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Research Article

Intestinal and Malaria Parasitic Infections among School-Aged Children in Selected Rural Communities in Nasarawa State, Nigeria

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ABSTRACT

Children in impoverished areas, particularly Nigeria and Sub-Saharan Africa, are frequently infected with polyparasitic organisms. The study took place in five different communities in Nasarawa's Karu Local Government Area. Fresh stool and blood tests revealed intestinal parasites and malaria infection. Using a standardized questionnaire, mothers, guardians, and caregivers were questioned to obtain demographic information about their children or wards, as well as to document their knowledge, attitudes, and behaviors surrounding parasite infections. Data from the survey and parasitological research were imported into a Microsoft Excel spreadsheet and evaluated using Chi-squared analysis. A total of 496 (100%) school pupils were recruited for the study and provided feces and blood samples to meet the requirements. The presence of different parasites was found in 317 (63.91%) of the 496 specimens collected and examined. Malaria was the most frequent parasitic infection in the villages, accounting for 80 percent of all infections (25.34%). According to the findings, there was no statistically significant difference in malaria parasite infection between the communities (p>0.05). Intestinal parasite infections discovered throughout the study included *Ascaris lumbricoides*, Trichuris trichiura, *Hookworm* spp., *Taenia* spp., Giardia lamblia, and Strongyloides stercoralis. Intestinal parasite infections were more common in *hookworm* sp (51%) than in other species (16.09%). The difference between malaria parasite infections and intestinal parasitic infections was statistically significant (p<0.05). Males had 56.25% more malaria parasites than their female counterparts (33.75%). Furthermore, males had 194 (61.20%) more intestinal parasitic infections than females, 123 (38.30%). Chi-square analysis found a significant difference (p<0.05) between malaria parasite infections and intestinal parasitic illnesses in relation to the gender of the children. With 53 (53.17%), Malaria parasites and *Ascaris lumbricoides* had the most double parasitic infections, whereas A. lumbricoides, *Taenia* spp., and *Trichuris trichiura* had the most triple parasitic infections with 38 (9.78%). Polyparasitism was found to be more frequent in youngsters aged 10 to 12 (106, 33.44%). There were statistically significant differences (p>0.05) across communities and age groups in polyparasitic infections. According to the current study, the burden of intestinal and malaria parasite illnesses among primary school children is quite high, indicating that more research is needed.

Keywords: Infection; Malaria; Parasite; Intestinal; Community; Plasmodium falciparum

INTRODUCTION

Children in impoverished countries, particularly those in rural areas of Sub-Saharan Africa, are more susceptible to infection. According to this study, Plasmodium falciparum and Schistosoma haematobium were the most common polyparastic illnesses among kids in rural Nasarawa State, Nigeria. Parasites can be found all over the world [1,2], but they are especially common in developing countries and tropical areas where, in addition to a favorable climate, a poor socioeconomic situation (e.g., poor sanitation and inadequate water supply) encourages the growth and spread of organisms, resulting in disease persistence in the population [3,4]. In numerous tropical endemic places around the world, malaria, intestinal parasitosis, and schistosomiasis are all highly frequent. These diseases have contributed to high rates of morbidity and mortality in endemic areas, especially among pregnant women and

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children [5-7].

Many parasites have comparable spatial and epidemiological distributions, despite their physical variety [8,9]. Because of their overlapping spatial patterns, several parasite infections in a single susceptible host are more likely [10]. Polyparasitic infections are widespread in endemic parasitic species such as Plasmodium falciparum, intestinal parasites (e.g. protozoa and helminths), and Schistosoma [8,11]. In polyparasitic infections, parasite combinations are influenced by similar means of transmission, epidemiological dispersion, immune modulation, and parasite interaction [10]. Polyparasitic infections are more common in rural areas because of poor socioeconomic conditions, as well as among school-aged children because of behavioral inclinations and a lack of immunity [11,12].

Despite the overwhelming evidence of coendemicity, which suggests that polyparasitic infection is more likely the norm than the exception, parasitic illness research often focuses on single parasitic infections. This has been demonstrated in several research in Nigeria [13,14], Ivory Coast [11,12], Rwanda and Senegal [15]. Malaria [14,16,17], intestinal parasitosis [14,18], and schistosomiasis [14] are all endemic in Nigeria, but there have been few research on polyparasitic illnesses in primary school children [19,20].

With children under the age of 14 accounting for over half of the Nigerian population and the majority of them residing in rural regions [20], research into the prevalence of polyparasitic infection among this vulnerable group is crucial. As a result, the goal of this research is to find out how common polyparasitic illness is among primary school students in Panda Development Area, Karu LGA, Nasarawa State, Nigeria.

MATERIALS AND METHODS

Population and study area

The study area was Panda, Panda Development Area, Karu Local Government Area, Nasarawa State, Nigeria. In the study region, peasant farmers predominate; others are civil servants, while others are merchants and women. Nasarawa State is situated between the latitudes of 70.45' N and 90.25' N, and the longitudes of 70 and 90 37' E, on the equator. According to the National Population Commission, Nasarawa's population was 18,632,75 during the 2006 National Population Census (2006). Nasarawa lies in the savannah region of Nigeria, where the rainy season lasts from May to October and the cold dry season lasts from November to April. Between April 2015 and March 2016, data was collected in five (5) rural locations.

Study design and sampling procedures

The survey includes giving mothers and caregivers a standardized questionnaire and collecting blood and stool samples from agreed-upon newborns and preschoolers for laboratory examination to screen for malaria and intestinal parasite infections. Prior to conducting field surveys, the research team trained community members through community leaders, primary health care (PHC) staff, and community volunteers.

After a random sample of households within the communities was taken, consenting parents with children aged 1-12 years were recruited for the study. Enumerating households within the communities yielded families with at least one infant or preschooler. The enumeration was followed by the simultaneous recruiting of willing parents or guardians and youngsters.

Data collection and laboratory methods

Stool samples: Parents/guardians who gave their consent were provided sterile universal bottles (or bottles) in which to send their children's fresh feces samples. The next day, in the early morning hours, eligible households were visited to collect feces samples, which were then taken to the laboratory for analysis. Using the sodium-acetate-acetic-acid formalin-ether (SAF-ether) concentration method, stool samples were analyzed for the presence of intestinal parasite cysts, eggs, and ova. The SAF-ether method was used to increase the sensitivity of detecting helminth and protozoan ova in feces, as well as to preserve the sample before sending it to the lab for examination. Within 24 hours of collection, samples were examined [21].

Each container holding a feces sample was covered and vigorously swirled to adequately suspend the stool in the solution. The feces suspension was strained into a centrifuge tube using double gauze of about 13 mm diameter placed in a funnel. The filtrate was centrifuged for 1 minute at 2500 rpm after the residue was discarded. The supernatant was removed after centrifugation, and 7 mL of normal saline was added to the sediment and allowed to resuspend. Before centrifugation at 2000 rpm for 5 minutes, a stopper was placed on the tube and the liquid was aggressively stirred to mix it. The first three layers of the suspension were piped out with Pasteur's pipette after centrifugation, leaving the final layer of sediment.

The silt was pipetted onto a clean, oil-free microscope slide and analyzed for intestinal parasite eggs using the Swiss TPH 2010 Diagnostic Bench Aids for species identification using parasite egg, cyst, and ova morphology [21].

Blood samples

Blood samples were obtained by hand pricking and analyzed microscopically for the presence of malaria parasites using malaria Rapid Diagnostic Test kits. Infants and preschoolers were placed on a census form for identification purposes, and a matching number was imprinted on each test kit with a permanent marker. The responders' fingers were cleansed in a circular motion for 10 seconds with an alcohol swab pack, the swab was allowed to air dry, and a lancet was used to prick their fingers for a drop of blood. The lancet was disposed of in a sharps container with a biohazard label. 10 µl of blood was obtained using the capillary pipette included in the test kit; the blood was then placed to the round well on the test kit cassettes and absorbed by the embedded pad [21].

Administration of questionnaires

Parents and caregivers whose children provided satisfactory stool specimens were carefully interviewed using a closed-end structured questionnaire in their varied homes. The questionnaire was used to capture the demographic data of the parent/caregiver, as well as the sanitary and personal hygiene conditions in the home, for each infant and preschooler. The structured questionnaire was also used to document mothers' and caregivers' attitudes and practices regarding parasitic infections and treatments, as well as knowledge about malaria and intestinal parasite infection and transmissions, knowledge about co-infections, and knowledge about co-infections.

Ethical approval

The Director of Primary Health Care for the Panda Development Area provided his verbal approval to the initiative. The study was publicized to the LGA's head of public health and the coordinators of each village's primary health care center, who helped with sensitization and mobilization of mothers and caregivers. Only mothers who signed the informed consent forms were enrolled in the study; the consent forms were spoken and translated into the parents' and caregivers' local languages.

Data analysis

The questionnaire and parasitological examination data were imported into Microsoft Excel and analyzed with SPSS 22.0 (Statistical Package for Social Sciences). Descriptive statistics such as proportions and percentages were produced for demographic data, and connections and links between risk factors and disease outcomes were analyzed using chi-square analysis at a 95 percent confidence level.

RESULTS

Prevalence of malaria and intestinal parasitic based on the communities

A total of 496 (100%) school-aged children were recruited for the study, and they all provided stool and blood samples in accordance with the study's requirements. The study took place in five different communities in Nasarawa's Karu Local Government Area. The presence of different parasites was found in 317 (63.91%) of the 496 specimens collected and examined. The Gitata community had the most parasites, with 69 (66.99%), Panda came in second with 87 (63.97%), and Kondoro Yeskwa had the least parasites, with 48 (58.54%). According to chi-square analysis, the distribution of intestinal and malaria infections in relation to each other was not statistically different (p>0.05) (Table 1).

Table 1: Prevalence of malaria and intestinal parasitic based on the communities.

Communities	No. examined (%)	No. positive (%)
Panda	136 (27.42)	87 (63.97)
Gitata	103 (20.77)	69 (66.99)
Kubang	97 (19.56)	62 (63.91)
Kuda Yeskwa	78 (15.73)	51 (65.38)
Kondoro Yeskwa	82 (16.53)	48 (58.54)
Total	496 (100)	317 (63.91)

Note: χ^2 calculated=1.52; χ^2 tabulated=9.48; df=4

Prevalence of malaria and intestinal parasite infections

Malaria was the most frequent parasitic infection in the villages, accounting for 80 (25.34%) of all infections. According to the findings, there was no statistically significant difference in malaria parasite infection between the communities (p>0.05). Intestinal parasite infections observed throughout the study included *Ascaris lumbricoides*, Trichuris trichiura, *Hookworm* spp., *Taenia* spp., Giardia lamblia, and Strongyloides stercoralis. *Hookworm* spp. had the most intestinal parasitic infections, with 51 (16.09%), followed by *Ascaris lumbricoides* 49 (15.46%), and Giardia lamblia 49 (15.46%). There was a statistically significant difference between malaria parasite infections and intestinal parasitic infections (p<0.05) (Table 2). Males had 56.25% more malaria parasites than their female counterparts (33.75%). Furthermore, males had 194 (61.20%) more intestinal parasitic infections than females, 123 (38.30 %). In respect to the participants' health, a chi-square analysis found a significant difference (p<0.05) between malaria parasite infections and intestinal parasitic disorders (Table 2).

Table 2: Prevalence of Malaria and Intestinal Parasite infections in relation to gender.

Parasites	Male	Female	Total
	No positive (%)	No positive (%)	No positive (%)
Malaria parasites	45 (56.25)	35 (43.75)	80 (25.24)
Ascaris lumbricoides	27 (55.10)	22 (44.89)	49 (15.46)
Trichuris trichiura	23 (58.97)	16 (41.03)	39 (12.30)
Hookworm spp.	37 (72.55)	14 (27.45)	51 (16.09)
Taenia spp.	32 (66.67)	16 (33.33)	48 (15.14)
Gardia lamblia	11 (55.0)	9 (45.0)	20 (6.31)
Strongyloides stercoralis	19 (63.33)	11 (36.67)	30 (9.46)
Total	194 (61.20)	123 (38.80)	317 (63.91)

Note: χ^2 calculated=1.52; χ^2 tabulated=9.48; df=4

The distribution of polyparasites in relation to communities

385 school-aged youngsters were discovered to have polyparasitism. Malaria parasites and *Ascaris lumbricoides* had the highest rate of double parasitic infections (53.17%), followed by *Ascaris lumbricoides* and *Trichuris trichiura* 41 (10.65%), and Malaria parasites and *Taenia* spp. 14 (3.64%). The most common triple parasitic infections were found in A. lumbricoides, *Taenia* spp., and *Trichuris trichiura* 38 (9.78%), followed by malaria parasites, *A. lumbricoides*, and *Strongyloides stercoralis* 37 (9.61%), and the least common 21 (5.45%) in *A. lumbricoides, Entamoeba histolytica*, and *Taenia* spp. There were statistically significant differences (p>0.05) in polyparasitic infections among communities and between double and triple infections (Table 3). Malaria parasites and STH were the most common parasitic combinations discovered in this survey.

Polyparasite prevalence in relation to age group

Polyparasitism was found to be more common in the age categories 10-12 years (33.44%), 4-6 years (76.97%), and 1-3 years (1-3 years) (19.56%). There were statistically significant differences (p>0.05) across communities and age groups in polyparasitic infections (Table 4).

Table 3: Distribution of Polyparasites in relation to the communities.

Parasites	Panda (%)	Gitata (%)	Kubang (%)	Kuda Koro (%)	Kondoro Yeskwa (%)	Total (%)
Mp+As	11 (20.75)	17 (32.08)	7 (13.21)	10 (18.87)	8 (15.09)	53 (13.77)
Mp+Tt	5 (16.67)	9 (30.0)	3 (10.0)	8 (26.67)	5 (16.67)	30 (7.79)
As+Tt	4 (7.76)	11 (26.83)	6 (14.63)	4 (9.76)	16 (39.02)	41 (10.65)
Mp+Hw	7 (23.33)	4 (13.33)	2 (6.67)	2 (6.67)	15 (50.0)	30 (7.79)
Mp+Eh	3 (10.34)	7 (24.14)	2 (6.89)	5 (17.24)	12 (41.38)	29 (7.53)
Mp+Tn	3 (21.43)	2 (14.29)	1 (7.14)	1 (7.14)	7 (50.0)	14 (3.64)
Mp+Gl	7 (23.33)	6 (20.0)	4 (13.33)	7 (23.33)	6 (20.0)	30 (7.79)
Mp+As+Ss	7 (18.92)	3 (8.11)	9 (24.32)	8 (21.62)	10 (27.03)	37 (9.61)
As+Tt+Hw	5 (19.23)	2 (7.69)	5 (19.23)	3 (11.54)	11 (43.31)	26 (6.75)
As+Hw+Ss	12 (33.33)	9 (25.0)	7 (19.44)	5 (13.89)	3 (8.33)	36 (9.35)
As+Eh+Tn	5 (23.81)	2 (9.52)	3 (14.29)	3 (14.29)	8 (38.09)	21 (5.45)
As+Tn+Tt	9 (23.68)	5 (13.16)	5 (13.16)	8 (21.05)	11 (28.95)	38 (9.87)
Total	78 (20.26)	77 (20.0)	54 (14.03)	64 (16.62)	112 (29.09)	385 (100)
0.024	0.024	0.024	0.024	0.024	0.024	0.024

Table 4: Prevalence of Polyparasites in relation to age group.

Age group (yrs)	Panda (%)	Gitata (%)	Kubang (%)	Kuda Koro (%)	Kondoro Yeskwa (%)	Total (%)
1-3	9 (14.52)	16 (25.81)	14 (22.58)	11 (17.74)	12 (19.35)	62 (19.56)
4-6	15 (19.74)	18 (23.68)	10 (13.16)	18 (23.68)	15 (19.74)	76 (23.97)
7-9	17 (23.29)	11 (15.07)	12 (16.44)	14 (19.18)	19 (26.03)	73 (23.03)
10-12	21 (19.81)	24 (22.64)	12 (11.32)	22 (20.75)	27 (25.47)	106 (33.44)
Total	62 (19.56)	69 (21.77)	48 (15.14)	65 (20.50)	73 (23.03)	317 (100)

Risks factors associated with polyparasitism

The risk variables connected to polyparasitic infections were also identified using structured questionnaires. There was a substantial correlation between toilet facilities and intestinal parasites; people who defecate in the jungle or at a rubbish dump were more likely to be infected with intestinal parasites, whereas malaria illness was linked to LLIN ownership and use ($p<0.05$). Households that slept under insecticide-treated nets on a regular basis had a reduced prevalence of malaria infection as compared to persons who did not sleep under the treated nets on a regular basis. Malaria infections, intestinal parasites, and risk factors such as water supplies, barefoot walking, malaria or STH causes, deworming efforts, or handwashing were all found to be unrelated (Table 5). However, there was a link between educational attainment and the occurrence of polyparasitic infections in this investigation. Polyparasitic infections were most common in school-aged children whose moms or guardians had a higher education.

Table 5: Risks factors associated with polyparasitism.

Risk factors	Polyparasitism	Percentage (%)
Educational status		Total
None	74	14.92
Primary	65	13.1
Secondary	249	50.2
Higher education	108	21.77
Washing of fruits/vegetables		
Yes	298	60.08
No	198	39.92
Washing of hands		
Regularly	321	64.72
Not regularly	175	35.28
Occupation		
Farmers	187	37.7
Artisans	212	42.74
Govt. employed	97	19.56
Toilet facilities		
None	146	29.44
Pit	89	17.94
Water closet	261	52.62
Sources of water		
Tap	103	20.77
Well	272	54.84
Stream/River	121	24.4
Deworming		
Yes	287	57.86
No	209	42.14
Mosquito nets usage		
Yes	356	71.77
No	140	28.23
Causes of Malaria		
Mosquito bite	398	80.24
Sunlight	98	19.76
Walked barefooted		
Yes	354	71.37
No	142	28.63

DISCUSSION

In this study, researchers looked at the frequency of intestinal and malaria parasite infections among school-aged children in a few rural areas in Nigeria's Nasarawa State. This is one of the few studies in the area that focus on polyparasitic infection in children.

Polyparasitism is frequent in Sub-Saharan Africa's rural communities, where a high percentage of the population is afflicted with many parasites. In rural locations, polyparasitic diseases are more common and are associated to poverty [22] and poor water, sanitation, and hygiene (WASH) conditions [23]. For policymakers to establish and implement control plans, they must first understand the epidemiology of these ailments in the community.

The bulk of the children (25.24%) tested positive on the RDT or microscopy. A recent study reported a high prevalence of 67.8% among children aged 6-12 years [24]; nevertheless, a much lower frequency was also found among school-age children in another district [25]. There is a decline in clinical malaria and an increase in asymptomatic presentations as children's immunity develops [26].

This study found a polyparasitic infection prevalence of 63.91% in the study communities, which is higher than the findings [27], who found that 38% of the children were infected with two or more parasites [28], who found a prevalence of 31.80% in coastal Kenya. The prevalence of intestinal parasitic and malaria parasite infections was high in this study, showing that polyparasitism is common in the study area. This could be due to favorable environmental factors like climate, enough soil moisture, and warm temperatures for larva growth, poverty, and inadequate sanitation, all of which favor parasite transmission.

Parasitic disorders like malaria, according to Sokhna et al. [29], are closely linked to the environmental situation in an area that supports malaria transmission, particularly during the rainy season. The study was conducted during the rainy season, which could explain the high rate of malaria, and intestinal parasite infection cases discovered, but other factors such as low socioeconomic status, ignorance, and inadequate sanitation could also be to blame. Similar findings were seen in Côte d'Ivoire schoolchildren, who were infected with two or more species at the same time on average [11].

The likelihood of polyparasitism increased with age; with older children aged 10 to 12 years (33.44%) being more affected than younger children aged 1 to 3 years (19.56%). The differences were statistically negligible ($p>0.05$) according to chi-square analysis. Because they are more active, adventurous, and indifferent about hygiene, this reflects their exposure patterns. Infection rates in 1-3-year-old children were related to decreased exposure to the parasite's infective stages as a result of less active excursions. Males had a higher prevalence of intestinal parasitic and malaria parasite infections than females in the research area, but the difference was statistically insignificant. The disparity appears to back up the idea that male behavior increases relative contact with the parasite's infective stages.

In Nigeria, an expanded helminth control program based on mebendazole or albendazole has been implemented among school-aged children and adults; however, newborns and preschool-aged children may not always benefit from this intervention, which is aimed at school-aged children. Malaria interventions, such as the distribution of LLIN and prenatal and postnatal programs, have been aimed at infants and preschoolers.

There were only a few cases of intestinal parasite infections in this analysis. The low levels could be attributed to the region's robust periodic deworming program, which targeted intestinal helminths [30]. Another study in the area [25] found a similar low prevalence among school children, though it's worth noting that the wet mount technique used in this study may have contributed to the low prevalence, as it's considered less sensitive than the Kato-Katz and formol-ether concentration methods [31].

The single stool and blood samples collected from research participants, who could have contributed to low levels of intestinal parasites, constitute a major flaw in the current study. Trabelsi et al. [32] and Ayah-Kumi et al. [25] discovered that taking several or serial stool and blood samples improved the likelihood of finding parasites in infected samples. The low amount of intestinal parasites discovered in this study, on the other hand, is supported by a previous investigation in the area [25]. This indicates that the low incidence of intestinal parasites among schoolchildren represents the actual situation in the region at the time of the study, maybe due to frequent deworming.

CONCLUSIONS

In conclusion, the current study discovered that the burden of intestinal and malaria parasitic infections was relatively high among primary school children, with single malaria parasite infections being the most common, followed by intestinal parasitic infections such as *Ascaris lumbricoides,* Hookworm spp., and *Taenia* spp. Malaria and intestinal parasites were also found in large numbers among children in the rural areas studied, and this coinfection is likely linked to a high frequency of anemia. More research is needed, according to the authors, to better understand the incidence of polyparasitic infections, their linkages, and their influence on morbidity and mortality rates in children in the region. Further actions are needed to combat future occurrences of intestinal and malaria parasite infections in these rural areas in order to protect these school-aged children from infection with pathogenic helminths, intestinal protozoa, and malaria.

Personal hygiene, health education for mothers and caregivers, improved access to clean drinking water and sanitation (good waste disposal system, provision of toilet facilities), mosquito net use, and proper treatment of infected people in the community are just a few of the measures that the government and health sector stakeholders should promote and advocate for.

CONTRIBUTIONS OF THE AUTHORS

The experiments were devised and designed by SSE. Authors SSE, MKT, MNE, and SAB conducted the experiments. The manuscript is reviewed and edited by SSE, OJO, and NCI. The original draft of the manuscript was written by SSE and SAB. The data was evaluated by authors SSE and IRO. The manuscript's final condition was agreed upon by all authors.

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CONSENT TO PARTICIPATE AND ETHICS APPROVAL

This study was approved by the ethical committee of the General Hospital in Panda, Nasarawa State. Participants' or subjects' verbal informed consent was collected and used in this investigation.

COMPETING INTEREST

There are no competing interests stated by the authors.

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