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Research Article

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Size-related variation in helminth infection among *Oreochromis niloticus* from sewage ponds in Gwale Local Government Area, Kano State, Nigeria

Habibu Maaruf Abdu[1], Mohammad Manjur Shah[1]*, Zainab Nura Nabegu[2], Binta Abdullahi Yuguda[1], Zakiyya Ibrahim Muhammad[1]

[1]Department of Biological Sciences, Northwest University, Kano, Nigeria, [2]Department of Biology, Yusuf Maitama Sule Federal University of Education, Kano, Nigeria

ABSTRACT

Helminth infections in freshwater fishes are a major ecological and public health concern, especially in polluted habitats such as sewage ponds where transmission risks are amplified. This study investigates the relationship between fish body size and helminth parasite infection in *Oreochromis niloticus* collected from sewage ponds in Gwale Local Government Area, Kano State, Nigeria. A total of 385 fish were collected and classified into four standard length groups (2-5 cm, 6-8 cm, 9-11 cm, and 12-14 cm). Parasitological examination revealed that helminth prevalence was highest in fish within the 9-11 cm group (47.01%) and lowest in the smallest size group (2-5 cm, 18.92%). Pearson's correlation test showed a moderate positive relationship between fish length and infection prevalence ($r=0.496$, $p<0.05$), suggesting that susceptibility to helminth infection increases with size up to a threshold, beyond which prevalence declines slightly. The observed pattern may reflect complex interactions between diet breadth, cumulative exposure time, and immune development. These findings provide useful insight into host-parasite dynamics in polluted freshwater ecosystems and emphasize the need for monitoring fish health in sewage-impacted aquaculture environments, both for ecological management and to safeguard public health.

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***Corresponding author:**
Mohammad Manjur Shah
E-mail: mmanjurshah@gmail.com

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INTRODUCTION

Fishes are a vital component of Nigeria's economy and public health, serving as a major source of animal protein with low cholesterol levels in the diets of millions, while also functioning as intermediate hosts for various parasites (Imam *et al.*, 2010). Among the most widely consumed fish in Nigeria is the Nile tilapia (*Oreochromis niloticus*), valued for its adaptability, and affordability. However, fish also play a critical role in the transmission of helminth parasites, which can have substantial economic, ecological, and public health implications.

Parasitic infections in fish are often linked to environmental contamination from pollutants such as heavy metals, hydrocarbons, and nutrient-rich organic matter (Onoja-Abutu, 2013). Polluted habitats, particularly those receiving untreated sewage, can facilitate the complete life cycles of many helminths, increasing infection risks to both the host fish and consumers. The intensity and prevalence of such infections are not uniformly distributed among individuals in a population; instead, host-related factors, including body size, often play an important role.

Fish size is a key biological parameter influencing susceptibility to parasitic infections. It affects feeding behaviour, habitat use, and immune competence, thereby altering the likelihood of contact with infective parasite stages (Biu & Nkechi 2013; Uneke & Jonah, 2017). In freshwater ecosystems, especially those impacted by anthropogenic pollution, helminth transmission dynamics can be further shaped by host age-size structure, as larger or older individuals may accumulate infections over time or encounter a wider range of intermediate hosts. Conversely, smaller fish may exhibit higher susceptibility due to underdeveloped immune defences.

O. niloticus in Nigeria is frequently harvested from unmanaged and heavily polluted environments, including sewage ponds

(Mukhtar *et al.*, 2010). In Kano State, particularly in Gwale Local Government Area, numerous sewage ponds exist, such as Kukkuba, Kwarin Mota (Bayan Gari), and Mai Allo Ponds. Originally excavated as burrow pits, these water bodies have been transformed into sewage receptacles through the deliberate channeling of residential wastewater (Getso *et al.*, 2021). The resulting nutrient-rich conditions create unique ecological niches that sustain dense tilapia populations, despite the high levels of pollution. *O. niloticus* is especially tolerant of such degraded habitats (Páez-Osuna *et al.*, 2024), making it an ideal model for studying host-parasite interactions under conditions of extreme anthropogenic disturbance.

Although previous research has documented the general prevalence of helminth parasites in tilapia from Nigerian inland waters (Bichi & Ibrahim, 2009; Bubu-Davies *et al.*, 2021), relatively few studies have examined how body size influences infection patterns in polluted aquatic systems. The size-related infection dynamics is essential for predicting parasite transmission, assessing fish population health, and evaluating potential public health risks in communities dependent on such water bodies for fish. The present study therefore investigates the prevalence and intensity of helminth infection across different size classes of *O. niloticus* from sewage ponds in Gwale Local Government Area, Kano State, Nigeria.

MATERIALS AND METHODS

Study Area

The study was carried out in two sewage ponds within the Gwale Local Government Area in Kano Metropolis. Pond A is known *as 'Bayan Gari Pond'* located within the coordinates of (Latitude 11.98153°, Longitude 8.50481°), behind Kano city tower (Ganuwa) at *'Hauren shanu'* along BUK road. Pond B is known as *'Kunkuba Pond'* located within the coordinates of (Latitude 11.98221°, Longitude 8.50899°) at *'Hauren Makaranta'* along BUK road opposite to Nigerian police headquarters, Kano zone 1 (Getso *et al.*, 2021).

Fish Collection and Handling

A total of 385 specimens of *Oreochromis niloticus* were procured from the catches of local fishermen between January 2024 and March 2025. The fish were randomly collected from both ponds, with 257 samples from Pond A and 128 from Pond B. Immediately after collection, the fish were placed in clean, aerated containers and transported to the Parasite Biodiversity Laboratory, Department of Biological Sciences, Northwest University, Kano. Upon arrival at the laboratory, the total length (TL) of each fish was measured to the nearest centimeter using a calibrated measuring board. Based on TL, fish were classified into four size categories:
Group I: 2-5 cm
Group II: 6-8 cm
Group III: 9-11 cm
Group IV: 12-14 cm

Parasitological Examination

All fish specimens were humanely euthanized in accordance with laboratory animal care protocols. Each fish was dissected by making incisions from the ventral side to expose internal organs. The entire alimentary tract was removed and separated into anatomical sections: oesophagus, stomach, intestine, and rectum. The gill arches were also carefully excised for parasite inspection. The gut contents were emptied into Petri dishes containing normal saline and examined under a dissecting microscope for the presence of helminth parasites. The mucosal lining of each gut section was also scraped using a blunt scalpel and examined on microscope slides to detect embedded or attached parasites. Similarly, the gills were examined for encysted or attached trematodes (Claar *et al.*, 2021).

Parasite Collection, Preservation, and Identification

Recovered helminths were gently removed with a fine brush, counted, and recorded. Trematodes were killed in warm normal saline and preserved in cold 4% formaldehyde. Cestodes were flattened under a cover slip and fixed in Alcohol-Formalin-Acetic acid (AFA) solution. The parasites were later stained with acetocarmine, dehydrated through a graded ethanol series, cleared in xylene, and mounted on glass slides for detailed microscopic examination (Nwadike *et al.*, 2023). Parasite identification was carried out using standard morphological keys identified in the literature (Shinn, 2023). Identifiable features such as body shape, internal structures, and site of attachment were used for classification to genus or species level.

Data Analysis

The prevalence of helminth infection was calculated as the percentage of infected individuals within each size group. Mean intensity was defined as the average number of parasites per infected host. Correlation analysis was conducted to examine the relationship between fish length and parasite prevalence using Pearson's correlation coefficient (r). A Chi-square test (χ^2) was applied to determine whether the differences in infection rates between size classes were statistically significant. All statistical analyses were performed using SPSS version 25.0, with significance set at $p<0.05$.

RESULTS

Out of the 385 *O. niloticus* examined, a total of 121 individuals were infected with helminth parasites, giving an overall prevalence of 31.43%. When categorized by body length, the prevalence of infection varied significantly across the four size groups: The lowest prevalence (18.92%) was observed in the smallest fish (2-5 cm), while the highest prevalence (47.01%) was observed in the 8-11 cm group. Interestingly, the prevalence decreased slightly to 26.92% in the largest fish (11-14 cm) (Table 1).

A moderate positive correlation was found between fish length and helminth parasite prevalence. Pearson's correlation

Table 1: Relationship between Fish Length and Helminth Prevalence

Fish Length Group (cm)	Number Examined	Number Infected	Prevalence (%)
2-5	74	14	18.92
6-8	99	23	23.23
9-11	134	63	47.01
12-14	78	21	26.92
Total	385	121	31.43

Pearson correlation coefficient: ($r=0.496$)

Table 2: Length range Prevalence of parasites observed in tilapia fish *(Oreochromis niloticus)* in the two ponds

Length (cm)	Pond A			Pond B		
	NE	NI	P%	NE	NI	P%
2-5	47	9	19.5	27	5	18.52
6-8	63	16	25.4	36	7	19.44
9-11	94	51	54.26	40	12	30.00
12-14	53	15	28.30	25	6	24.00
Total	257	91	35.4	128	30	23.44

Table 3: Parasite Mean Intensity across Size Groups

Size Group (cm)	Mean Intensity
2-5	1.64
6-8	2.49
9-11	3.26
12-14	2.18

coefficient yielded an r value of 0.496 ($p<0.05$), indicating that longer fish were generally more susceptible to infection, up to a certain threshold. Although larger fish (12-14 cm) exhibited slightly lower prevalence than mid-sized fish, they still showed higher infection rates than the smallest size group, suggesting a nonlinear but significant relationship.

The infection generally increases with fish length in both ponds. However, the prevalence was consistently higher in Pond A compared to Pond B across all length groups (Table 2).

Parasite Load across Size Groups

The mean intensity (average number of parasites per infected fish) also varied with size: Fish in the 9-11 cm group had the highest parasite load, both in terms of prevalence and intensity (Table 3).

DISCUSSION

The observed pattern in this study is consistent with earlier reports indicating that longer fish tend to harbour higher helminth infection rates due to increased exposure to infective stages and a broader feeding spectrum (Olurin & Somorin, 2006; Bichi & Ibrahim, 2009). In a related study on *Tilapia zilli* from Tiga Dam, Kano, Bichi and Ibrahim (2009) found significantly higher infection rates in longer-sized fish, attributing this to their wider foraging range and higher probability of ingesting intermediate hosts. Similarly, Olurin and Somorin (2006) reported that susceptibility to parasitic infection in fish from Owa Stream, South-Western Nigeria, increased with body length. The present results align with these findings, particularly in showing a positive relationship between size and infection, although our study also reveals a slight decline in prevalence among the largest fish, suggesting a nonlinear relationship.

The positive association between fish length and helminth prevalence in *O. niloticus* could be explained by feeding ecology. Larger fish often have a more diverse diet, including crustaceans and benthic organisms, which may serve as intermediate hosts for helminths (Richard, 2008). This agrees with Amare *et al.* (2014), who found that parasite prevalence was related to fish size and age due to dietary shifts from plankton to larger prey items. In the sewage pond ecosystem of Kano, where organic matter and intermediate hosts are abundant, larger *O. niloticus* may be more exposed to infection during feeding, thereby increasing their infection risk.

However, the present findings differ from those of Bubu-Davies *et al.* (2021) in Port Harcourt, Rivers State, and Biu and Nkechi (2013) in Maiduguri, who both reported higher prevalence in smaller tilapia species compared to larger individuals. According to Klinger and Francois-Floyd (2009), higher infection in smaller fish may be due to underdeveloped immune systems, making them less capable of resisting parasitic invasion. This difference in trend may be due to environmental factors, parasite species composition, and host-parasite dynamics in different ecological settings. For instance, in nutrient-rich sewage ponds such as those in Kano, intermediate hosts may be more accessible to larger fish due to their broader feeding range, overshadowing any immune advantage smaller fish might have.

Our results are, however, in agreement with Kawe *et al.* (2016), who found larger *Clarias gariepinus* in Abuja to be more heavily infected with helminths. This similarity may be linked to comparable environmental factors in inland Nigerian freshwater systems, where larger fish species feed more extensively on benthic fauna. Conversely, Nwadike *et al.* (2023) demonstrated that the relationship between fish size and helminth infection can vary among species, with some showing a positive correlation, others an inverse relationship, and some no significant association. This suggests that the size–infection relationship may be species- and habitat-dependent.

On the other hand, the slight decline in prevalence observed in the largest size class (12-14 cm) of *O. niloticus* in the present study may suggest a threshold beyond which fish either develop partial acquired immunity or modify their feeding behaviour to avoid heavily infected prey. Alternatively, this reduction could be due to selective mortality, where heavily infected large fish are removed from the population, leaving less infected individuals in the upper size classes.

CONCLUSION AND RECOMMENDATIONS

Conclusion

In conclusion, this study confirms that fish body size significantly influences helminth infection patterns in *O. niloticus* from

sewage-fed ponds in Kano State, Nigeria. This finding highlight the importance of including fish size as a factor in parasite surveillance, public health risk assessment, and aquaculture management, particularly in environments subject to pollution and poor sanitary practices.

Recommendations

Based on the findings of this study, the following are recommended:

Routine Size-Based Screening should be employed to identify high-risk categories and guide intervention strategies in both wild and farmed fish populations.

Efforts to reduce snail populations and organic pollution in sewage ponds should be made to lower transmission of trematode parasites, particularly those affecting mid-sized fish.

Studies involving experimental infections or longitudinal tracking of fish growth and infection status are recommended for a better understanding of host immunity and parasite development across size ranges.

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