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Malaria and Soil Transmitted Helminths Among Patients Attending Some Hospitals in Kano Metropolis, Kano State, Nigeria

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Abstract

Soil-transmitted helminths (STHs) and Plasmodium falciparum are known to the causative agents of neglected tropical diseases that continue to pose significant public health challenges in Nigeria and other endemic countries. This study was aimed at determining malaria and STHs coinfection in Kano metropolis, Kano state, Nigeria. The prevalence of malaria and STHs was determined using microscopy and formol ether concentration methods, respectively. Data on socio-demographic and risk factors were collected from three hundred (300) patients using structured questionnaires. The findings revealed a high prevalence of malaria (92.7%) and low STHs (19.0%). Malaria was more prevalent in males (52.3%) than females (40.3%), with the highest prevalence observed among individuals aged 6 – 12 years (25.7%). The difference in malaria prevalence based on age was not statistically significant ($p>0.05$), contrary to gender which showed a significant difference in their association ($p<0.05$). STHs infections were more common in participants aged between 6 - 12 years (11.3%), and the difference in prevalence among age groups was statistically significant ($p<0.05$). Among the study sites, patients exhibited a higher prevalence of Ascaris infection (14.3%) compared to Hookworm infection (4.6%). Co-infection was recorded in 19.0% of the patients, while 73.7% had malaria infection alone. During this study, malaria and STHs were prevalent in Kano metropolis and there was a co-infection of Malaria and STHs among patients attending the selected hospitals in Kano.

Keywords: Malaria, Soil-transmitted Helminths, Prevalence, Co-infection, Kano metropolis.

INTRODUCTION

Malarial infection causes considerable morbidity and mortality, globally, with an estimated 241 million cases and 627,000 deaths reported in 2019, most of which occurred in Sub-Saharan Africa (WHO, 2020). Malaria is caused by *Plasmodium* parasites. In Nigeria alone, malaria rates vary across different regions with rates as high as 81% to 94% (Ojurongbe *et al.,* 2018). According to Ajumobi *et al.* (2018), malaria accounts for a significant portions of healthcare

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visits in Nigeria comprising of about 60% outpatients' visits, 30% childhood mortality and 11% maternal deaths.

Soil transmitted helminths (STHs) are caused by parasitic worms (*Ascaris lumbricoides*, *Trichuris trichura* and hookworm) transmitted through contaminated soil (Suchdev *et al.*, 2014). It affects millions of individuals worldwide with over one billion people estimated to be infected globally with high prevalence in tropical and subtropical regions were the climates are warm and humid coupled with poor sanitation and hygiene practices of inhabitants (Suchdev *et al.,* 2014; Humphries *et al.,* 2017). In Nigeria, studies (e.g Oguanya *et al.,* 2012; Babatunde *et al.,* 2013; Salawu and Ughele, 2015) have documented high prevalence of STHs among different populations including children, pregnant women and farmers. These infections have detrimental effect on child growth and development, leading to malnutrition, anaemia and impaired cognitive function (Oguanya *et al.,* 2012).

Malaria and (STHs) remain two prevalent parasitic infections that continue to pose significant public health challenges in Nigeria (Ojurongbe *et al.,* 2018). These infections have profound impacts on vulnerable populations particularly children aged under 5 years and pregnant women (Odinaka *et al.,* 2015; Bassey and Izah, 2017). The transmission of both infections is influenced by various factors such as poor hygiene, inadequate sanitation and low socio-economic status (Efunshile *et al.,* 2011; Adewale *et al.,* 2017). The co-infection of these two parasitic diseases within the same individual raises concern for public health as it may have significant implications for disease burden, treatment outcomes and control strategies (Bassey and Izah, 2017; Adewale *et al.,* 2018). Previous studies (e.g. Efunshile *et al.,* 2015; Degarege *et al.,* 2016) suggest that helminths infections may influence the susceptibility and severity of malaria particularly due to immune response they induce. Understanding the transmission dynamics of co-infection is essential for designing effective and integrated interventions that address both STHs and malaria infections concurrently. In Nigeria, it is of greatest importance to evaluate prevalence data overtime to understand the advancements and setbacks that have occurred. Nigeria having diverse ecological zones with high populations bears a considerable burden of both malaria and STH infections. The study was designed to determine malaria and STHs co-infections among patients attending selected hospitals in Kano metropolis, Kano state.

MATERIALS AND METHODS

Study Area and Study Sites

The research was conducted at Kano Metropolis, located in Kano State, Nigeria (Figure. 1). Kano State has been identified as an endemic area with a high prevalence of malaria, both within the state and in the country as a whole (Dawaki *et al.,* 2016; WHO, 2020). Kano state is situated in the northwestern region of Nigeria, and it lies between latitude 10°33'N and 12°23'E and longitude 7°45'N and 9°29'E. It encompasses a total land area of 21,276.87 square kilometers.

The study was conducted in three hospitals; Murtala Muhammad Specialist Hospital (MMSH) in Kano Municipal Local Government, Muhammad Abdullahi Wase Teaching Hospital (MAWTH) in Nasarawa Local Government, and Waziri Gidado General Hospital (WGGH) in Ungoggo Local Government.

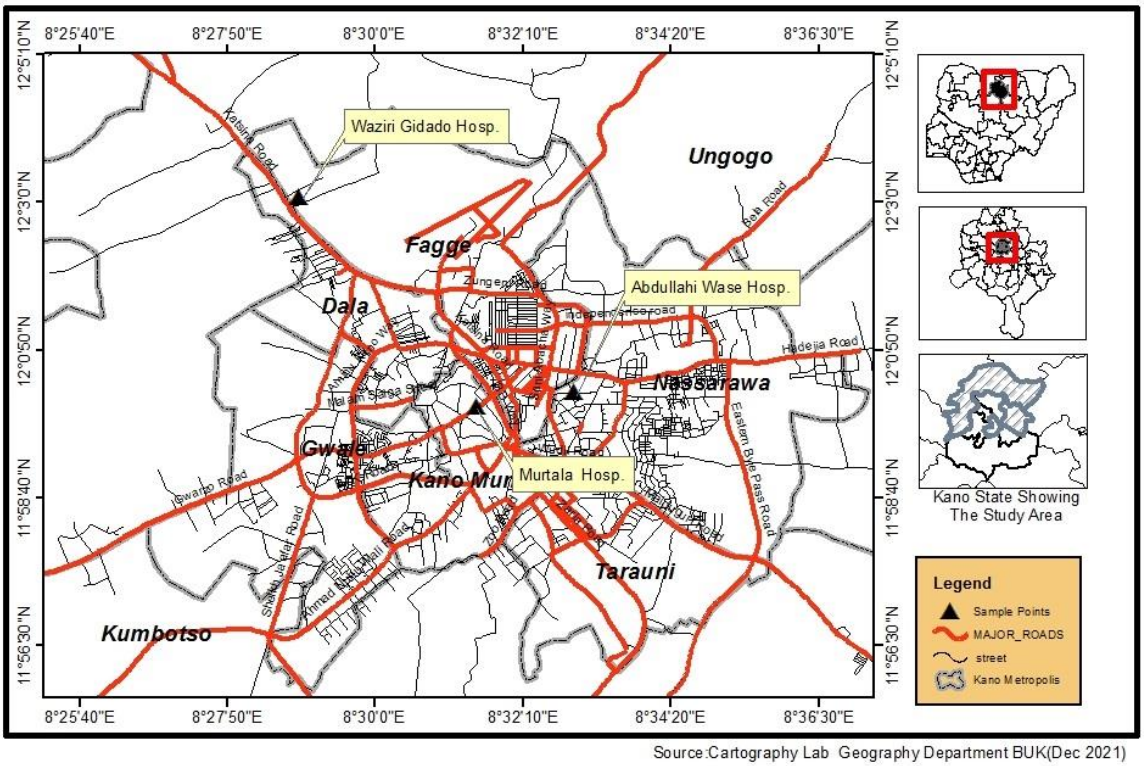

Figure 1: Map of Kano Metropolis showing the selected hospitals

Study Design and Study Population

A cross sectional study involving three hundred (300) participants who visited the General Out-patients Department of these hospitals were recruited for the study in the months of September, 2019 to February, 2020. The sample size was determined based on WHO (2009) guidelines,

Where N is the sample size, Z is a constant normal variate =1.96, P is the previous prevalence within the population (81%). D is degree of precision.

$N = (1.96)^2\ 0.81\ (1 - 0.81)/\ (0.05)^2 = 236$ samples with an attrition of 20% sample size = 47

A total of 283 $\sim$ 300 samples

A total of 300 patients (100 from each hospital selected) were randomly selected for the study.

Questionnaire Administration

A structured questionnaire was employed to obtain the demographic and socio-economic information of the study patients such as use of Insecticide Treated Nets (ITNs), water contact, personal and environmental hygiene.

Ethical Approval

Ethical approval for the research was obtained from the Hospital Management Board of the Ministry of Health in Kano State, based on the consent of the Hospitals' Ethical Committee (no. MOH/Off/797/T.I/1596). Individual consents were obtained from all the study subjects or their guardians before sample collection.

Blood Sample Collection and Blood Microscopy

One (1) ml of vein-puncture blood samples was obtained from each participant using a sterile disposable syringe. The blood was placed in labeled plastic bottles containing 0.5 mg/ml Ethylene Diamine Tetra-Acetic Acid (EDTA). Thick film was prepared and stained with Field

stain following the guidelines prescribed by WHO (2010). The blood smears were examined under a microscope using oil immersion.

Stool Samples Collection and Microscopy
Stool samples were collected in labeled sample bottles from participants between 8 am and 10 am. The stool samples were prepared by adhering to the standard of formol-ether concentration method techniques and helminth eggs were identified using CDC (2016) identification keys.

Statistical Analysis
The obtained data were analyzed using SPSS version 21. Chi square was used to determine the association between prevalence rate of malaria and STHs and the risk factors, P-value less than 0.05 is considered statistically significant.

RESULTS

Prevalence of Malaria
Table 1 shows the prevalence of malaria among participants attending the selected hospital. Out of the 300 patients screened, the prevalence of malaria varied based on age, with higher prevalence observed in individuals aged 13 – 17 years (26.0%), while the lowest were found in the age group of 5 years or younger (18.3%). However, there was no significant difference ($p>0.05$) between malaria prevalence and age groups. Notably, the prevalence was also higher among patients attending Waziri Gidado General Hospital and Murtala Muhammad Specialist Hospital (94% each) compared to Muhammad Abdullahi Wase Teaching Hospital (90%).

In Muhammad Abdullahi Wase Teaching Hospital, the prevalence was higher among individuals aged 18 years and older (28.0%), whereas the age group of 5 years or younger had the lowest prevalence (17.0%). However, in Murtala Muhammad Specialist Hospital, with higher prevalence among individuals aged 13 – 17 years (39.0%) and the least in ≤5 years (12.0%). In Waziri Gidado General Hospital, malarial prevalence was highest among the age groups of 6-12 years (34%) and least in ≥18 years subjects (14.0%). However, there was no significant difference ($p>0.05$) among the age groups in the prevalence of malaria across the three hospitals (Table 1).

Table 2 shows malarial prevalence between gender in the selected hospitals. Overall, it was observed to be higher in males (52.3%) as compared to females (40.3%), and the statistical difference was observed to be significant ($p<0.05$). Specifically, in Muhammad Abdullahi Wase Teaching Hospital and Murtala Muhammad Specialist Hospital, the prevalence was significantly ($p<0.05$) higher in males (58% and 54%, respectively) compared to females (32% and 40%, respectively). Conversely, in Waziri Gidado General Hospital, the prevalence was higher in females (49%) than males (45%). There was a significant difference ($p<0.05$) in malarial prevalence between sexes among the patients examined in the three hospitals (Table 2).

Table 1: Prevalence of Malaria Among Age Group Attending MMSH, MAWH and WGGH Kano State

Variable	Number examined (n)	Number Infected	p – value
MAWTH			0.145
≤5	17	17 (17.0)	
6 – 12	29	26 (26.0)	
13 – 17	24	19 (19.0)	
≥18	30	28 (28.0)	
Total	100	90 (90.0)	
MMSH			
≤5	13	12 (12.0)	0.591
6 – 12	18	17 (17.0)	
13 – 17	40	39 (39.0)	
≥18	29	26 (26.0)	
Total	100	94 (94.0)	
WGGH			
≤5	28	26 (26.0)	0.649
6 – 12	37	34 (34.0)	
13 – 17	20	20 (20.0)	
≥18	15	14 (14.0)	
Total	100	94 (94.0)	
Overall			0.698
≤5	58	55 (18.3)	
6 – 12	84	77 (25.7)	
13 – 17	84	78 (26.0)	
≥18	74	68 (22.7)	
Total	300	278(92.7)	

Table 2: Prevalence of Malaria According to the Sex of Patients Attending MMSH, MAWH and WGGH Kano State

Variable	No. Examined	No. Infected	p-value
MAWTH			<0.05
Male	60	58 (58.0)	
Female	40	32 (32.0)	
Total	100	90 (90.0)	
MMSH			<0.05
Male	54	54 (54.0)	
Female	46	40 (40.0)	
Total	100	94 (94.0)	
WGGH			<0.05
Male	45	45 (45.0)	
Female	55	49 (49.0)	
Total	100	94 (94.0)	
Overall			
Male	159	157 (52.3)	<0.05
Female	141	121 (40.3)	
Total	300	278 (92.7)	

Prevalence of Soil Transmitted Helminths

Out of the 300 patients examined, the prevalence of soil transmitted helminths (STH) varied based on age, with higher prevalence observed among patients aged 6-12 years (11.3%), while

the lowest rates were found in the age group of 18 years or older (0.0%). It was observed that there was a significant difference ($p<0.05$) between the prevalence of STH and age groups. Notably, the prevalence was higher among patients attending Waziri Gidado General Hospital (26.0%), followed by Muhammad Abdullahi Wase Teaching Hospital (18.0%), and the lowest prevalence was recorded in Murtala Muhammad Specialist Hospital (13.0%). Specifically, the prevalence was highest among the participants aged 6-12 years in Murtala Muhammad Specialist Hospital (8%) and Waziri Gidado General Hospital (18%), whereas the age group of 5 years or younger had the highest prevalence (10.0%) in Muhammad Abdullahi Wase Teaching Hospital. The lowest prevalence across all three hospitals was found in the age group of 18 years or older. There was significant ($p<0.05$) difference among age groups in the three hospitals (Table 3).

Table 4 shows the prevalence of STHs according to gender in the studied patients. The prevalence was observed to be higher in males (22.6%) compared to females (14.9%) across all the three selected hospitals. Among males, the highest rate of infection was observed in those attending Waziri Gidado General Hospital (26.0%), followed by Muhammad Abdullahi Wase Teaching Hospital (18.0%) and Murtala Muhammad Specialist Hospital (13.0%). Specifically, *Ascaris* infection was more prevalent in males (22%), while hookworm infection was more common among females (3.5%). However, there was no significant difference ($p>0.05$) between the level of infection of soil transmitted helminths and gender (Table 4).

Table 3: Prevalence of Soil Transmitted Helminth Among Age Group Attending MMSH, MAWH and WGGH Kano State.

Variable	Number examined (n)	Number infected (%)	*A. lumbricoides*	Hookworm	p-value
MAWTH					<0.05
≤5	17	10 (10.0)	7 (7.0)	3 (3.0)	
6 – 12	29	8 (8.0)	7 (7.0)	1 (1.0)	
13 – 17	24	0 (0.0)	0 (0.0)	0 (0.0)	
≥18	30	0 (0.0)	0 (0.0)	0 (0.0)	
Total	100	18 (18.0)			
MMSH					<0.05
≤5	13	5 (5.0)	3 (3.0)	2 (2.0)	
6 – 12	18	8 (8.0)	6 (6.0)	2 (2.0)	
13 – 17	40	0 (0.0)	0 (0.0)	0 0.0)	
≥18	29	0 (0.0)	0 (0.0)	0 (0.0)	
Total	100	13 (13.0)			
WGGH					
≤5	28	7 (7.0)	6 (6.0)	1 (1.0)	<0.05
6 – 12	37	18 (18.0)	14 (14.0)	4 (4.0)	
13 – 17	20	1 (1.0)	0 (0.0)	1 (1.0)	
≥18	15	0 (0.0)	0 (0.0)	0 (0.0)	
Total	100	26 (26.0)			
Overall					<0.05
≤5	58	22 (7.3)	16 (5.3)	6 (2.0)	
6 – 12	84	34 (11.3)	27 (9.0)	7 (2.3)	
13 – 17	84	1 (0.3)	0 (0.0)	1 (0.3)	
≥18	74	0 (0.0)	0 (0.0)	0 (0.0)	
Total	300	57 (19.0)			

Table 4: Prevalence of Soil transmitted Helminth according to sex of Patients Attending MMSH, MAWH and WGGH Kano state

Variable	Number examined (n)	Number infected (%)	*A. lumbricoides*	Hookworm	p-value
MAWTH					0.456
Male	60	12 (12.0)	10 (10.0)	3 (3.0)	
Female	40	6 (6.0)	8 (8.0)	3 (3.0)	
Total	100	18 (18.0)			
MMSH					0.237
Male	54	9 (9.0)	5 (5.0)	2 (2.0)	
Female	46	4 (4.0)	3 (3.0)	2 (2.0)	
Total	100	13 (13.0)			
WGGH					0.130
Male	45	15 (15.0)	12 (12.0)	4 (4.0)	
Female	55	11 (11.0)	5 (5.0)	0 (0.0)	
Total	100	26 (26.0)			
Overall					0.088
Male	159	36 (12.0)	27 (9.0)	9 (3.0)	
Female	141	21 (7.0)	16 (5.3)	5 (1.7)	
Total	300	57 (19.0)			

Prevalence of Malaria and Soil Transmitted Helminth Co-infection

Table 5 shows the rate of co-infection of malaria and soil transmitted helminths among patients of different age groups attending the selected hospitals. The highest rate of co-infection was found among subjects attending WGGH (26.0%), followed by MAWTH (18.0%), and the lowest prevalence was recorded at MMSH (13%).

In MAWTH, the highest prevalence was observed for malaria alone in individuals aged 18 years and older, while co-infection was most prevalent among those aged 5 years or younger. At MMSH, individuals infected with only malaria was observed to be highest among the patients aged 13 – 17 years (39%), while the highest co-infection rate was observed among the age group of 6-12 years (8%). At WGGH, the highest prevalence was observed for malaria alone in individuals aged ≤5 years and 13 – 17 years (19% each), while the highest co-infection rate was observed in the age group of 6-12 years (18%).

Overall, 73.7% of the patients tested positive for malaria only, while 19% were co-infected with soil transmitted helminths and malaria. The highest co-infection rate was found in patients' age group of 6-12 years (43%), while the lowest prevalence was observed in individuals aged 18 years and older (0.0%). Interestingly, individuals aged 13 – 17 years had a higher prevalence of only malaria compared to other age groups.

Malarial and soil transmitted helminth co-infection rate by sex amid patients attending MAWTH, MMSH, and WGGH is presented in Table 6. Co-infection was more common in male patients than female ones in all the three hospitals. Males attending MAWTH and MMSH were observed to have a lower rate of co-infection (45% and 46%, respectively) compared to females (26% and 36% respectively), contrary to this, females a lower coinfection rate at WGGH.

Table 5: Malaria and Helminthes Co-Infection Among Patients Attending MMSH, MAWH and WGGH, Kano State.

Variable	Number examined (n)	Malaria only	Co-infected	p-value
MAWTH				<0.05
≤5	17	7 (7.0)	10 (10.0)	
6 – 12	29	18 (18.0)	8 (8.0)	
13 – 17	24	19	0 (0.0)	
≥18	30	28	0 (0.0)	
Total	100	72 (72.0)	18 (18.0)	
MMSH				<0.05
≤5	13	7 (7.0)	5 (5.0)	
6 – 12	18	9 (9.0)	8 (8.0)	
13 – 17	40	39 (65.0)	0 (0.0)	
≥18	29	26	0 (0.0)	
Total	100	81 (81.0)	13 (13.0)	
WGGH				
≤5	28	19 (19.0)	7 (7.0)	<0.05
6 – 12	37	16 (16.0)	18 (18.0)	
13 – 17	20	19	1 (1.0)	
≥18	15	14	0 (0.0)	
Total	100	68 (68.0)	26 (26.0)	
Overall				
≤5	58	33 (11.0)	22 (7.3)	<0.05
6 – 12	84	43 (14.3)	34 (11.3)	
13 – 17	84	77	1 (0.3)	
≥18	74	68	0 (0.0)	
Total	300	221 (73.7)	57 (19.0)	

Table 6: Malaria and Soil-transmitted Helminths Co-Infection Among Patients Attending MMSH, MAWH and WGH, Kano State.

Variable	Number examined (n)	Malaria only (%)	Co-infected (%)	p-value
MAWTH				
Male	60	46 (46.0)	12 (12.0)	
Female	40	26 (26.0)	6 (6.0)	
Total	100	72 (72.0)	18 (18.0)	0.826
MMSH				
Male	54	45 (45.0)	9 (9.0)	
Female	46	36 (36.0)	4 (4.0)	
Total	100	81 (81.0)	13 (13.0)	0.355
WGGH				
Male	45	30 (30.0)	15 (15.0)	
Female	55	38 (38.0)	11 (11.0)	
Total	100	68 (68.0)	26 (26.0)	0.239
Overall				
Male	159	121 (40.3)	36 (12.0)	
Female	141	100 (33.0)	21 (7.0)	
Total	300	221 (73.7)	57 (19.0)	

Risk Factors Associated with Malaria and Soil-Transmitted Helminthes Infections

Table 7 shows the risk factors that are associated with malaria and STHs infections. Gender was significantly ($p<0.05$) associated with malaria infection among the study population. Age, education, use of ITNs and toilet facilities type were not significantly ($p<0.05$) associated with

associated with malaria. Educational status and age were observed to be associated with STHs infection, other factors like gender, toilet facility and use of ITNs were not significantly ($p<0.05$) associated with STHs infections. The highest prevalence of malaria was among the male (56.5%; 157/278) children aged 13 – 17 years old (28.1%; 78/278), those who uses ITNs (69.4%), those whose educational background were primary (38.8%; 108/278). Amongst the 57 study subjects infected with STHs, the highest prevalence was observed among children aged 6 – 12 years old (59.7%), those who were not having any formal educational status (54.4%) and those who uses pit latrines (61.4%) (Table 7)

Table 7: Risk Factors Associated with the Prevalence of Malaria and Soil-Transmitted Helminthes

Characteristics	Number examined	Malaria N= 278	p-value	Soil transmitted helminths N= 57	p-value
Age					
≤5	58	55 (19.7)	0.698	22 (38.6)	<0.05
6 – 12	84	77 (27.7)		34 (59.7)	
13 – 17	84	78 (28.1)		1 (1.7)	
≥18	74	68 (24.4)		0 (0.0)	
Sex					
Male	159	157 (56.5)	<0.05	36 (63.2)	0.881
Female	141	121 (43.5)		21 (36.8)	
Education					
None	35	34 (12.2)	0.334	25 (43.9)	<0.05
Primary	114	108 (38.8)		31 (54.4)	
Secondary	105	94 (33.8)		1 (1.7)	
Tertiary	46	42 (15.1)		0	
Toilet facilities					
Pit latrine	182	168 (60.4)	0.767	35 (61.4)	0.899
Water closet	118	110 (39.6)		22 (38.6)	
Use of ITNs					
Yes	212	193 (69.4)	0.093	40 (70.2)	0.928
No	88	85 (30.6)		17 (29.8)	

N = Number infected

DISCUSSION

Prevalence of Malaria

The study found an overall malaria prevalence of 92.7% among the participants. WGGH and MMSH had higher overall prevalence rates (94%) compared to MAWTH (90%). These variations in prevalence rates between hospitals may be attributed to factors such as geographical location, socioeconomic factors, population density and local malaria control efforts.

The high level of malarial reported in this research indicates that malaria transmission is still a significant issue in the Kano metropolis. This prevalence was higher than previous research by Dawaki *et al.* (2016) and Oladele *et al.* (2018) in Kano, which reported prevalence of 60.6% (334/551) and 59.4% (1353/2405), respectively. These result confirmed that malaria continues to be a major cause of morbidity in Kano State. Consistent with the present study, previous studies (e.g Shuaibu *et al*., 2017; Moise and Robert, 2017; Babamale *et al*., 2018; Nnamonu *et al*., 2020) conducted in Jigawa, Kwara, Enugu, and Bauchi States also reported high prevalence of

malaria among study subjects, with rates of 63.7% (300/471), 64.8% (5,115/7,899), and 35.8% (118/330), respectively.

The highest prevalence was found among individuals aged 13-17 years (26.0%), while the lowest rates were observed in the age group of 5 years or younger (18.3%). However, these differences were not statistically significant ($p>0.05$). This suggests that the observed variations could be due to random chance rather than a genuine association between age and malaria prevalence. This could be explained by children more susceptible to malaria by having weaker immune systems compared to adults who engage in more outdoor activities, particularly at night, might have higher exposure to mosquito bites. This contradicts the study conducted by Efunshile *et al.* (2015) who recorded higher prevalence in children younger than 5 years.

At MAWTH, the rate of malarial was highest among individuals aged ≥ 18 years (28.0%), while the age group of 5 years or younger had the lowest prevalence (17.0%). In MMSH, individuals aged 13-17 years exhibited the highest prevalence (39.0%), while those aged 5 years or younger had the lowest prevalence (12.0%). Studied patients in WGGH showed a different pattern, the highest infection rate was observed in the age group of 6-12 years (34%) and the lowest in individuals aged 18 years and older (14.0%). However, similar to the overall analysis, the lack of statistically significant differences ($p>0.05$) among the age groups in the prevalence of malaria across the three hospitals indicate that age alone may not be a major determining factor for malaria risk within these settings.

The result also reveals a statistically significant difference ($p<0.05$) in malaria prevalence between males and females across all three hospitals. The overall prevalence was higher in males (52.3%) compared to females (40.3%). In MAWTH and MMSH, males had significantly higher prevalence rates (58% and 54%, respectively) than females (32% and 40%, respectively). Conversely, in WGGH, females had a higher prevalence (49%) compared to males (45%).

Overall, the study revealed a higher prevalence of malaria in males (52.3%) compared to females (40.3%), which is consistent with previous studies conducted in Kano metropolis by Oladele *et al.* (2018). Osagiede *et al.* (2017) also reported a similar trend in Kaduna State, where male patients had a higher malaria infection rate than females, although there was no significant between infection rate and gender. These differences in malaria prevalence may be attributed to differences in immune responses, occupational exposure to mosquitoes, and varying healthcare-seeking behaviors among males and females.

Prevalence of Soil Transmitted Helminths

Overall, the prevalence of STHs in the study population was 19.0%. Patients from WGGH had the highest prevalence (26.0%), followed by MAWTH (18.0%), and MMSH (13.0%). These variations in prevalence rates among hospitals may be influenced by factors such as local environmental conditions, sanitation practices, and socioeconomic factors.

The observed prevalence was lower than the rates reported in children from Kwara (33.5%), Nasarawa (36.5%), and Edo States (52.0%) (Adedoja *et al.*, 2015; Abe *et al.*, 2019; Isaac *et al.*, 2019), but higher than the research conducted by Nzeukwu *et al.* (2022) and Yaro *et al.* (2019). The highest rates of STH were observed among individuals aged 6-12 years (11.3%), while the lowest rates were found in the age group of 18 years or older (0.0%). There was significant difference between rate of infection and age ($p<0.05$). Age was a crucial risk factor for STH infections within the study population. Younger children, in particular, appeared to be more

susceptible to STH infections, likely due to increased exposure to contaminated soil and lower levels of personal hygiene practices. The absence of STHs infections in the age group of 18 years or older might indicate a decline in exposure or acquired immunity over time.

When examining the prevalence of STHs within each hospital by age groups, distinct patterns emerged. MMSH and WGGH exhibited the highest prevalence rates among individuals aged 6-12 years (8% and 18%, respectively). In contrast, MAWTH had the highest prevalence (10.0%) among the age group of 5 years or younger. Additionally, the age group of 18 years or older consistently showed the lowest prevalence across all three hospitals. This study is not in agreement with the one conducted by Sumbele *et al.* (2017) who observed higher prevalence in adults. These age-specific prevalence differences were statistically significant ($p<0.05$), indicating that age plays a crucial role in determining the risk of STH infections within these healthcare facilities.

Soil transmitted helminths prevalence by gender revealed higher overall rates among males (22.6%) compared to females (14.9%) across all three hospitals and the difference was not significant ($p>0.05$). WGGH had the highest prevalence (26.0%), followed by MAWTH (18.0%) and MMSH (13.0%). Specifically, Ascaris infection was more prevalent in males (22%), while hookworm infection was more common among females (3.5%). Similar incidence of higher infection of ascariasis was recorded in studies conducted by Nzeukwu *et al.* (2022) and in Ethopia by Alemu *et al.* (2016). These results have emphasized that the parasite has a wide range of ecological niche. The lack of a significant gender difference in STH prevalence suggests that factors other than gender, such as environmental exposure and hygiene practices, may contribute more significantly to STH infection rates.

Overall, the study found a prevalence of 12.0% and 7.0% of STHs respectively in male and female patients, and the difference was not statistically significant ($p>0.05$). The results of this research agree with the findings reported by Abe *et al.* (2019), who observed prevalence rates of 36.3% and 31.1% for males and females, respectively, and found no statistically significant difference ($p>0.05$). These findings suggest that both genders are susceptible to STH infections in the study area.

Prevalence of Malaria and Soil Transmitted Helminths Co-infection

Amid the three hospitals examined, WGGH had the highest occurrence of co-infection (26.0%), followed by MAWTH (18.0%), and MMSH (13%). The differences in co-infection rates between these hospitals might be influenced by factors such as geographical location, environmental conditions, and population demographics.

Overall, 73.7% of the patients tested positive for only malaria, while 19% were co-infected with both malaria and STH. The age group of 6-12 years exhibited the highest prevalence of co-infection (43%), indicating that children in this age range might be particularly susceptible. Conversely, individuals aged 18 years and older had the lowest prevalence (0.0%), suggesting they may have a low risk of co-infection. There was high rate of only malarial infection among those aged 13-17 years implies that this age group might be more exposed to malaria without concurrent STH infections. This age-specific pattern suggests that different age groups may have varying levels of exposure and susceptibility to co-infection with malaria and STH.

Furthermore, the study also showed that males had a higher co-infection rate compared to females in all three hospitals. Specifically, males attending MAWTH and MMSH showed a lower co-infection rate compared to females, while females had a lower co-infection rate at

WGGH. The gender differences may be influenced by various factors, including disparities in exposure patterns, behaviour, and access to healthcare services. All patients infected with STHs were co-infected with malaria. These findings are consistent with research conducted by Degarege *et al.* (2016) and Mulu *et al.* (2012), which also reported a high prevalence and association of co-infection.

CONCLUSION AND RECOMMENDATION

The study revealed the presence of malaria and STHs infection in Kano metropolis. It discovered an overall malaria and STHs prevalence of 92.7% and 19.0% respectively. Malaria was more prevalent among 6 – 12 years old (25.7%) and was higher in males (52.3%) than in females (40.3%). STHs was more prevalent in 6 – 12 years (11.3%) patients and in males (12.0%). Age and educational level were found to be associated to the rate of infection with Soil Transmitted Helminths. Gender was associated with the Malaria rate of infection in Kano metropolis. Owing to the high prevalence of malaria and STHs recorded in this study, there is an urgent need for public enlightenment and interventions with a view of controlling these diseases.

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