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Epidemiology of Malaria Parasite and Intestinal Helminths among Children Attending Specialist Hospital and Maryam Abacha Women and Children Hospital in Sokoto Metropolis

K. Mohammed [a*], M. U. Iduh [a] and S. Muhammed [a]

[a] *Department of Medical Microbiology, School of Medical Laboratory Science, College of Health Sciences, Usmanu Danfodiyo University, Sokoto, Nigeria.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Co-infection of Malaria parasite and intestinal helminths is a serious global problem with increasing morbidity and mortality rate especially in the developing countries and it occurs among all age groups and gender. Despite the fact that this disease affects all age groups, the frequency and severity of the disease are most common among children less than 15 years of age due to their undeveloped immunity coupled with their frequent exposure to the predisposing factors.
Aims: This research aimed to determine the co-infection of Malaria parasite and intestinal helminths among children attending some selected hospitals during the course of the study.
Study Design: This was a cross sectional, descriptive study.

**Corresponding author: Email: mkohd1970@yahoo.co.uk;*

Place and Duration of Study: The study was conducted among children (1 to 15 years) attending Specialist hospital and Maryam Abacha Women and Children's hospital in Sokoto metropolis, from May 2020 to October 2020.

Methodology: A total of 152 stool and blood samples were collected. Parasitological examination was carried out on stool samples using microscopy following formal ether concentration methods while malaria parasites were determined using rapid diagnostic test (RDT).

Results: Findings revealed that 58 (38.2%) were positive for malaria parasite while 11 (7.2%) were positive for intestinal helminths. The intestinal helminths encountered in this study were *A. lumbricoides* with a prevalence rate of 2.6%, *T. trichiuria* with a prevalence of 2.0% followed by *D. latum* and *E. vermicularis* with a prevalence rate of 1.3% each. In this study, a higher rate of prevalence for malaria infection was recorded in males (39.3%) and a lower prevalence was seen in females (36.5%). There was no statistical significance between malaria infection and gender (X^2= 0.319, *P-value*= 0.572). The age group 11-15 had the highest prevalence rate for malaria infection (42.9%), while the least prevalence rate (33.3%) was seen in the age group 1-5 years. There was no statistical significance between malaria infection and age group (X^2= 1.073, *P-value*= 0.585). For intestinal helminth infection, males showed a higher prevalence of 9.0% than their female counterparts with 4.8%. But this was not statistical significant (X^2 = 1.337, *P- value* = 0.720). For the overall study, only one sample was found to have co-infection of malaria parasite and intestinal helminths which gave a co-infection prevalence rate of 1 (0.7%).

Conclusion: The overall 152 blood and stool samples collected 38.2% were positive for malaria parasite while intestinal helminths were 7.2% only. The co-infection prevalence rate recorded so far was 0.7% and no multiple intestinal helminths were seen in any sample throughout the research.

Keywords: Malaria; helminth; stool; blood; infection; parasite.

1. INTRODUCTION

"Malaria is an acute fever related illness caused by the transmission of the parasite to people by the bites of infected female Anopheles mosquitoes. If untreated within 24 hours, *P.falciparum* malaria can progress to severe illness, often leading to death. Among the parasites that cause malaria, the most deadly is *Plasmodium falciparum* and it is the most prevalent in Africa, where cases of malaria and deaths are heavily concentrated" [1]. "In 2015, roughly 3.2 billion people, almost half of the world's population were at risk of malaria" [1]. "As published by the latest CDC estimates in December 2016, there were 212 million cases of malaria in 2015 (of this figure, the WHO African region accounts for 90% of the global malaria cases, with the South-East Asia region and Eastern Mediterranean region accounting for 7% and 2% respectively) with 429,000 deaths"[2]. In individuals with compromised or lowered immune systems, symptoms manifest in about 7 days or more (usually 10-15 days) after the infective mosquito bite. The initial symptoms which may include headache, fever, chills and vomiting – may be mild and difficult to recognize as malaria.

"An intestinal parasite is an organism that infects the human (and other animals) gastrointestinal tracts" [3]. "They may be found in other parts of the body, but they have an affinity for the walls of the intestines. These parasites may gain access into the body through the ingestion of undercooked meat, intake of untreated or infected water and penetration via the skin. These intestinal parasites cause morbidity and mortality if not properly handled. Intestinal parasitic infection has worldwide endemicity and it poses a significant medical health concern in developing countries where they present a high rate of prevalence" [4,5]. "About 3.5 billion people are estimated to be affected, with 450 million showing signs of illness resulting from these infections, the majority being children. These nematodes are associated with significant degrees of morbidity and mortality in children. Anaemia, poor growth, reduced physical activity, impaired learning ability, malnutrition, dysentery, fever, dehydration and vomiting are amongst the numerous symptoms associated with helminthiasis in children" [6]. "Protein energy malnutrition, intra uterine weight gain and low pregnancy weight are also related to helminthic infection" [4]. "Gastrointestinal nematodes such as *Hookworm, Ascaris lumbricoides, Trichuris trichiura, Enterobius vermicularis* and *S. stercoralis* are very common in children between the ages of 0 and 12years world over" [7].

"Malaria and helminth coinfection are the most important public-health problems affecting children in Sub-Saharan Africa" [8]. "It is estimated that over a third of the world's population, mainly those individuals living in the tropics and subtropics, are infected by parasitic intestinal helminths or one or more of the species of Plasmodium" [9].

"Malaria and helminths infections are widespread and they both have similar geographical and overlapping distribution in developing countries with the major consequence of the co-infection being anaemia" [10]. "The major soil transmitted helminths (*Ascaris lumbricoides, hookworm* and *Trichuris trichiura*),coupled with schistosomiasis are responsible for more than 40% of the worldwide morbidity from all tropical infections, excluding malaria. Children co-infected with these parasites have been shown to have hampered cognitive and physical development that leads to reduced learning and school achievements and are also prone to increased susceptibility to other infections. Concomitant parasitic infections could induce modifications of the specific immune response to each pathogen and thus leading to modification of clinical expression. Studies have shown that helminths can either protect or worsen" [11] malaria severity and young children from rural areas are the most affected.

"In Nigeria, falciparum malaria and helminths infections are reportedly endemic and pose a significant health problem among children" [12]. "They are particularly more prevalent in rural communities and are closely associated with poverty. Studies have shown that individuals co-infected with more than one parasite species are at risk of increased morbidity as well as at a risk of developing frequent and more severe disease due to interactions among the infecting parasite species. Despite existence of contrasting evidence on the interaction of helminth and malaria infection, more results have pointed to the fact that individuals infected by helminth are more likely to develop malaria than helminth free individuals" [13].

The aim of this research was to determine prevalence and risk factors of Malaria infection and intestinal helminths among children attending Specialist hospital and Maryam Abacha women and children hospital in Sokoto metropolis.

2. MATERIALS AND METHODS

2.1 Study Area

"Sokoto is the capital city of Sokoto State; it lies between latitude 13° 3' 490N, longitude 5°14' 890E and at an altitude of 272 m above sea level above. It is located in the extreme North Western part of Sokoto North and South local government areas and also some parts of Kware LGA from the North, Dange Shuni LGA from South and Wamakko LGA to the West. Sokoto metropolis is estimated to have a population of 427,760 people"[14] and "by virtue of its origin, the state comprises mostly Hausa/Fulani and other groups such as Gobirawa, Zabarmawa, Kabawa, Adarawa, Arawa, Nupes, Yorubas, Igbos, and others. Occupation of city inhabitants includes trading, commerce, with a reasonable proportion of the population working in private and public sectors" [15]. "The Sokoto township is in dry Sahel surrounded by sandy terrain and isolated hills. Rainfall starts late that is in June and ends early in September but may sometimes extend into October. The average annual rainfall is 550 mm with peak in the month August. The highest temperatures of 45°C during the hot season are experienced in the months of March and April. Harmattan, a dry cold and dusty condition is experienced between the months of November and February. Modern Sokoto city is a major commerce centre in leather crafts and agricultural products" [15].

2.2 Study Population

The study population are children between 1 to 15 years attending Specialist hospital and Maryam Abacha Women and Children hospital in Sokoto metropolis.

2.3 Inclusion Criteria

Only children attending Specialist hospital and Maryam Abacha Women and Children hospital were included in the research. Only children between 1 to 15 years were included in the research. Only children whose parents or guardians gave their consent were included in the research.

2.4 Exclusion Criteria

Children not attending Specialist hospital or Maryam Abacha Women and Children hospital were excluded from the research. All children above 15 years of age or below 1 year of age were excluded from the research. Children whose parents or guardians did not consent with the research were also excluded from the research.

2.5 Sample Size Determination

The sample size is determined according to Cochran, [16] using the formula: $n = (z^2 p\ q)/d^2$

Where;

n = minimum sample size,
z = standard normal deviation i.e. 0.05 at 95% confidence limits (1.96)
p = Prevalence rate from previous studies (10%), [17]
q = Compliment of p i.e 1 – p= 1-0.1=0.9
d= Tolerance margin of error=95% i.e. (100%-95%)= 5%=0.05

Therefore;

$n= (1.96^2 \times 0.1 \times 0.9) / (0.05)^2$,
$n= (3.8416 \times 0.1 \times 0.9)/0.0025$
$n= (0.345744)/0.0025$,
n=138 samples approximately.

Using attrition rate of 10% = 10/100 ×138=13.8

Therefore, the total minimum samples required = 138+13.8= 152 samples approximately.

2.6 Study Design

This is a cross sectional study which was carried out among patients (children) visiting Specialist and Maryam Abacha women and children hospitals during the study period.

2.7 Laboratory Analysis

Detection of malaria parasites using rapid diagnostic test (RDT).

2.8 Principle of Malaria RDT

“Malaria RDTs are qualitative immunochromatographic lateral flow tests in dipstick (strip), cassette or card form that detect malaria antigen in peripheral blood (i.e) it is based on the migration of liquid across the surface of a nitrocellulose membrane where the malaria antigen from a lyzed blood sample is reacted with anti-malaria monoclonal antibody conjugated to colloidal gold (pink-mauve) particles. The antigen-antibody colloidal gold complex migrates along the nitrocellulose membrane where it becomes bound (captured) by a line of specific monoclonal antibody, producing a pink line in the test result area. This line can be seen after a washing buffer has removed the background haemoglobin. A further pink line, i.e. inbuilt positive control, is produced above the test line indicating that the test reagents have migrated satisfactorily (it is not a malaria antigen control)” [18].

Procedure:

- The pouch pad of the RDT was opened immediately before use.
- The middle finger of the patient was cleansed with a swab containing 70% alcohol
- After the finger was dried, the finger was pricked with a sterile lancent.
- The first drop of blood that came out was wiped away.
- The subsequent drop of blood that followed was placed onto the sample pad A of the RDT.
- Two drops of buffer were added to the sample pad B of the kit.
- The result of the test was read after 15 minutes.

Interpretation of Result:

- For a positive test, a pink line appeared in both the C (Control) and the T (Test) viewing windows.
- While for a negative test, a pink line appeared only in the C (Control) viewing window.
- Absence of band on the control(C) line of the test kit indicated an invalid test. [18].

2.9 Formol-Ether Concentration Technique

2.9.1 Sample collection

Stool sample containers were distributed to the parents/ guardians of the children and they were guided on how to collect the stool samples and the right time for sample collection as well as the appropriate volume required.

2.9.2 Principle

Sedimentation techniques use solutions of lower specific gravity than the parasitic organisms, thus concentrating the latter in the sediment.

It takes advantage of the high specific gravity of protozoan cysts and helminth eggs compared to water. Their natural tendency to settle out in aqueous solutions can be accelerated by light centrifugation.

Formalin fixes the eggs, larvae, and oocysts, so that they are no longer infectious, as well as preserves their morphology. Faecal debris is extracted into the ethyl acetate phase of the solution. Parasitic elements are sedimented at the bottom.

(https://microbeonline.com/formal-ether-sedimentation-techniques/)

Procedure:

- About 1 gram of the faecal sample was emulsified in about 4ml of 10% formol water contained in a screw-cap tube
- Further 3ml of 10% formol water was added and capped. The tube was mixed well by shaking.
- The emulsified faecal sample was sieved and the sieved suspension was collected in a beaker.
- The sieved suspension was transfered into a centrifuge tube and 3ml of diethyl ether was added.
- The tube was stoppered and mixed for 1 minute by vigorous shaking
- With a tissue paper wrapped around the top of the tube, the stopper was loosened to release the inbuilt pressure.
- The preparation was centrifuged at 3000rpm for 1 minute
- Using the stem of a plastic bulb pipette, the layer of faecal debris from the side of the tube was loosened and the tube was inverted to discard the ether, faecal debris, and formol water. The final sediment remained.
- The tube was returned to upright position to allow the fluid from the side of the tube to drain to the bottom. The bottom of the tube was tapped to mix the sediment. The whole of the sediment was transferred on a clean grease-free glass slide, and covered with a cover slip
- The slide was viewed under 10× and 40× objective lenses [18].

3. RESULTS

A total of 152 blood and stool samples each was collected from children aged 1-15 years who attended two different hospitals within Sokoto metropolis; Maryam Abacha Women and Children hospital (MAWACHS) and Specialist hospital Sokoto (SHS). As indicated in Table 1, Out of the 152 samples, malaria infection had a prevalence of 58 (38.2%) while intestinal helminths had a prevalence of 11 (7.2%). MAWACHS had the highest prevalence (40.4%) of malaria infection as compared to SHS with a prevalence of 37.0%. But for intestinal helminthic infection, SHS had the highest prevalence of 7.0% compared to MAWACHS with a prevalence of 7.7%.

In Table 3, the frequencies of intestinal helminths eggs seen among the study population showed that *A. lumbricoides* had the highest infection rate of 2.6% followed by *T. trichiuria* with 2.0% and the least was seen in *D. latum* and *E. vermicularis* with a prevalence rate of 1.3% each. In this table, SHS had a higher prevalence of 4.6% while MAWACHS had a lower prevalence rate of 2.6%.

Table 1. Overal occurrence of malaria and intestinal helminths infection among study participants in MAWACHS and SHS

Hospital	No examined n (%)	Malaria parasite		Intestinal helminths	
		Infected n (%)	Non infected n (%)	Infected n (%)	Non infected n (%)
MAWACHS	52 (34.2)	21 (40.4)(59.6)	31	4 (7.7)	49 (94.2)
SHS	100 (65.8)	37 (37.0) (63.0)	63	7 (7.0)	92 (92.0)
Total	152 (100)	58 (38.2) (61.8)	94	11 (7.2).	141(92.8)

MAWACHS = Maryam Abacha Women and Children Hospital Sokoto
SHS = Specialist Hospital Sokoto

Table 2. Prevalence of malaria parasite infection among children from studied hospitals based on gender and age

Variable	No. examined n (%)	Malaria parasite		X^2	*P-value*
		Infected n (%)	Non infected n (%)		
Gender					
Male	89 (58.6)	35 (39.3)	54 (60.7)		
Female	63 (41.4)	23 (36.5)	40 (63.5)	0.319	0.572
Total	**152 (100)**	**58 (38.2)**	**94 (61.8)**		
Age (years)					
1-5	39 (25.7)	13 (33.3)	26 (66.7)		
6-10	50 (32.9)	18 (36.0)	32 (64.0)	1.073	0.585
11-15	63 (41.4)	27 (42.9)	36 (57.1)		
Total	**152 (100)**	**58 (38.2)**	**94 (61.8)**		

Table 3. Distribution of intestinal helminths among studied hospitals

Hospital	No.exami n (%)	*A.lumbricoides* Infected n (%)	*T. trichiuria* infected n (%)	*D. latum* infected n (%)	*E. vermicularis* infected n (%)
MAWACHS	52 (34.2)	1 (1.9)	2 (3.8)	0 (0.0)	1 (1.9)
SHS	100 (65.8)	3 (3.0)	1 (1.0)	2 (2.0)	1 (1.0)
Total	**152 (100)**	**4 (2.6)**	**3 (2.0)**	**2 (1.3)**	**2 (1.3)**

SHS = Specialist Hospital
MAWACHS= Maryam Abacha Women and Children Hospital

4. DISCUSSION

The overall malaria prevalence observed in the present study was 38.2% which was relatively higher than the study conducted in Southern Ethopia (18.3%) (17), Southwest Nigeria (19.7%) [19], and the study conducted in Osogbo, Nigeria which was 25.6% (12). But very far lower than that of the study conducted in Cameroon (98.5%) [20], and relatively lower than that in western Kenya [21] which was 46.4%. These discrepancies could be explained by the fact that the present study was hospital-based in which sick children were enrolled, compared to the other studies in which apparently healthy children either from schools or the community were involved. Furthermore, the difference in the prevalence may be associated with differences in the study areas, climatic change, study participants and techniques used by different researchers. The low prevalence of this study may be attributed to climatic change because the study was carried out some weeks before the onset of rainy season (when the breeding of mosquitoes is very high).

In this study, the prevalence of malaria was higher in males (39.3 %%) than in females (36.5%) but there was no statistical significance between malaria infection and gender (X^2= 0.319, *P-value*= 0.572). This was in line with a study in Cameroon where the prevalence was higher in males than females [20]. But it was contrary to a study in Rivers state where the prevalence in females was higher than that of males [7] and to the work in Osogbo, Nigeria where the prevalence higher in females (12). Although not significant, the higher prevalence of malaria infection discovered within the age group 11-15 in the present study was 42.9% while 33.3% least in 1-5. This was contrary to the work of Teklemariam et al., in Southern Ethiopia [17] but in line with the work of Eze et al in Rivers state [7]. Out of the 152 stool samples analysed in this present study, only 11 samples were positive for intestinal helminths which gave an overall prevalence of 7.2%. This prevalence was lower compare to the work of Ojurongbe et al in Osogbo, Nigeria [12], and the work by Njunda et al. [20] with a prevalence of 11.9%. It was also lower than the study carried out in Thailand [22] which was 22.7% but the prevalence of this study was higher compare to the work in Rivers state, Nigeria [7] which was 1.65%. This variation could be attributed to different techniques used in the various study or due to geographical variations. There were four intestinal helminths isolated in this study; *A. lumbricoides*, *E. Vermicularis*, *T. trichiuria* and *D. Latum*. *A. lumbricoides* emerged to have the highest frequency of occurrence with a least frequency seen in *D. latum* and *E. vermicularis*. *A. lumbricoides* appeared to be the most predominant intestinal helminth causing infection in children; this was also in line with studies conducted in some areas of Cameroon [23] and elsewhere [24]. Isolation of more than one intestinal helminths in any sample was not observed in this study and this made it similar to a study by Njunda et al [20].

Intestinal helminthic infection in the present study was higher within age group 11-15 (10.3%) and least within age group 1-5 (2.4%), there was no statistical significance between intestinal helminths and the age groups (X^2 = 5.675, *P-value*= 0.461).This could be due to increase exposure to the parasite as children grow up. A higher prevalence of intestinal helminths infection was recorded among the males patients than their female counterparts. This could be due to increase exposure of the males to these parasites especially in the course of struggling for their daily breads outside their homes. The co-infection prevalence rate recorded in this study was 0.7% approximately representing only one [1] individual from the entire study population. This result was close to that obtained by Ishaleku and Mamman [25] where overall malaria parasite and helminth co-infection was 4.7% and that obtained by Eze et al.[7] who reported a prevalence of 0.43%.

5. CONCLUSION

A total of 152 blood and stool samples were collected from children attending Maryam Abacha Women and Children hospital and Specialist hospital in Sokoto metropolis during the course of the study. Out of the total samples collected only 58 (38.2%) were positive for the malaria parasite (*P. falciparum*) and 11 (7.2%) were positive for intestinal helminths (*A. lumbricoides*, *E. vermicularis*, *T. trichiuria* and *D. latum*).The most predominant among these parasites was *A. lumbricoides*. No multiple intestinal helminthic infections were encountered during this present study. There was no statistical significance between infections by these parasites with gender and age distribution among the study participants in both hospitals. The coinfection of malaria parasite and intestinal helminths in this study was extremely low (0.7% approximately) and it was recorded only among children who attended Specialist hospital Sokoto.

INFORMED CONSENT

For each participant whose specimens were used in this study, an informed consent (assent) was first obtained from their parents or guardians prior to the sample collection.

ETHICAL CONSIDERATION

In order to avoid violations of ethics in medical research, ethical permission was obtained from both Hospital managements prior to the study.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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