



PREVALENCE OF MALARIA AND INTESTINAL PARASITIC CO-INFECTION AMONG DIABETIC PATIENTS IN CALABAR.

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ABSTRACT

Background: Malaria and intestinal parasitosis is a public health problem among diabetic patients, therefore, this work evaluates the prevalence of intestinal parasitic infection and malaria co-infections in diabetics.

Materials and Methods

Capillary blood and fecal samples were collected from 190 diabetic patients at the outpatient clinic of University of Calabar Teaching Hospital and Navy Reference Hospital Calabar and another batch of capillary blood and fecal samples from 110 non-diabetic subjects. The stool samples were examined macroscopically and microscopically by direct smear and formol- ether concentration method and also stained by modified Ziehl- Neelsen acid fast stain. The thick and thin blood film were stained with 10% Giemsa stain and viewed microscopically.

Result: Amongst the test subjects, malaria parasites had a prevalence rate of 30 (15.8%), intestinal parasites had a prevalence rate of 48 (25.3%), and prevalence of co-infection with malaria parasites and intestinal parasites were 8 (4.2%), the difference was statistically significant ($p=0.036$). Amongst the non-diabetic subjects, prevalence of malaria parasites was 12 (10.9%), intestinal parasites had a prevalent rate of 12 (10.9%) and a co-infection prevalence rate of 12 (3.6%). Amongst the diabetic patients, subjects aged 21-30 years had the highest infection rate of 14 (70.0%) for malaria parasites while 31-40 years had the highest infection of 8 (57.1%) for intestinal parasites the difference was statistically significant $p=0.0001$. Amongst the non-diabetic subjects, age group 31-40 had the highest prevalence rate for malaria parasites 4(28.6%) and intestinal parasites 6(42.9%), while age group 31-40 and 41-50 had the highest prevalent rates of 2(14.3%) for co-infection. Amongst the diabetic patients, male subjects had a higher prevalence rates for malaria parasites, intestinal parasites and co-infection of 20(33.3%), 26(43.3%) and 6(10.0%) respectively which was statistically significant ($p=0.001$). For the non-diabetic subjects, females had a higher prevalence rate for malaria infection 8(13.3%), while males had a higher prevalence rate for intestinal parasites and co-infection of 8(16.0%) and 4(8.0%) respectively, the difference was not statistically significant ($p=0.250$). Hookworm was the most observed parasite, 18(37.5%), *Ascaris lumbricoides*, 14 (29.2%), *Cryptosporidium parvum*, 8 (16.7%), *Cyclospora cayetanensis*, 4 (8.3%), *Trichuris trichiura*, 2 (4.2%) and Microsporidia, 2 (4.2%).

Conclusion: Based on findings in this study, this work has shown a prevalence of intestinal parasites (25.3%), and prevalence of malaria infection (15.8%) in diabetic subjects; and this study also illustrate the prevalence of malaria and intestinal parasitic co- infection of 4.2%, and the need to put in place strategies for the control of the parasite among this group of patients.

INTRODUCTION

Malaria and intestinal parasitic co-infection is a major public health concern in the world, and have remained a significant health challenge.

Numerous studies have reported that two of the most prevalent types of human infection in the developing world, malaria and helminths, overlap extensively in their epidemiological (geographical) distribution and

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frequently co- infect the same individuals (Brooker *et al.*, 2009). Studies on malaria - helminthes co- infections had shown heterogeneous results such as positive association (Degarege *et al.*, 2012), no significant association (Shapiro *et al.*, 2005) and even negative association (Van *et al.*, 2009).

World Health Organization has reported an estimated of 241 million cases of malaria in 2020 and mortality rate estimated to be about 627,000 with children under 5 being the most affected (WHO, 2022). Africa has a large proportion of the global malaria burden having about 94% of malaria cases and deaths. In 2019, 6 countries were accounted for almost half of all malaria deaths worldwide: Nigeria (23%), the Democratic Republic of the Congo (11%), United Republic of Tanzania (5%), Burkina Faso (4%), Mozambique (4%) and Niger (4%) (WHO, 2021).

Malaria is endemic in tropics contributing to huge morbidity and mortality rate, malaria incidence in Nigeria shows seasonal variation among the several geopolitical coverage (Ogundeyi *et al.*, 2015). Ogundeyi *et al.* (2015) had reported the incidence of malaria in the six geographical regions to be 32.7% for (South - South), 36.6% for (South-West), 30.7% for (South- East), 58.8% for (North Central), 55.3% for (North-East) and 33.6% for (North- West). Malaria affects all age groups of the population on annual basis (Hawaria *et al.*, 2019).

Malaria together with diabetes mellitus is common in developing countries like Nigeria and a chief cause of mortality in adults (Okoroiwu *et al.*, 2020). However, it has been noted that malaria and type 2 diabetes mellitus has continue to affect millions of people worldwide especially in developing countries and as such type 2 diabetes mellitus and malaria can be considered as a global phenomenon (Udoh *et al.*, 2020).

Intestinal parasites are important cause of morbidity and mortality although they usually create non - aggressive diseases and constitute a major public health problem in their transmission from person to person, especially in developing countries where poor sanitary conditions and lack of information result in the contamination of food and water sources, which consequently continues parasite cycles (Gil *et al.*, 2013). In countries where there is adequate sanitation conditions and health education, some of these parasites play an important role in causing diseases in specific groups such as immune- compromised individuals and young children (Fantry *et al.*, 2002). There is a large overlap between intestinal parasites and diabetes distribution, and the pathogenic mechanisms of both diseases suggest that they might have influence on each other (Elliott and Weinstock. 2017).

The aim of this work was to determine the prevalence of malaria and intestinal parasitic infection among diabetic patients in Calabar.

MATERIALS AND METHODS

Study Area

The research was carried out in Calabar. Calabar is the capital of Cross River State and is located on latitude 8'20" E and 4'58" N. The city is adjacent to the Calabar and Great Kwa rivers and creeks of the Cross River. Calabar is often described as the tourism capital of Nigeria. Administratively, the city is divided into Calabar Municipal and Calabar South Local Government Areas.

It has an area of 406 square kilometers and a population of 371, 022 as at 2006 census.

Some of the health institutions in Calabar includes; University of Calabar Teaching Hospital (UCTH), Navy Hospital, General Hospital and several family and private clinics. Also, tertiary institutions include; University of Calabar, Cross River State University of Technology (CRUTECH), School of Nursing, College of Health and Technology etc.

Study Design

This was a comparative cross- sectional study.

Ethical Clearance

Ethical clearance was sought and obtained from the ethical committee of UCTH. Written informed consent was also obtained from each subject before incorporating into the study group.

Inclusion Criteria

Patients with history of diabetes who signed the informed consent form either in written or oral form.

Exclusion Criteria

Patients who didn't give consent, those on de-worming and anti-malaria tablets.

Questionnaires' Administration

Structured questionnaires were distributed to respondents prior to the sample collection. Questionnaires with information on the age, gender, educational level, hand washing habit, clipping nails habit, types of latrines used, consumption of raw food habit, social status of subject and availability of clean potable water. The questionnaire was filled by each participant. Participants were informed and assured about the confidentiality of the information on the questionnaires.

Sample Collection

Capillary blood samples were collected through finger prick method with the use of a sterile lancet. Thick and thin blood films were made on the same slide.

Clean universal screw capped plastic container with identification number, were distributed to the subjects for the collection of stool sample.

Sample size calculation

Sample size formula (Prashant and Supriya, 2010)

$$SS = \frac{Z^2 \times P(1-P)}{C^2}$$

Where

- Z = confidence level at 95% (standard value of 1.96)n
- P = estimated prevalence rate of both malaria and intestinal parasites (24.7%) (Eze, et al., 2021)
- C = Confidence interval of 5% (standard value of 0.05)
- SS = $\frac{(1.96)^2 \times 0.247(1-0.247)}{0.05^2}$
- = $\frac{3.8416 \times 0.247 \times 0.753}{0.0025}$
- = 286

For convenience sake, 300 samples were collected.

A total of three hundred (300) samples were collected. 190 were test samples while 110 were control samples, collected from subjects between April and August, 2021. All samples were promptly transported to the parasitological laboratory of the University of Calabar Teaching Hospital (UCTH) for analysis. Stool samples were preserved using 10% formal saline where delay was anticipated.

Processing of Blood Samples

The thick film was allowed to dry completely, the thin film was fixed by dipping inside the container of methanol for few seconds to fix the red cells, the thick film was not fixed thus care was taken to make sure the methanol don't touch the thick film.

Ten (10) % Giemsa stain was gently flooded on the slide and allowed to stain for 15 minutes and washed with clean tap water thereafter. The slide was placed on the drying rack with the film side facing downwards to ensure it drain and dries.

Microscopy

The thick and thin film was viewed with the microscope using the x 100 oil immersion objective lens and result obtained using the plus system.

Processing of Stool Sample

Macroscopic Examination

The physical appearance of the stools samples was examined with the unaided eye. The color, consistency, presence of blood or mucus, presence of adult worm and segment of larva was reported.

Microscopic Examination

This was carried out directly from faecal specimen for the detection of the larvae, or as well as ova, trophozoites or cysts of parasites. Concentration technique was carried out in order to detect those parasites that may have been missed by direct preparation.

Procedure of Direct Smear

For formed stool, a representative portion of the stool was picked using an applicator stick and put into another clean universal container. Normal saline was to emulsify the stool. Using an applicator stick, a portion of the stool was placed on a clean grease-free slide at both ends. To one end, normal saline was added while to the other end, iodine was added. Cover slip was placed on the smears and viewed using x 10 and x40 objective lens of the microscope.

Concentration Method.

Formal ether Concentration Method

It is used to recover protozoan cysts, larva and helminthic eggs. About 1g of stool sample was placed in a clean universal container using an applicator stick. 10% formol-saline was added, mixed, well shaken and allowed to stand for 30 minutes for adequate fixation. The emulsified faeces were sieved using strainer, placed in a funnel to remove large faecal particles. The faecal suspension was transferred into a glass centrifuge tube, 4ml of ether was added to the faecal suspension and shaken properly, the preparation was centrifuged at 3000rpm for 5mins. Using a clean stick, the layer of the fatty debris was loosened and inverted to discard the supernatant. The sediment was transferred to a slide, covered with a coverslip and examined microscopically with x10 and x40 objective lenses of the microscope (Cheesbrough, 2009).

Modified Ziehl-Neelsen method for Oocysts of *Isospora belli*, *Cryptosporidium parvum* and *C. cayetanesis* was also done.

Briefly a smear was prepared from the sediment obtained by the formal ether oocyst concentration technique, air dried and fixed with methanol for 2 minutes. The smear was stained with unheated carbol-fuchsin for 15 minutes and then washed out with water.

One (1) % acid alcohol was used as decolourizer for 10 seconds and wash off with water. The smear was counterstain with 0.5% Methylene blue for 30 seconds. It

was wash off with water and the slide was allowed to stand in a draining rack for the smear to dry

The smear was examined microscopically for oocysts, using a low power magnification to detect and the oil immersion objective to identify them.

Statistical Analysis

Quantitative variables were summarized using mean and standard deviations. Data obtained from the study were analyzed using the SPSS software (version 21.0). The significance of the relationship between variables was tested using the chi-square. The Chi-square test with confidence interval (CI) of 95% and less than 5% ($P < 0.05$) was deemed statistically significant

RESULTS

Table 1 shows the prevalence of malaria parasite infection amongst control subjects (10.9%) and diabetic subjects (15.8%); the difference was not statistically significant ($X^2 = 0.689$, $p = 0.406$). The prevalence of intestinal parasites amongst control subjects and diabetic subjects were (10.9%) & (25.3%) respectively; the difference was statistically significant ($X^2 = 4.486$, $p = 0.036$). The prevalence of the co-infection that were observed amongst control subject was (3.6%) and diabetic subject (4.2%); the difference was not statistically significant ($X^2 = 0.030$, $p = 0.863$).

The prevalence of parasitic infections amongst subjects examined according to age group is as shown in table 2. Test subject aged 21- 30 years had the highest infection rate of (70.0%) for malaria parasites and the lowest amongst those of age >50 (20.0%) there was a significant difference in the prevalence of malaria parasite infection by the age of the subject examined ($X^2 = 30.203$, $p = 0.001$). The prevalence of intestinal parasite by age of subject shows a higher prevalence in the age range of 31- 40 years with a prevalence of 28.6% while the lowest prevalence rate was observed in the age range of 21- 30 & >50 years with prevalence of 20.0% respectively, statistically there was no significant difference in the study group with ($X^2 = 4.81$, $p = 0.186$). The age group of 21- 30 and >50 had no prevalence rate with co-infection, there was no significant difference in the co-infection by age of test subject examined ($X^2 = 7.336$, $p = 0.062$). The prevalence rates of parasitic infection in the test group was higher than that of the control group, but both groups were significantly different in infection amongst subjects examined according to age.

Table 3 shows the distribution of parasitic infection amongst subjects examined according to gender. In the test subject malaria, intestinal parasites and co-infections was higher in males 33.3%, 43.3% and 10.0% respectively than in females 7.7%, 10.9% and 1.5% respectively and there was significantly difference in malaria infection ($X^2 = 10.150$, $p = 0.001$), in intestinal parasitic infection ($X^2 = 7.583$, $p = 0.006$), and ($X^2 = 12.918$, $p = 0.001$) for co-infection. The highest prevalence rate of malaria infection was observed amongst control females 13.3% while males had 8.0%, the difference was statistically not significant ($X^2 = 0.399$, $p = 0.528$), amongst those infected with both intestinal parasitic and co-infected males (6.01) and (8.04) had the highest prevalence while females had 6.71% and 0% respectively, also difference was not statistically significant with ($X^2 = 1.222$, $p = 0.269$) and ($X^2 = 20491$, $p = 0.115$) respectively.

Table four shows the distribution of intestinal parasite amongst study subjects. In test subject Hookworm carries the highest prevalence of 37.5%; *Cyclospora cayetanensis* and *Trichuris trichiura* 4.2% as the least prevalence rate, there was statistical significant difference observed in the distribution of the different species of intestinal parasites ($X^2= 14.615$, $p= 0.012$). The control group was observed with a higher prevalence of Hookworm (50.0%) and the least prevalence was observed in *Trichuris trichiura* (16.7). Statistically there was no significant difference in the distribution of intestinal parasite among control study ($X^2=8.148$, $p= 0.148$). *Cryptosporidium parvum*, *Microsporidia* and *Cyclospora cayetanensis* were not identified in the study for control group.

Table five shows the socio- demographic characteristics collected from both groups. In test subject, educational level, presence of stagnant water, source of water and type of toilet used were statistically significant (<0.05). While occupation statistically had no significant difference $p>0.05$. In control subjects only presence of stagnant water was statistically significant ($p= <0.05$). Among the diabetic subjects, those with no formal

education had the highest prevalence of 38.5% and those with secondary school education had the least prevalence of 9.6%, while in the control subjects, those having gone through tertiary education had the highest prevalence of 33.3% while those with no formal education had the least prevalence of 16.7%. According to occupation, among diabetic subjects, students had the least prevalence of infection (4.2%) while the unemployed had the highest prevalence (32.7%). In the control group, students also had the least prevalence (9.5%), while the unemployed also had the highest prevalence (38.1%). Presence of stagnant water had a higher prevalence rate of infections for both diabetic and control subjects of 80.8% and 66.7% respectively. Borehole water had higher prevalence rate of infections for both diabetic and control subjects than well-water (92.3% and 71.4% against 7.7% and 28.6%), respectively. For the type of toilet used, for diabetic subjects, pit toilet had a higher prevalence (52.1%) and open defecation had the lowest prevalence (6.2%), while for control subjects, water closet had a higher prevalence (58.8%) and open defecation had the lowest prevalence (5.9%).

TABLE 1: prevalence of parasitic infections among subjects.

Study group	Number examined	No (%) with malaria parasite infection	No (%) without malaria parasite infection	No (%) with intestinal parasite infection	No (%) without intestinal parasite infection	No (%) with co-infection
Diabetic	190	30(15.8)	160(84.2)	48(25.3)	142(74.7)	8(4.2)
Control	110	12(10.9)	98(89.1)	12(10.9)	98(89.1)	4(3.6)
Total	300	42(14.0)	258(86.0)	60(20.0)	240(80.0)	12(4.0)

Table 2: Distribution of parasitic infections amongst subjects according to age

Test (diabetic subject)						Control (non--diabetic subject)					
Age (years)	No Examined	No: (%) with Malaria parasite infection	No: (%) with intestinal parasite infection	No: (%) with co-infection	FBS level (mmol/l)	No Examined	No: (%) with Malaria parasite infection	No: (%) with intestinal parasite infection	No: (%) with co-infection	FBS level (mmol/l)	
21 - 30	20	14(70.0)	4(20.0)	0(0)	9.67 ± 3.71	44	2(4.5)	4(9.1)	0(0)	4.44 ± 0.41	
31 - 40	14	4(28.6)	8(57.1)	2 (14.3)	7.19 ± 1.39	14	4(28.6)	6(42.9)	2(14.3)	4.83 ± 0.46	
41 - 50	56	10(17.9)	16(28.6)	6(10.7)	9.33 ± 3.07	14	2(14.3)	2(14.3)	2(14.3)	4.53 ± 0.71	
51 - 60	100	2(2.0)	20(20.0)	0(0)	10.25 ± 3.98	38	4(10.5)	0(0)	0(0)	4.66 ± 0.58	
Total	190	15(15.8)	48(25.3)	8(4.2)		110	12(10.9)	12(10.9)	4(3.6)		

Table 3: Distribution of parasite infections amongst subjects according to gender

Test (diabetic subject)						Control (non-diabetic subject)					
Gender	No Examined	No: (%) with Malaria parasite infection	No: (%) with intestine infection	No: (%) with co-parasite infection	FBS level (mmol/l)	No Examined	No: (%) with Malaria parasite infection	No: (%) with intestine infection	No: (%) with co-parasite infection	FBS level (mmol/l)	
Male	60	20(33.3)	26(43.3)	6(10.0)	10.37 ± 3.93	50	4(8.0)	8(16.0)	4(8.0)	4.53 ± 0.59	
Female	130	10(7.7)	22(16.9)	2(1.5)	9.38 ± 3.45	60	8(13.3)	4(6.7)	0(0)	4.51 ± 0.51	
Total	190	30(15.8)	48(25.3)	8(4.2)		110	12(10.9)	12(10.9)	4(3.6)		

Table 4: Distribution of intestinal parasite in diabetic patients and control group

Test (diabetic subject) Parasite species	control subject		non-diabetic subject	
	No: examined	Frequency (%)	No: examined	Frequency (%)
Hookworm	190	18(37.5)	110	6(50.0)
<i>Ascaris lumbricoides</i>	190	14(29.2)	110	4(33.3)
<i>Cryptosporidium parvum</i>	190	8(16.7)	110	0(0)
Microsporidia	190	4(8.3)	110	0(0)
<i>Cyclospora cayetanensis</i>	190	2(4.2)	110	0(0)
<i>Trichuris trichiura</i>	190	2(4.2)	110	2(16.7)
Total	190	48(25.3)	110	12(10.9)

Table 5: Socio – demographic characteristics of study population

Variable	Test (diabetic subject)				control (non- diabetic subject)							
	No: Examined	(%)	No: with infection	(%)	X ²	P Value	No: Examined	(%)	No: with infection	(%)	X ²	P Value
Educational Level												
Tertiary	70(36.8)		20(19.2)		17.977	0.001	40(36.3)		8(33.3)		1.097	0.982
Secondary	20(10.5)		10(9.5)				32(29.1)		6(25.0)			
Primary	50(26.3)		34(32.7)				28(25.5)		6(25.0)			
No formal	50(26.3)		40(38.5)				10(9.1)		4(16.7)			
Total	190		104(54.7)				110		24(21.8)			
Occupation												
Students	10(5.3)		2(4.2)		8.703	0.191	20(18.2)		4(9.5)		6.349	0.385
Unemployed	46(24.2)		34(32.7)				30(27.3)		16(38.1)			
Self employed	70(36.8)		20(19.2)				20(18.2)		12(28.6)			
Employee	64(33.7)		30(28.8)				40(36.4)		10(23.8)			
Total	190		104(54.7)				110		42(38.2)			
Presence of stagnant water												
Yes	128(67.4)		84(80.8)		9.385	0.009	30(27.3)		16(66.7)		12.009	0.002
No	62(32.6)		20(19.2)				80(72.7)		8(33.3)			
Total	190		104(54.7)				110		24(21.8)			
Source of water												
Borehole	150(78.9)		120(92.3)		22.106	0.001	90(81.8)		30(71.4)		2.465	0.292
Well	40(21.1)		10(7.7)				20(18.2)		12(28.6)			
Total	190		130(68.4)				110		42(38.2)			
Types of toilet used												
Pit latrine	60(31.6)		50(52.1)		20.192	0.001	20(18.2)		12(35.3)		5.484	0.241
Water closet	120(63.4)		40(41.7)				86(78.2)		20(58.8)			
Open defecation	10(5.3)		6(6.2)				4(3.6)		2(5.9)			
Total	190		98(50.0)				110		34(30.9)			

DISCUSSION

This study was to investigate the impact of co-infection of intestinal and malaria parasites among diabetic subjects. Malaria and intestinal parasitic infections have great influences on the world's population as they contribute to serious complications, high morbidity and mortality of affected persons. Both malaria and intestinal parasites have the ability to deplete stored iron, therefore lead to energy depletion, resulting to weight loss and low metabolism (Morimoto *et al.*, 2017) and also affect the beneficial microbes found in the gut that is necessary for blood glucose homeostasis (Zaccone and Hall, 2012; Tracey *et al.*, 2016). Also it is possible that some parasites can damage pancreatic cells leading to insulin secretion in diabetic persons and could influence diabetes complications (Moudgil *et al.*, 2019) as diabetes have been reported to be an immune-compromised disease, so that the clearance of these parasites might have been lessened in diabetic patients (Baiomy *et al.*, 2010).

In this study, the prevalence rate of intestinal parasite of 25.3% was recorded among diabetic subject which is lower than that reported by Maori *et al.* (2021) who recorded prevalence rate of 50.8% in Kano state, Nigeria; Machado *et al.* (2018) with prevalence rate of about 64% in Brazil and Drawany *et al.* (2019) with prevalence rate of 27% as recorded in Egypt. The low prevalence could be as a result of improved hygiene practices and or urban settlements in which there are improved social amenities. The prevalence was higher than the prevalence rate of 20.6% obtained by Almgadam *et al.* (2021) which was carried in Sudan, and also higher than 19.2% prevalence reported from Ethiopia by Ambachew *et al.*, (2020). This could be due to different geographical locations, difference in sample size and study population, as well as location and season.

A prevalence rate of 15.8% for malaria infection was recorded which was slightly lower than that recorded by Danquah *et al.* (2010) who reported 16.0% caused by *P. falciparum* in type 2 diabetes patients as seen in Ghana, and Mohapatra (2001) with a prevalence rate of 17.4% and Pravat and Thatoi (2018) with a prevalence of 40.74%. This could have been due to increased malaria prevention awareness programs. However, this study showed a higher prevalence rate than of those recorded by Udoh *et al.* (2020) with a prevalence rate of 7.2% in Lagos and 4.47% as reported by Ndiok *et al.* (2016) in Bayelsa. These discrepancies could be explained by the fact that could be attributed to a poor glycemic control and resistance to insulin from participant. Compared to similar studies done in other countries, the prevalence of malaria as recorded by Eze *et al.*, 2019 was 5.5% as surveyed from south-central Cote d'Ivoire.

However, no studies in Nigeria have looked at malaria and intestinal parasitic co-infections in diabetic subjects. Hence this study was undertaken and the prevalence rate of 4.2% for co-infection of malaria and intestinal parasite was recorded among the subjects examined.

In this study, age and gender significantly affected the prevalence of malaria and intestinal parasitic co-infections in diabetic subjects; this could be due to awareness, an improved hygiene practice, adherence to environmental hygiene and adequate measures against these infections.

Test subject aged 21- 30 years had the highest infection rate of (70.0%) for malaria parasites, which is not in agreement with Udoh *et al.* (2020) who had a mean age of 54.5 years having a prevalence of 7.2% using light microscope. This was so because Udoh *et al.* (2020) study was done with subjects aged 40-70 years. This study observed that by age, it was not in agreement with Wyss *et al.* (2017) whom had a prevalence rate of 38.2% for the age group 18-29 years. Having the highest prevalence rate in this age group 21-30 years in this study could suggest that probably this group of individuals' lifestyle/ eating habit could have made them diabetic and therefore susceptible to malaria infection. Prevalence of intestinal parasite by age of subject showed a higher prevalence in the age range of 31- 40 years with a prevalence of 28.6%

In this study, a total of six different intestinal parasites were identified from which three of them were intestinal protozoans *Cryptosporidium parvum* 4 (16.7%), *Microsporidia* 2 (8.3%), and *Cyclospora cayetanensis* 1 (4.2%) and the remaining three were helminths (Hookworm 9 (37.5%), *Ascaris lumbricoides* 7(29.2%) and *Trichuris trichiura* 1 (4.2%)). All helminthes were more prevalent than protozoans among diabetic subjects. This finding was different from the study carried out in Egypt with three different intestinal parasites (*Entamoeba histolytica/dispar* 13 (39.4%), *Ascaris lumbricoides* 1 (3%), and no Hookworm infection were identified (Sabah and Tamsah, 2015).

The present study showed that level of educational level, occupation, presence of stagnant water, source of water and type of toilet used were significantly associated with the prevalence of intestinal parasitic infection and malaria in diabetic subjects, with P-values= 0.982, 0.385, 0.002, 0.292 and 0.241 respectively. Diabetic persons who had no formal education (38.5%) were more likely to be infected with parasitic infection than the literate category (above high school), which is in agreement with Akibo *et al.* (2013), in which no formal education had 27.7% than the literate category and were statistically significant. Contrast to this finding, a study conducted in Iran showed that education (AOR = 2:87; 95% CI (0.66, 12.38); p = 0:157) was not significantly associated with the prevalence of intestinal parasitic infections among diabetes mellitus patients (Mohtashamipour *et al.*, 2015). This might be due to the difference in the level of awareness of parasitic transmission in the population.

CONCLUSION

The study has shown a prevalence of intestinal parasites (25.3%), and low prevalence of malaria infection (15.8%) in diabetic subjects; and this study also illustrate the low prevalence of malaria and intestinal parasitic co-infection of 4.2% in diabetic subjects.

It is recommended that improved level of hygiene will reduce intestinal parasitic infection as well as breeding space for mosquitoes to prevent malaria, especially in immune-compromised individuals like diabetes.

Diabetic individuals should also be educated on the dangers associated with co-infections to increase their life-span and chances of living. Government should provide clean pipe borne water and provide clean road-side toilets.

REFERENCES

- Akibo F. O., Olujobi S. O., Omoregie R. and Egbe C., 2021. Intestinal parasitic infections among diabetes mellitus patients. *Biomarkers and Genomic Medicine*. 5(1-2):44-47
- Almugadam, B. S., Ibrahim, M. K., Liu, Y., Chen, S., Wang, C., Shao, C., Ren, B.R., and Tang, L., 2021. Association of urogenital and intestinal parasitic infections with type 2 diabetes individuals: a comparative study. *BMC Infectious Disease*. 21(1):1-9
- Ambachew S., Assefa M., Tegegne Y., Zeleke A J., 2020. The Prevalence and Their Associated Factors among Diabetes Mellitus Patients at the University of Gondar Referral Hospital, Northwest Ethiopia. *Journal of Parasitology Research*. 2020:8855965
- Baiomy A.M.S, Mohamed K., Ghannam, M.A.M, Shahat S. A and al-Saadawy A. S., 2010. Opportunistic parasitic infections among immune-compromise Egyptian patients. *Journal of the Egyptian Society of Parasitology*. Vol. 40(3):797-808
- Brooker, S., Kabatereine, N. B., Gyapong, J. O., Stothard J. R. and Utzinger J., 2009. Rapid mapping of schistosomiasis and other neglected tropical diseases in the context of integrated control programmes in Africa. *Parasitology*. 136(13): 1707-1718.
- Danquah I., Bedu-Addo G. and Mockenhaupt F. P., 2010. Type 2 diabetes mellitus and increased risk for malaria infection. *Emerging Infectious Diseases Journal* Vol. 16, No. 10, Pp. 1601-1604.
- Degarege, A., Legesse, M., Medhin, G., Anmut A. and Erko B., 2012. Malaria and related outcomes in patients with intestinal helminthes: a cross-sectional study. *BMC Infectious Diseases*.12: 291.
- Drawany Z.E.E., Saleh S.H.A, Etewa S.E.S, and Ibrahim S. M., 2019. Prevalence of Intestinal Parasites among Type1 Diabetic Patients in Pediatric.s Zagazig University Hospital. *Endocrinology and Metabolism International Journal*. 7(6):1-9.
- Elliott, D. E., and Weinstock, J. V., 2017. Nematodes and human therapeutic trials for inflammatory disease. *Parasite Immunology*. Vol. 39(5).
- Eze I. C., Esse C., Bassa S. K., Acka F., Schindler C., Imboden M., Laubhouet-Koffi V., Kouassi D., N'Goran E. K., Utzinger J., Bonfoh B and Probst-Hensch N., 2019. Asymptomatic Plasmodium infection and glycemic control in adults: Results from a population-based survey in South-central Cote d'Ivoire. *Diabetes Research and Clinical Practice*. 156 pp1-10.s
- Eze C. N, Owhoeli O and Olasunkanmi R. M., 2021. Malaria and Intestinal Parasites among Children in Muslim Schools, Port Harcourt, Rivers State, Nigeria. *International Journal of Tropical Disease and Health*. 42(6):8-16
- Fantry, L., 2002. Gastrointestinal infections in the immunocompromised host. *Current opinion in gastroenterology*. 18(1): 34- 39.
- Gil, F. F., Barros, M. J., Macedo, N. A., Junior G. E., Redoan R., Busatti H., Gomes M. A. and Santos F. G., 2013. Prevalence of intestinal parasitism and associated symptomatology among hemodialysis patients. *Revista do Instituto Medicina Tropical de Sao Paulo*. 55(2): 69- 74.
- Hawaria D. Getachew H., Zhong G., Demissew A. Habitamu K., Raya B., Lee M., Yewhalaw D. and Yan Guiyuni 2019. Ten years malaria trend at Arjo-Didessa sugar development site and its vicinity, Southwest Ethiopia: a retrospective study. *Malaria journal*. 18 (1): 1-11
- Machado E., Matos N. O., Rezende S.M., Carlos D., Silva T.C., Rodrigues L., Almeida J.R. De Oliveira M.R.G., Muniz-Junqueira M. A and Gurgel-Goncalves R., 2018. Host-Parasite Interactions in Individuals with Type1 and 2 Diabetes Result in Higher Frequency of *Ascaris lumbricoides* and *Giardia lamblia* in Type2 Diabetic Individuals. *Journal of Diabetes Research*. Vol 2018(1): pp 1-5.
- Maori L., Suleiman H., Kalang J. J., Haruna M., Mamtara RC., Peters E., Yakubu A. and Muhammed U., 2021. Intestinal Parasitic Infections among Diabetes Mellitus Patients Attending Murtala Muhammad Specialist Hospital (MMSH), Kano, Kano State. *South Asian Journal of Parasitology*. 5(2):6-14
- Mohapatra M. K., 2001. Profile of severe falciparum malaria in diabetics. *International journal of Diabetes in Developing Countries*. Vol. 21. pp 1-5
- Mohtashamipour M, Hoseini S. G., Pesehchian N., Yousefi H., Fallah E. and Hazratian T., 2015. Intestinal parasitic infections in patients with diabetes mellitus: a case-control study. *Journal of Research in Clinical Medicine*. 3(3):157-163.
- Morimoto, M., Azuma N., Kadowaki H., Abe T., and Suto Y., 2017. Regulation of type 2diabetes by helminth-induced Th2 immune response. *Journal of Veterinary Medical Science*. 78(12): 1855-1864.
- Moudgil V., Rana R., Tripathi P. V., Farooq U., Sehgal R. and Khan M. A., 2019. Copevalence of parasitic infections and diabetes in Sub-Himalayan region of Northern India. *International Journal of Health Sciences*. 13(1):19-24.

- Ndiok, O., Ohimain E, and Izah S. C., 2016. Incidence of malaria in type2 diabetic patients and the effect on the liver; a case study of Bayelsa state. *Journal of Mosquito Research*. 6(15):1-8.
- Ogundeyi S. B., Idowu O. A., Fadairo J. K. and Daniels A. O., 2015. Prevalence of Malaria Amongst Children 0-4 years in Olugbo, Odeda Local Government, Ogun State, Nigeria. *Journal of Mosquito Research*. Vol. 5(16):1-4
- Okoroiwu H. U., Uchendu K. I. and Essien R. A., 2020. Causes of morbidity and mortality among patients admitted in a tertiary hospital in southern Nigeria: A 6-year evaluation. *PLoS ONE* 15(8):1-12.
- Pravat K. and Thatoi S. R., 2018. Diabetes and Severe Malaria- Clinical Profile and Outcome. *Diabetes*. 67(1)
- Prachant K. and Supriya B., 2010. Sample Size Calculation. *International Journal of Ayurveda Research*. Vol. 1(1): 55-57.
- Sabah A. A and Temsah A. G., 2018. Prevalence of some gastro-intestinal parasites in diabetic patients in Tanta city, Gharbia Governorate, Egypt. *Journal of Egyptian Society of Parasitology*. Vol 45(3): 681-684
- Shapiro A. E., Tukhebwa E. M., Kasten J, Clarke S. E., Magnuseen P., Olsen A., Kabatereine N. B., Ndyomugenyi R. and Brooker S., 2005. Epidemiology of helminth infections and their relationship to clinical malaria in southwest Uganda. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. 99:18-24
- Tracey, E. F., Mc Dermott, R. A. and McDonald, M. I., 2016. Do worms protect against the Emetabolic syndrome? A systematic review and meta-analysis. *Diabetes Research of Clinical Practice*.120; 209-220.
- Udoh B. E. Iwalokun B. A., Etukuma E. and Amoo J., 2020. Asymptomatic falciparum Malaria and its Effects on Type 2 Diabetes Mellitus Patients in Lagos, Nigeria. *Saudi Journal of Medical Sciences* 8(1):32-40
- Van Eijk A. M., Lindblade K. A., Odhiambo F. Peterson E., Rosen D. H., Karanja D., Ayisi J. G., Shi Y. P., Adazu K and Slusker L., 2009. Geohelminth infections among pregnant women in rural western Kenya: a cross-sectional study. *PLoS Neglected Tropical Diseases*. Vol. 3(1):e370.
- World Health Organization, 2021. Malaria. Retrieved 22/10/2021 at <https://www.who.int/health-topics/malaria>
- World Health Organization, 2022. Malaria. Retrieved 14/07/22 at <https://www.who.int/malaria/malaria>
- Wyss K., Wangdahi A., Vesterlund M., Hammar U., Dashti S., Naucner P., and Farnert A., 2017. Obesity and diabetes as Risk Factors for Severe Plasmodium falciparum Malaria: Results from a Swedish Nationwide Study. *Clinical Infectious Diseases*. Vol 65(5):949-958.
- Zaccone, P., and Hall S.W., 2012. Helminth infection and type 1 diabetes. *Review of Diabetic Studies*. 9(4): 272-286.