relation to age at p = 0.57. The highest prevalence rate of 35.4% was observed in the age group 31-40 years, consistent with the findings of Okafor-Elenwo et al. [4]. The lower prevalence among participants aged 71 years and above and children aged 0-10 years compared to those aged 11-60 years could be due to behavioral patterns in rural and suburban settings, where younger children are well cared for at home, while older children handle most errands, including open-water activities such as fishing, washing, and food processing in streams and rivers. The middle-aged group is often engaged in agricultural activities and fish farming, exposing them to parasites in the soil, water bodies, and other environmental reservoirs.

Table 2: Prevalence of Intestinal Parasite among Typhoid Fever Patients in Relation to Age

Age Group	Number Examined	Number Positive	Prevalence (%)
≤ 10	41	7	17.1
11-20	57	18	31.5
21-30	114	39	34.2
31-40	79	28	35.4
41-50	56	19	33.9
51-60	45	12	26.7
61-70	29	6	20.7
71 ≥	15	3	20.0
Total	436	134	30.7

χ^2 @7df (parasite and age group) =13.69, p=0.057 (p>0.05)

Table 3 indicates that among the 163 samples collected from patients with secondary education, 56 (34.4%) tested positive for intestinal parasites. This was followed by uneducated patients, with a prevalence rate of 32.1%. Patients with primary education had a prevalence rate of 28.7% (33 out of 115), while those with graduate or postgraduate education had the lowest prevalence rate at 24.3% (18 out of 74). It is evident from Table 3 that there is no significant association between intestinal parasitic infections and typhoid fever in relation to the level of education (*P* = 0.585), which is greater than the 0.05 threshold for statistical significance. The highest prevalence of 34.4% was observed among patients with secondary education. The lack of significant association suggests that education level alone is not a determining factor in the prevalence of intestinal parasitic infections among typhoid fever patients.

The study results show that individuals with graduate or postgraduate education have the lowest prevalence of intestinal parasitic infections. This lower prevalence is likely due to higher levels of education, which correlate with better sanitation practices and greater awareness of how intestinal parasites are transmitted through the fecal-oral route. Educated individuals are more likely to understand the importance of personal hygiene and environmental sanitation, enabling them to take appropriate measures to prevent infection.

Table 3: Prevalence of Intestinal Parasites among Typhoid Fever Patients in Relation to Level of Education

Variables	No. Examined	No. Positive	Prevalence (%)
Uneducated	84	27	32.1
Primary School	115	33	28.7
Secondary School	163	56	34.4
Graduate/Post Graduate	74	18	24.3
Total	436	134	30.7

χ^2 @3df (parasite and level of education) =1.94, p=0.585 (p>0.05)

Table 4 outlines the prevalence of intestinal parasites among typhoid fever patients according to their occupation. Among the 128 samples from unemployed individuals, 43 (33.6%) tested positive for intestinal parasites. The infection rates among unskilled laborers, skilled laborers, and those in civil/military positions were 30.6% (31 out of 101), 29.6%

(34 out of 115), and 28.3% (26 out of 92), respectively, resulting in an overall prevalence rate of 30.7%. Chi-square analysis indicated that there is no significant association between intestinal parasitic infections and typhoid fever with respect to occupation (*P* = 0.919), which exceeds the 0.05 significance level.

The highest prevalence (33.6%) was observed among the unemployed. This increased prevalence among unskilled and skilled laborers is likely due to their involvement in manual labor, which exposes them to various environmental hazards. Their frequent consumption of street food and contact with soil in their daily tasks further heightens their risk of parasitic infections. This finding contrasts with Okafor-Elenwo et al. [4], who identified a strong association between occupation and intestinal infections, particularly among mine workers and farmers. The elevated prevalence among unskilled laborers may also be related to lower literacy levels and reduced awareness of personal hygiene practices, which increases their likelihood of consuming contaminated food.

Table 4: Prevalence of Intestinal Parasites among Typhoid Fever Patients in Relation to Occupation

Variables	No. Examined	No. Positive	Prevalence (%)
Wash hand	194	48	24.7
Do not wash hand	83	31	37.3
Do not wash hand Always	159	55	34.6
Total	436	134	30.7

χ^2 @3df (parasite and occupation) =0.50, p=0.919 (p>0.05)

Table 5 shows the prevalence of intestinal parasites among typhoid fever patients in relation to the type of toilet facility used. Out of the 144 patients who defecate in open spaces or fields, 51 (35.4%) tested positive for intestinal parasites. Among those using pit toilets, 55 (29.7%) were infected, while the prevalence among water closet users was 28 (26.2%). Chi-square analysis indicates a significant association between the type of toilet facility and the prevalence of intestinal parasitic infections and typhoid fever (p = 0.005).

Patients who defecate in open fields exhibited the highest prevalence (35.4%), corroborating Amuta et al. [34], who highlighted that the availability or lack of sanitary facilities, especially toilets, significantly influences the infection rates of intestinal parasites. The high prevalence among those practicing open defecation could be due to poor hygiene practices, such as wiping with leaves or paper and not washing hands afterward. The second highest prevalence was among pit toilet users, which may be attributed to children defecating at the pit's mouth, often in poorly maintained and unroofed conditions. These untidy pit toilets can attract houseflies, facilitating the spread of intestinal parasite eggs and cysts.

Table 5: Prevalence of Intestinal Parasites among Typhoid Fever Patients in Relation to Type of Toilet Facility

Variables	No. Examined	No. Positive	Prevalence (%)
Pit Toilet	185	55	29.7
Water Closet	107	28	26.2
Open Space/Field	144	51	35.4
Total	436	134	30.7

χ^2 @2df (parasite and toilet facility) =15.102, p=0.005 (p<0.05)

Table 6 reveals the prevalence of intestinal parasites among typhoid fever patients in relation to handwashing practices after using the toilet. Among patients who do not wash their hands after using the toilet, 31 (37.3%) tested positive for intestinal parasites. Those who do not always wash their hands had a prevalence of 55 (34.6%). In contrast, patients who consistently wash their hands after using the toilet had a lower prevalence rate of 24.7%.Chi-square analysis shows a significant association between handwashing after toilet use and the prevalence of intestinal parasitic infections and typhoid fever (p = 0.0476). This is lower than the 43% prevalence reported by Mama and Alemu [35] for individuals who do not wash their hands after using the toilet. The findings are in line with Abdulhadi et al. [36], who observed that food contamination can occur through unwashed hands after defecation or via flies that transfer pathogens between feces and food, thereby increasing the risk of intestinal parasite transmission.

The high prevalence among those who do not wash their hands after defecation can be attributed to the transmission of parasite eggs and cysts from unwashed hands to food and drinks. Children with infected fingernails who do not wash their hands after defecating can significantly increase the transmission rate of intestinal parasites.

Table 6: Prevalence of Intestinal Parasites among Typhoid Fever Patients in Relation to Hand Washing after Toilet use

Variables	No. Examined	No. Positive	Prevalence (%)
Unemployed	128	43	33.6
Unskilled Laborer	101	31	30.6
Skilled Laborer	115	34	29.6
Civil/Military Job	92	26	28.3
Total	436	134	30.7

χ^2 @2df (parasite and hand washing habit) =6.089, p = 0.0476 (p<0.05)

Table 7 shows the prevalence of intestinal parasites among typhoid fever patients in relation to their source of drinking water. Of the 179 samples from patients using river/stream water, 69 (38.5%) were infected with intestinal parasites. Those who used other water sources had a prevalence rate of 27.9%, followed by borehole users at 24.6%. The lowest infection rate was found among those using pipe-borne water, at 16.7%.Chi-square analysis indicates a significant association between the source of drinking water and the prevalence of intestinal parasitic infections and typhoid fever (p = 0.028). This demonstrates a synergistic relationship between these infections and the source of drinking water. The study reveals a 38.5% prevalence rate among those using river/stream water. Those using other sources had a prevalence of 27.9%, followed by borehole users at 24.6%. The lowest prevalence was among pipe-borne water users (16.7%).

This result aligns with Atswe et al. [37], who reported a high prevalence of intestinal parasites among those using stream/river water in Vandeikya, Benue State. In rural communities where open defecation is practiced, surface water often washes parasite eggs and fecal materials into rivers and streams. Additionally, wastewater released into water bodies increases the transmission rate as it carries parasite eggs and cysts. Chi-square analysis confirms that the source of drinking water is significantly associated with intestinal parasitic infections and typhoid fever (p = 0.028).

Table 7: Prevalence of Intestinal Parasites among Typhoid Fever Patients in Relation to Source of Drinking Water

Variables	No. Examined	No. Positive	Prevalence (%)
Pipe-Borne Water	24	4	16.7
Borehole	122	30	24.6
River/Stream	179	69	38.5
Satchet water, bottle water, spring	111	31	27.9
Total	436	134	30.7

χ^2 @df (parasite and source of drinking water) =9.10, p=0.028 (p<0.05)

Figure 2 illustrates the frequency of occurrence of intestinal helminths, with Ascaris lumbricoides having the highest prevalence rate, followed by hookworm, Strongyloidesstercoralis, and Trichuris trichiura. The identified helminths in this study include Ascaris lumbricoides, hookworms, Strongyloidesstercoralis, and Trichuris trichiura.The higher prevalence of helminthic infections compared to protozoan infections observed in this study can be attributed to the multiple routes of helminth infection (oral and dermal), whereas protozoan infections primarily spread through a single oral route. Ancylostoma duodenale (hookworm) was the most prevalent intestinal helminth identified in children. The incidence of hookworm infection is directly related to soil exposure where filariform larvae reside and penetrate human skin, which is exacerbated by poor personal hygiene and sanitation.The presence of Ascaris lumbricoides and Trichuris trichiura, along with Entamoeba species, indicates fecal-oral transmission, likely due to children not washing their hands after using the toilet. Strongyloidesstercoralis and Ancylostoma duodenale detected in samples suggest regular bare-body contact with soil, allowing the parasite cysts/larvae to penetrate the skin.

Intestinal parasites, as identified in this and other studies, are predominantly found in the high-humidity tropical regions of the world, including Nigeria. The climatic conditions in these regions favor the survival and transmission of these parasites. Additionally, factors such as low income, poor environmental sanitation, and personal hygiene, lack of potable drinking water, inadequate healthcare, and poor educational awareness contribute to the high prevalence rates of these infections. In areas with increased public sensitization and awareness programs, coupled with good sanitation and proper personal hygiene, very low incidence rates of gastrointestinal infections with parasites are typically recorded [38].

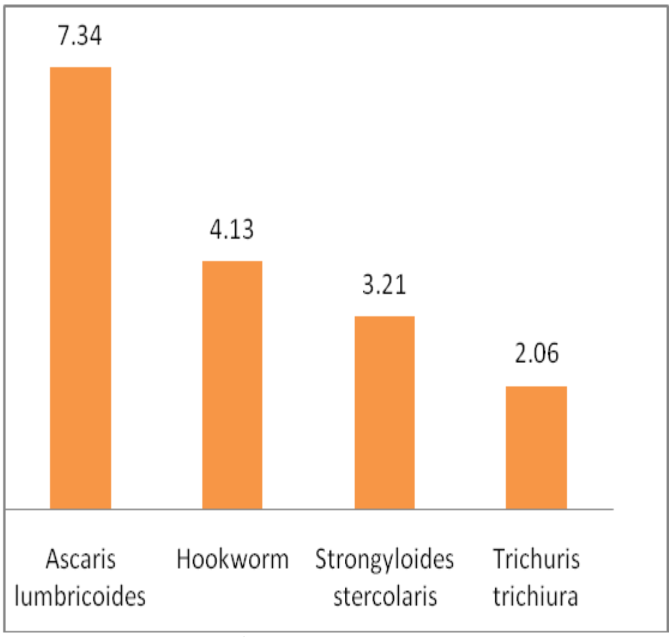

Figure 2: Prevalence of Intestinal Helminthes among Typhoid Fever Patients.

6. Conclusion and Future Scope

6.1 Conclusion

The results of this study clearly indicate a high prevalence of intestinal parasitic infections, particularly among rural dwellers. This prevalence can be attributed to factors such as ignorance, poverty, poor environmental and personal hygiene, lack of clean potable water, and indiscriminate defecation. Parasitic infections of the gastrointestinal tract are among the most common in the area. The study identified Ascaris lumbricoides as the most prevalent parasite, with the primary transmission route being the ingestion of contaminated food, water, and vegetables. This highlights the urgent need for effective elimination and control measures.The location and lifestyle of individuals, particularly those living in rural areas and engaging in agricultural activities, increase their exposure to soil, animals, and animal waste, which heightens their risk of parasitic infections. Intestinal parasitic infections pose a significant public health problem, leading to iron deficiency, anemia, growth retardation in children and adults, and various physical and mental health issues. High infection rates are closely linked to poverty, poor environmental hygiene, and inadequate medical services. In Nigeria, the frequent discharge of human and animal waste into the soil contributes to the spread of pathogenic organisms, including parasite cysts, eggs, and larvae.The study also found a synergistic relationship between intestinal parasitic infections and typhoid fever, particularly concerning the source of drinking water. Co-infection with Salmonella species and helminths can complicate the treatment of enteric fever if not properly diagnosed. Helminths can provide a focus for the multiplication of Salmonella bacteria, which can then enter the bloodstream and cause septicemia. This finding underscores the importance of administering anti-helminthic treatment alongside chemotherapy for Salmonella infections to ensure effective treatment and prevent early relapses of typhoid fever.Given that both typhoid and intestinal parasitic infections are linked to social factors such as poverty and hygiene, it is recommended that governments focus on improving the living standards of individuals in high-endemicity areas. Early detection and treatment of infections are crucial to prevent further transmission. Public education on the importance of personal hygiene and the provision of affordable drugs are essential. Continuous microbiological and parasitological surveillance is vital. It is highly recommended to drink water from safe sources, properly wash food items, especially vegetables, before consumption, and conduct regular deworming, ideally every three months. Additionally, consuming a balanced diet can help build immunity to fight parasitic infections.

6.2 Future Scope

i. Enhanced Public Health Interventions: Future studies should focus on evaluating the effectiveness of various public health interventions aimed at reducing intestinal parasitic infections and typhoid fever, particularly in rural areas.
ii. Development of Integrated Treatment Protocols: Research should be directed toward developing integrated treatment protocols that simultaneously address co-infections with Salmonella and helminths to improve patient outcomes.
iii. Longitudinal Studies on Hygiene Education: Conducting longitudinal studies to assess the long-term impact of hygiene education programs on the prevalence of intestinal parasites and typhoid fever would be beneficial.
iv. Water Quality Improvement Initiatives: Investigating the impact of water quality improvement initiatives on the prevalence of parasitic infections and typhoid fever can provide valuable insights for policy development.
v. Nutritional Interventions: Exploring the role of nutritional interventions in enhancing immunity and reducing the burden of parasitic infections could offer additional strategies for disease prevention and control.

Data Availability
Data will be available upon request

Conflict of Interest
Authors declare that they do not have any conflict of interest.

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Authors' Contributions
Thompson Oche drafted the manuscript and conducted the laboratory tests. Adulugba, O.A. developed the methodology, and Abah, E. A. edited the manuscript. All authors approved the final version of the manuscript.

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References

[1] A.A. Adedokun, E.O. Onosakponome, and E.A. Austin, "Intestinal parasites and Salmonella typhi infection among food-handlers in Port Harcourt metropolis, Nigeria," *Journal of Advances in Medicine and Medical Research*, Vol.**32**, Issue.**18**, pp.**1-9, 2020**.

[2] O.I. Funso-Aina, H.N. Chineke, and P.O. Adogu, "A review of prevalence and pattern of intestinal parasites in Nigeria (2006-2015)," *European Journal of Medical and Health Sciences*, Vol.**2**, Issue.**1**, pp.**1-6, 2020**.

[3] J.E. Obioma, E.O. Christopher, and O. Thankgod, "Prevalence of gastrointestinal parasites among school children in Delta State, Nigeria," *London Journal of Research in Science: Natural and Formal*, Vol.**22**, Issue.**8**, pp**.231-237, 2022**.

[4] E.J. Okafor-Elenwo, E.O. Izevbuwa, and O.A. Akpoka, "Prevalence of Intestinal Parasites amongst selected age groups within Okada, South-South Nigeria," *International Journal of Applied Biology*, Vol.**4**, Issue **1**, pp.**1-9, 2020**.

[5] M. Fabio, S. Higinio, T. Valentina, G. Simona, R. Patricia, R. Mimmo, P. Grover, M. Mario, B. Alessandro, and C. Gabriella, "Intestinal parasitic infections and associated epidemiological drivers in two rural communities of the Bolivian Chaco," Journal of Infectious Diseases and Developing Countries, Vol. **10**, Issue **9**, pp. **1012-1019, 2016**.

[6] K.O. Iyevhobu and B.N. Obodo, "Prevalence of parasitic infections in relation to CD4+ and antiretroviral (ART) usage of HIV seropositive patients attending Irrua Specialist Teaching Hospital (ISTH) Irrua, Edo State, Nigeria," *International Journal of Innovative Research and Advanced Studies*, Vol.**7**, Issue.**6**, pp.**205-211, 2020**.

[7] World Health Organization (WHO), "Report on intestinal parasitic infections," WHO Technical Report Series, pp.**978-985, 2016**.

[8] K.A. Ismail, "Prevalence of Intestinal Parasitic Infection among School Children in Taif," Insights in Biomedicine, Vol.**3**, Issue.**2**, pp.**10-14, 2018**.

[9] M.K. Hadiza, D.B. Maikaje, and U.J.J. Ijah, "Prevalence of Intestinal Parasites among children Attending daycare and orphanage centers in Kaduna Metropolis, Kaduna," *Science World Journal*, Vol.**14**, Issue.**3**, pp.**42-47, 2019**.

[10] E.C. Achi, O.O. Njoku, A.U. Nnachi, A.M. Efunshile, J.O. Mbah, I.N. Aghanya, and P.O. Nnemelu, "Prevalence of intestinal parasitic infections among under-five children in Abakaliki Local Government Area of Ebonyi State," *European Journal of Pharmaceutical and Medical Research*, Vol.**4**, Issue.**4**, pp.**218-222, 2017**.

[11] D. Ishaleku, E.U. Umeh, O. Amali, and G.M. Gberikon, "Enteric Salmonella species and Intestinal Helminthes Co-infection among Typhoid Fever Patients attending PHC Clinics in the Northern Zone of Nasarawa State, Nigeria," *Asian Journal of Applied Science*, Vol. **3**, Issue **2**, pp. **106-112, 2015**.

[12] C.O. Elemuwa, J.O. Isibor, N.J. Inyang, G.U. Elemuwa, R. Omoregie, M. Ayanlere, and E. Akpan, "Prevalence of Intestinal Parasites among Patients Accessing care in Secondary and Tertiary Healthcare Institutions in Edo State, Nigeria," *American Journal of Biomedical Science & Research*, Vol. **18**, Issue **3**, pp. **24-37, 2023**.

[13] A.A. Nyundo, D.Z. Munisi, and A.P. Gesase, "Prevalence and correlates of intestinal parasites among patients admitted to Mirembe National Mental Health hospital, Dodoma, Tanzania," *Journal of Parasitology Research*, pp. **1-6, 2017.**

[14] J.U. Udensi, I.C. Mgbemene, I. Emeka-Nwabunnia, M.G. Ugochukwu, and I.N. Awurum, "Prevalence of intestinal parasites among primary school children in three geopolitical zones of Imo State, Nigeria," *Science Journal of Public Health*, Vol. **5**, Issue **3**, pp**. 25-28, 2015**.

[15] P.I. Agbalaka, O.R. Ejinaka, D.P. Yakubu, U.M. Obeta, R.I. Jwanse, and A. Dawet, "Prevalence of parasites of public health significance in vegetables sold in Jos Metropolis, Plateau State, Nigeria," American Journal of Public Health, Vol. **7**, Issue **2**, pp. **48-57, 2019**.

[16] D.U. Nwaneri, V.O. Omuemu, and S.O. Alikah, "Prevalence of Intestinal Parasites among Patients with Typhoid Fever Attending University of Benin Teaching Hospital, Benin City, Nigeria," *Journal of Medicine and Biomedical Research*, Vol. **12**, Issue **2**, pp. **150-156, 2013**.

[17] J.L. Walson, B.T. Stewart, and L. Sangaré, "Evaluation of Impact of Albendazole on Growth and Anaemia in Children in a High Helminth Prevalence Region of Mali," *BMC Public Health*, Vol. **10**, pp. **770-781**, **2010.**

[18] S. Bhattacharya, U. Das, and B. Choudhury, "Prevalence of Intestinal Parasitic Infections in a Tertiary Care Hospital in Assam," *Indian Journal of Pathology and Microbiology*, Vol. **55**, Issue **3**, pp. **377-380, 2012**.

[19] P. Salgame, G.S. Yap, and W.C. Gause, "Effect of Helminth-Induced Immunity on Infections with Microbial Pathogens," Nature Immunology, Vol. **14**, Issue **11**, pp. **1118-1126**, **2013**.

[20] T.W. Mwangi, J. Bethony, and S. Brooker, "Malaria and Helminth Interactions in Humans: An Epidemiological Viewpoint," Annals of Tropical Medicine & Parasitology, Vol. **100**, Issue **7**, pp**. 551-570, 2011**.

[21] N.R. Steenhard, B.J. Vennervald, and A.A. Udraite, "Anthelmintic Treatment and the Risk of Invasive Bacterial Disease: Evidence of Increased Susceptibility after Treatment in Murine Models and Human Studies," *PLoS Neglected Tropical Diseases*, Vol. **4,** Issue **10**, pp. **e743, 2010**.

[22] P.J. Hotez, D.H. Molyneux, A. Fenwick, J. Kumaresan, S.E. Sachs, J.D. Sachs, and L. Savioli, "Control of Neglected Tropical Diseases," *New England Journal of Medicine*, Vol. **357**, Issue **10**, pp. **1018-1027, 2008**.

[23] D. Bansal, R. Sehgal, and H.S. Bhatti, "Prevalence of Intestinal Parasitic Infections Among Patients in a Tertiary Care Hospital in Northern India," Journal of Infection and Public Health, Vol**. 8,** Issue **4**, pp**. 409-414, 2015**.

[24] B.O. Olopade, C.O. Falade, and C.O. Olopade, "Prevalence of Malaria and Helminth Co-infection in Nigeria: A Review of the Literature," *Tropical Medicine & International Health*, Vol**. 19**, Issue **1**, pp**. 1-10, 2014.**

[25] K.S. Phiri, F.H. Verhoeff, and M. Bracher, "The Impact of Intestinal Helminths on the Nutrition of Schoolchildren in Rural Zambia," Public Health Nutrition, Vol.**5**, Issue.**5**, pp.**631-638, 2012.**

[26]M.B. Ogunniyi, "Science, Technology, and Mathematics," *Journal of Science Education*, Vol.**18**, Issue**.3**, pp.**267-284, 2009**.

[27] M. Cheesbrough, "District Laboratory Practice in Tropical Countries (Part 1)," *2nd Edition Update*, Cambridge University Press, Cambridge, pp.**191-235, 2006.**

[28] O.R. Ejinaka, M.U. Obeta, R.I. Jwanse, I.E. Lote-Nwaru, J.P. Nkop, P.I. Agbalaka, "Prevalence of Intestinal Parasites among Students of a Tertiary Institution in Jos, Nigeria," *Journal of Bacteriology and Parasitology*, Vol.**10**, pp.**360-365, 2019.**

[29] T. Hailegebriel, "Prevalence of Intestinal Parasitic Infections and Associated Risk Factors Among Students at Dona Berber Primary School, Bahir Dar, Ethiopia," BMC Infectious Diseases, Vol.**17**, pp.**362**, **2017**. DOI: 10.1186/s12879-017-2362-5.

[30] J.G. Damen, J. Luka, E.I. Biwan, M. Lugos, "Prevalence of Intestinal Parasites Among Pupils in Rural North-Eastern Nigeria," *Journal of the Nigeria Medical Association*, Vol.**52**, Issue.**1**, pp.**4-6, 2013.**

[31] L. Adekunle, "Intestinal Parasite and Nutritional Status of Nigerian Children," *African Journal of Biomedical Research*, Vol.**4**, Issue.**5**, pp**.115-119, 2015.**

[32] A.S. Kumurya, A.S. Muhammad, N.M. Bunza, "Prevalence and Associated Risk Factors of Intestinal Parasitic Infections Among Food Handlers in Kano Metropolis, Kano State, Nigeria," *Microbes and Infectious Diseases*, Vol.**2**, Issue.**3,** pp.**590-596, 2021**.

[33] F. Zewdineh, M. Kucho, "Prevalence of Intestinal Parasites and Associated Risk Factors Among Diarrheal Patients Attending Negelle Borena General Hospital: A Case-Control Study," *Journal of Parasitology Research*, Vol.**10**, pp.**1-9, 2023**.

[34] E.U. Amuta, M.O. Iboyi, S. Ajangem, "A Comparative Study of Gastrointestinal Parasites Among Secondary School Students in the Rural and Urban Communities of Makurdi Local Government Area of Benue State, Nigeria," *International Journal of Tropical Disease and Health*, Vol.**25**, Issue.**4,** pp.**1-9, 2017**.

[35] M. Mama, G. Alemu, "Prevalence and Factors Associated with Intestinal Parasite Infections Among Food Handlers of South Ethiopia," *Journal of Public Health*, Vol.**16**, Issue.**1, 2016**.

[36] S.K. Abdulhadi, S.M. Asma'u, N.M. Bunza, "Prevalence and Associated Risk Factors of Intestinal Parasitic Infections Among Food Handlers in Kano Metropolis, Kano State, Nigeria," *Microbes and Infectious Diseases*, Vol.**2,** Issue.**3**, pp.**590-596, 2021**.

[37] T.S. Atsuwe, V.U. Obisike, J.I. Chikwendu, C.K. Kondo, C.T. Tyoakoso, E.U. Amuta, "Epidemiological Study of Intestinal Parasites in Schools in Vandeikya LGA, Benue State, Nigeria," *Asian Journal of Immunology*, Vol.**2**, Issue.**1**, pp.**1-8, 2019**.

[38] U.P. Esiet, I.A. Edet, "Comparative Relevance of Intestinal Parasites Among Children in Public and Private Schools in Calabar South, Cross River State, Nigeria," American Journal of Research Communication, Vol.**5**, Issue.**1**, pp.**80-97, 2017**.

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