The Perception of Mothers on Malaria, Toxoplasmosis and their Pathological Consequences in the Mother and Baby in Biyem-Assi Yaounde

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Authors' contributions

This work was carried out in collaboration among all authors. Author JLNN Designed the work, participated in data collection, wrote and edited the manuscript. Author KFL participated in data collection, data analysis and wrote the draft of the manuscript. Authors STCL and DTDM contributed in data collection. All authors read and approved the final manuscript.

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ABSTRACT

Malaria is a parasitic disease that causes morbidity and mortality in many areas of the world especially in Sub-Saharan Africa and particularly in Cameroon. It is characterised by febrile manifestation, liver inflammation and anaemia. Toxoplasmosis is another parasitic infection caused by an obligate intracellular parasite (*Toxoplasma gondii)* and is found in many countries of the world. It causes spontaneous abortion in pregnant women and hydrocephally in new- born babies. Malaria and Toxoplasmosis co-infections can cause serious pathological consequences on both mother and fœtus. The aim of this study was to determine the prevalence of malaria, toxoplasmosis, and malaria and toxoplasmosis coinfection in pregnant women during ante natal consultations at Biyem - Assi hospital and to assess their knowledge of the pathological consequences of malaria, toxoplasmosis, and coinfection on the mother and baby. It was a cross-sectional study. Blood samples were collected by finger-prinking and structured questionnaires were administered to 226 pregnant women. The results showed that 39.38 %, 23 % and 8.4 % of

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women tested positive for malaria, toxoplasmosis and coinfection respectively. The most commonly cited consequence of theses infections was spontaneous abortion. The results obtained showed a significant association between the level of education and the level of knowledge of women about toxoplasmosis and coinfection of toxoplasmosis and malaria ($p < 0.05$). The level of knowledge of the pregnant woman is not satisfactory as regards toxoplasmosis and co-infection but quite good as regards malaria. The studies have revealed the need for continouos education on toxoplasmosis for pregnant women and girls of childbearing age, and more comprehensive preventive measures. The implementation of public health and education policies that take into account economic, social, environmental and cultural differences are of prime importance.

1. INTRODUCTION

In recent years, malaria has remained one of the causes of mortality and morbidity in developing countries in Africa and Cameroon in particular. Malaria is a febrile and hemolytic erythrocytopathy due to the presence and development in the liver and in the red blood cells of a hematazoan of the genus *Plasmodium* [1]. It is transmitted to humans by an infecting bite of a female mosquito belonging to the genus *Anopheles*. This disease is a major public health problem in the world, particularly in tropical regions. It is endemic with some areas of low endemicity, hyper endemicity, meso endemicity and holo endemicity [2]. According to W.H.O 2018 report on malaria in the world, the number of malaria cases was estimated at 219 million worldwide in 2017. In total, the ten African countries hard hit by the disease had recorded 3.5 million additional cases compared to 2016. Malaria is responsible for more than 435,000 deaths each year mostly in Africa. Children under 5 years are particularly vulnerable, one child out of two dies every two minutes from this disease [2]. Similarly, it can lead to a high rate of miscarriage and more than 10% of maternal deaths and at times up to 50% for severe forms [3]. Pregnant women and children are therefore the most vulnerable population. In children under the age of 5, malaria causes severe anemia and fatal convulsions. In pregnant women, it can be responsible for severe anemia, spontaneous abortion, and fetal hypotrophy. In Cameroon, the plasmodial species encountered are: *Plasmodium falciparum, Plasmodium malariae,* and *Plasmodium ovale* [4].

The public authorities have become accustomed to following a trend whereby great importance in terms of financial and human resources are directed towards pathologies with high indicators (morbidity and mortality) such as malaria, AIDS and tuberculosis. Thus, bacterial and viral diseases are of greater interest to the public authorities because their consequences are visible and diverse compared to those of indirect parasites that are common in the human population, such as toxoplasmosis. Indeed, toxoplasmosis is a coccidiosis infesting most domestic and wild mammals [5]. Toxoplasmosis is specifically an abortive disease of sheep and females caused by *Toxoplasma gondii* whose definitive host is the cat [6].

Toxoplasmosis is a cosmopolitan parasitosis caused by *Toxoplasma gondii* which is an obligate intracellular protozoan [7]. It is a widespread parasitosis in several countries around the world. It also affects many species of domestic and wild mammals [8]. However the parasite can only be transmitted if it enters the food chain environment or if it passes from an infected mother to her fetus [9] leading to congenital toxoplasmosis. The common modes of human contamination are: consumption of raw or undercooked meat containing cysts of the parasite and ingestion of oocysts with fruits and vegetables soiled by the feces of infested cat [10].

Rarely the parasite can also be transmitted from human to human through organ transplantation or blood transfusion. Toxoplasmosis is a zoonosis. It is qualified as an abortive disease of small ruminants and women with the cat as the definitive host and the most important clinical signs are abortion and congenital malaise [11]. The acquired form of this pathology is often benign in immunocompetent subjects, but it is dreadful in immunocompromised subjects. Toxoplasmosis in pregnant women has serious consequences for the fetus, the newborn and the child. It results in jaundice, cranial calcification, microcephaly, hydrocephaly, and psychomotor retardation [12].

Toxoplama gondii and *Plasmodium falciparum* are two endemic parasites belonging to the

phylum Apicomplexa that cause febrile illness in children in the sub-Saharan region of Africa. These two parasites share common receptors for pathogenicity and both effectors of certain hematological parameters [13]. The prevalence of malaria and toxoplasmosis coinfection was 20% in Nkolbison [13] and 17.7% in Ghana [14]. The presence of these two parasites in a subject would improve the physiology of blood cell production [13]. Congenital toxoplasmosis and malaria in pregnancy have been individually identified as causing severe adverse effects in pregnancy. Co-infection of these two parasites could induce hypertension and preterm delivery [14]. Studies on the co-infection of these two parasites in Cameroon are neccessary as such information will be useful to the Ministry of public Health in planning health-care provision especially among pregnant women and may assist in the modification of health policy.

Few studies have been conducted on the different clinical aspects of the association between malaria and toxoplasmosis. To better prevent a disease, the community of interest needs to know about the disease, its pathology and its preventive strategies. Pregnant women are the most vulnerable to these pathologies and it is neccessary to assess their knowledge on the transmission, pathological consequences of these diseases on both mother and baby and applicable prevention strategies. Thus, we ask ourselves the following questions: What are the prevalences of malaria and toxoplasmosis among women in prenatal consultation? What is the state of their knowledge of these diseases? To do this, a hospital-based study was conducted with objectives as follows : to determine the prevalence of malaria among pregnant women; to determine the prevalence of toxoplasmosis among pregnant women; to assess the knowledge of pregnant women in Biyem-Assi on malaria, toxoplasmosis and co-infection and to assess pregnant women's knowledge on the pathological consequences of malaria and toxoplasmosis co-infection in the mother and baby.

2. MATERIALS AND METHODS

2.1 Study Site and Study Period

The study was conducted during the period from April to December 2019 at the Biyem - Assi Hospital located in Yaounde in the Foundi Division of the Yaounde VI District of the Central Region. Yaounde is the capital of the Central

Region. It is located at latitude 3°52' North and longitude 11°31' East [15]. It has an area of 18,000 hectares and an altitude of 750m above sea level the climate is of equatorial type. Biyem-Assi is a popular District of the Yaoundé VI District. It has about 300,000 inhabitants including other well-known neighborhoods, markets, schools, and hospitals [16]. Our study concerned women and the source population was made up of HIV-negative pregnant women from the Yaoundé VI district undergoing prenatal consultation at the BIYEM-ASSI hospital.

2.2 Study Design, Study Population and Sample Population

This study was a descriptive cross sectional one that took place from April to December, 2019 at the District Hospital of Biyem-Assi. For data collection, a questionnaire was used. A section was reserved on the form for the results obtained after the samples were taken. The target population was HIV-negative women in prenatal consultation at the Biyem-Assi Distric Hospital. The sample size was calculated according to the Lorentz formula [7]

$N = (Z^2 x P x Q)/d^2$, Where Z is the statistical power (1.96), P is the estimated prevalence of disease (17.7% by Blay et al. in 2015 [14], Q=1-P, d is the significance level (0.05).

As such, N= 224.

The calculated sample was therefore 224 and so a total of 300 questionnaires were issued out. In in the end, 226 pregnant women who consented to the study were sampled. Samples were obtained by 'in situ' convinient sampling technique based on the voluntary consent of the participants.

2.3 Data Collection

The data was collected from the pregnant women during an individual interview in which questionnaires were filled out after each question asked. The questions were to obtain information on the socio-demographic parameters such as the age of the participant, educational level (illiterate, primary school, secondary school, higher education, occupation or profession, place of residence, marital status (single, married), religion, type of locality of residence (rural area, urban area), type of building material of the habitat. In addition, clinical data included age of gestation, blood transfusion, consumption of

poorly cooked meat, raw meat, unpasteurized milk, poorly washed or unwashed vegetables, untreated water, contact with animals such as cats, use of impregnated mosquito nets, presence or absence of swamps, and compliance with sanitation rules. Also, questions were designed to sample the knowledge of each participant regarding malaria and toxoplasmosis pathology; attitudes and behaviors to adopt in order to curb malaria and toxoplasmosis, recognition of symptoms, mode of transmission, consequences and prevention methods.

2.3.1 Blood collection and test procedure

➢ The materials used for data collection consisted of pipettes, sterile vaccinostyl, strips of the ONE STEP TOXO IgG/IgM Test (Cat: MS - 2053C; version: 02) of the laboratory Lab pro Pharma, LLC for the detection of IgG and IgM antibodies, slides, light microscope, filter paper; test tube, beaker, alcohol 70 %, distilled water, and a 20 % solution of Giemsia.

➢ The procedure for collecting blood samples was clearly explained to the pregnant women in order to prepare them psychologically and obtain their approval. For malaria and toxoplasmosis examinations, blood was collected from a finger prick that had been previously cleaned at the lobe with alcohol-soaked cotton and pricked with a sterile lancet. This blood was used to prepare the thick film for the malaria examination and a drop was collected using a micro-pipette deposited on the strip for use in the detection of toxoplasmosis.

2.3.2 Laboratory analysis

2.3.2.1 Principle of the test: case of malaria

For blood examinations concerning malaria, thick blood films were used in the determination of the presence of *Plasmodium*.

➢ **Procedure**

After participant identification, the number of the participant and the date of the sampling were written with a pencil at the end of the slide, the third or the fourth finger of the left hand of the subject was disinfected with an alcohol swab. With the help of a sterile vaccinostyl, a capillary puncture was made with a sharp prick of the left

hand and the pricked finger was pressed to obtain a drop of blood. The first drop of blood was removed with a dry cotton ball and then two drops of blood were placed in the center of a labeled slide. Using the end of another slide, circular motions were made until the drop was about one centimeter in diameter. Then it was left to air-dry.

➢ **Coloration**

The blood being already-dried, staining was done using 20% Giemsa prepared as follows: from an initial solution of rapid Giemsa of volume 500ml and 100 % concentrated, 1ml was taken out using a pipette. It was introduced in a test-tube then 19ml of distilled water was introduced in the test-tube containing 1ml of Giemsa and homogenized. With the help of a wattman paper the mixture was filtered in order to eliminate possible particle. The filtrate obtained was used for staining. Staining was done for 20 minutes. Then the slides were rinsed using distilled water left to dry on a rack and then observed under the microscope.

➢ **Observation of the slides under the microscope**

The slides were read under a UNICO® light microscope with a x100 objective using immersion oil. Malaria parasites were counted against 200 leukocytes in thick films [17].

2.3.2.2 Test principle: case of toxoplasmosis

The test used was the one-step IgG/IgM test which is a qualitative immune test based on the use of a strip for the detection of IgG and IgM antibodies to *Toxoplasma gondii* in blood. The test device consisted of a burgundy colored conjugate pad containing *Toxoplasma gondii* antigenic envelopes conjugated to colloidal gold and a rabbit IgG gold conjugate, a nitrocellulose strip containing two test bands (T1 and T2) and a control band (C band). The T1 test strip was pre-coated with antibodies for the detection of anti-Toxoplasma IgM, the T2 strip was coated with antibodies for the detection of anti-Toxoplasma IgG and the C strip was coated with goat and rabbit IgG. When blood sample was placed on the strip, it migrated by capillary action into the strip. Toxoplasma IgG if present, would bind to the Toxoplasma conjugate and the immune complex would be captured by the pre-induced reagent on the burgundy-colored T2 strip indicating IgG-positive toxoplasmosis and

suggesting recent or repeated infection. If Toxoplasma IgM was present in the sample, it would bind to the Toxoplasma conjugate and the immune complex formed was then captured by the reagent-coated T1 band; there would be a burgundy appearance indicating a new infection. The absence of any T1 and T2 bands indicated a negative result. The test strip contained an internal control band (the C strip) which had to show a burgundy coloration prohibition of the immune complex of the rabbit-goat IgG conjugate regardless of the development of the color on any of the T strips, otherwise the test result was invalid.

2.3.2.3 Test Procedure

After the working surface was sanitized, the test device was placed on it. On the strip, the number of the participant was marked. The finger was massaged, then cleaned with alcohol soaked cotton and with a sterile lancet the finger was pricked. A drop of blood was collected with the help of a micro-pipette and introduced in the sample well of the strip, then two drops of buffer was added and allowed for 10 to 15 minutes for result to be read.

2.4 Statistical Analysis

Data were entered using Microsoft Excel and analyzed with statistical package for social scintist (SPSS) software version 24. Prevalences were calculated as the proportion of serologically positive samples among all tested samples. An analysis was performed to assess the association between subject characteristics and *Plasmodium falciparum* and *Toxoplasma gondii*

infection. Proportions were compared using the chi-square test and Fischer's accuracy test with a 95% confidence interval and a p-value less than 0.05 considered statistically significant.

3. RESULTS

3.1 Demographic Characteristics of the Study Population

In the study, the majority of pregnant women were between 21 and 30 years of age (N=118, 52.21%). The majority of these women were Christians (95.1%, N= 215). In relation to educational levels, most had attained secondary and university education (N = 102, 45.13%, N = 102, 45.13% respectively). The distribution of participants according to educational level is as shown in Table 1.

3.2 Prevalence of Malaria among Pregnant Women In Biyem-Assi Yaounde

Among the women sampled, 39.38% (N = 89) tested positive for *Plasmodium falciparum* and 60.62% (N = 137) tested negative (Fig. 1).

According to their level of education, 3.98% of the positive women had primary education, 17.69% had secondary education and 17.69% had higher education. Similarly, among pregnant women who tested negative, 5.75% had primary education, 27.43% had secondary education and 27.43% had university education. There was no significant association between prevalence and level of study of (p > 0.05) (Table 2).

Table 1. Demographic characteristics of the study population

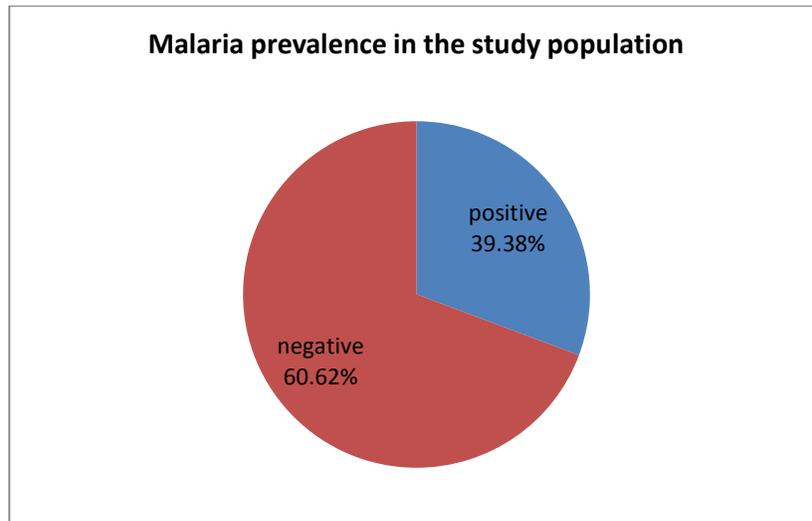| Demographic characteristics of the study population			
Characteristic	**category**	**Number examined**	**Percentage %**
Education	Primary	22	9,73
	Secondary	102	45,13
	University	102	45,13
Total		226	99.99
Religion	Christians	215	95.1
	Muslims	6	2.7
	Others	5	2.2
Total		226	100
Age of pregnant women	< 20 years	35	15.5
	21 – 30 years	118	52.2
	31 – 40 years	57	25.2
	>40years	16	7.1
Total		226	100

Fig. 1. Prevalence of malaria among pregnant women in Biyem-Assi

Table 2. Prevalence of malaria with respect to level of education

Level of education		Primary		Secondary		University		p-value
		Number examined	%	Number examined	%	Number examined	%	
Malaria	Positive	9	3.98	40	17.69	40	17.69	0,116
	Negative	13	5.75	62	27.43	62	27.43	
Total		22	9.73	102	45.13	102	45.13	

3.3 Prevalence of Toxoplasmosis in Pregnant Women Women in Biyem-assi Yaounde

In this study, 23% (n = 52) of women tested positive for *Toxoplasma gondii* and 77%, (n = 174) tested negative (Fig. 2).

Based on their level of education, 2.21% of the positive women had primary education, 14.15% had secondary education and 6.63% had higher education and were positive for toxoplasmosis. Among the pregnant women who tested negative, 7.52% had attended primary school, 30.97% secondary school and 38.49% higher education (Table 3) and there is no significant association between the prevalence of toxoplasmosis and the level of education (p = 0.14 > 0.05).

3.4 Prevalence of Co-infection of Malaria and Toxoplasmosis in Pregnant Women in Biyem-assi Yaounde

Out of the 226 women sampled, 19 tested positive for both *plasmodium falciparum* and

Toxoplasma gondii, i.e. 8.40 % of the population. Few (n = 31, 13.71%) women tested negative for malaria and positive only for toxoplasmosis, 68 tested positive only for malaria and negative for toxoplasmosis (30.08%) and finally 108 tested negative for both malaria and toxoplasmosis (47.78%) (Table 4).

Among the women sampled in this study, 19 tested positive for both *Plasmodium* and *Toxoplasma gondii*, i.e. 8.40%. Their distribution according to the level of education is as follows: 1.32% had primary education, 5.75% secondary education and 1.32% higher education. There was no significant association between the prevalence of co-infection and the level of education (p > 0.05) (Table 5). Also, 13.7% of women were negative for malaria and positive only for toxoplasmosis. These were distributed according to the level of education as follows: 0.88% with primary education, 8.40% with secondary education and 4.42% with university studies. Among pregnant women, 30.08% were positive for malaria and negative for toxoplasmosis, i.e., 2.65% with primary education, 11.94% with secondary education and

15.48% with higher education and there was no significant association between the prevalence of co-infection and the level of education (p > 0.05) (Table 5).

3.5 Pregnant Women's Knowledge of the Pathological Consequences of Malaria in the Mother and Baby

Most of the women, (67.23%) had knowlege on the pathological consequences of malaria on mother and baby. For the specific aspects of this knowlege, most of them knew of spontaneous abortion (58.84%), a few women (3.09%) knew about anemia, some (5.3%) said that death of baby and mother could occur and 0% knew about pre-term delivery (Fig. 3). The majority of participants had significantly good level of knowledge of the consequences of toxoplasmosis (p = 0.04, p < 0.05) in mother and baby compared to those who did not know.

In relation to the level of knowledge of the pregnant woman on the pathological consequences of malaria and their level of education, it was observed that among the women with primary education, 36.36% knew about spontaneous abortion, 4.54% knew about death, and the rest (59.1%) knew nothing. Among women with secondary education, 64.70% knew about spontaneous abortion and the remaining 35.3% knew nothing. Similarly, among women with university education, 57.84% knew about spontaneous abortion, 6.86% about anemia and 10.78% about death. Thus, we observed a significantly low level of knowledge (p < 0.05) among women with lesser education compared to their counterparts who had attained secondary or university education (Table 6).
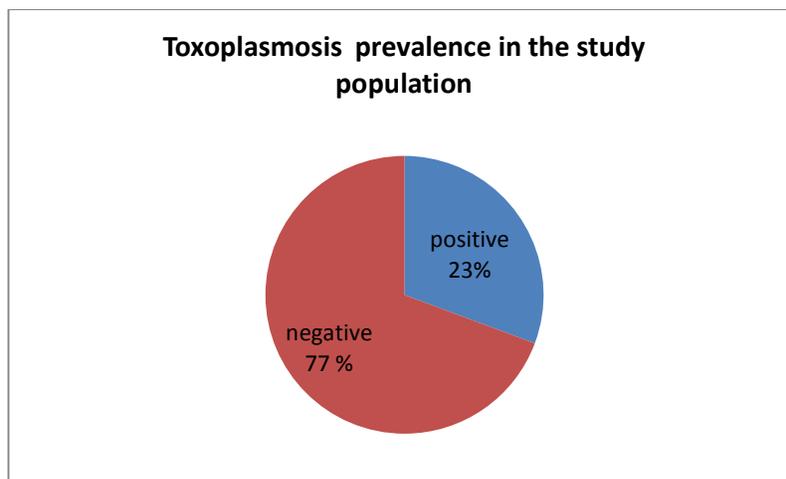

Fig. 2. Prevalence of toxoplasmosis among pregnant women in Biyem-Assi

Table 3. Prevalence of toxoplasosis in relation to level of education

Level of education		Primary		Secondary		university		p-value
		Number examined	%	Number examined	%	Number examined	%	
Toxoplasmosis	Positive	5	2.21	32	14.15	15	6.63	0.14
	Negative	17	7.52	70	30.9	87	38.49	
Total		22	9.73	102	45.13	102	45.13	

Table 4. Co-infection of mlaria and toxoplasmosis among pregnant women in Biyem-Assi

Co-infection of malaria and toxoplasmosis			
Toxoplasmosis	Malaria		
	Positive	Negative (%)	Total
Positive	19 (8.40)	31 (13.71)	50 (22.12)
Negative	68 (30.08)	108 (47.78)	176 (77.9)
Total	87 (38.5)	139 (61.5)	226 (100%)

Table 5. Prevalence of malaria and toxoplasmosis co-infection according to educational level

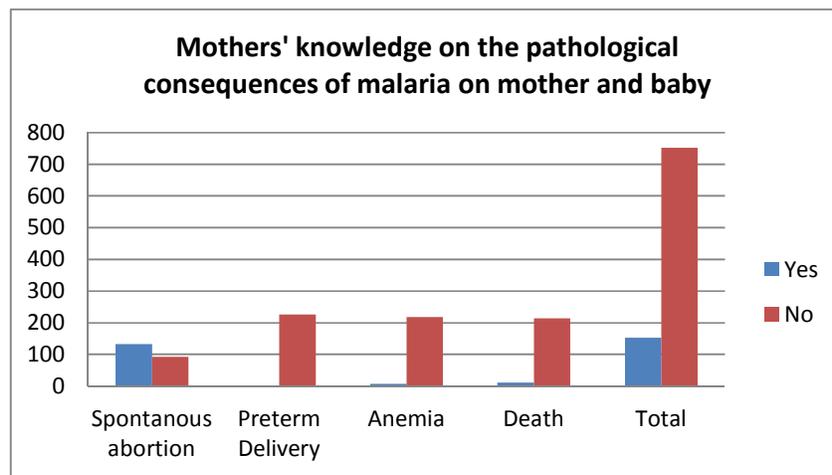| Level of Education	Primary		Secondary		University		p-value
	Number examined	%	Number examined	%	Number examined	%	
Toxo-Positive/Malaria-Negative	2	0.88	19	8.40	10	4.42	0.19
Toxo-Negative/Malaria-Positive	6	2.65	27	11.94	35	15.48	
Toxo-Positive/Malaria-Positive	3	1.32	13	5.75	3	1.32	0.13
Toxo-Negative/Malaria-Negative	11	4.86	43	19.02	54	23.89	
Total	22	9.71	102	45.11	102	45.11	

Fig. 3. Mother's knowledge on the pathological consequences of malaria on mother and baby
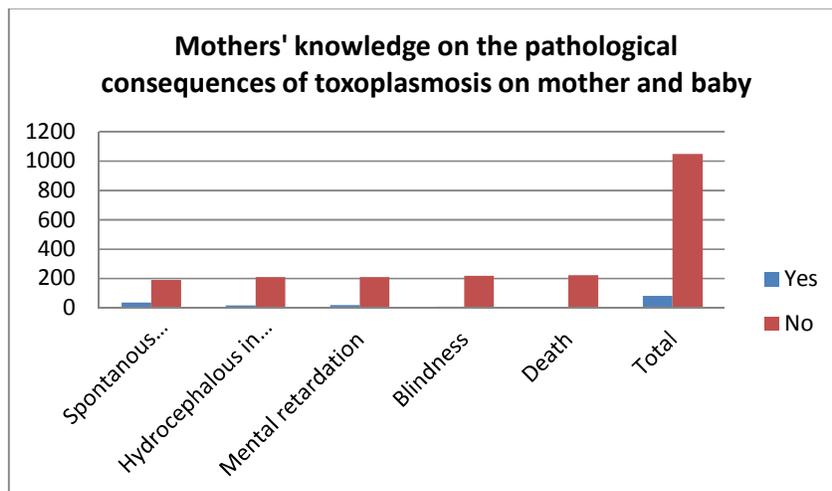

Fig. 4. Mother's knowledge on the pathological consequences of toxoplasmosis on mother and baby

Table 6. Mothers' knowledge on the pathological consequences of malaria in relation to the level of education

Mothers' knowledge on the pathological consequence of malaria on mother and baby

Pathological consequence	Mothers' knowledge			Primary eduation			Secondary education			University education		
	Yes	No	p-value	Yes	%	No	Yes	%	No	Yes	%	No
Spontanous abortion	133	93	0,099	8	36,36	14	66	64,70	36	59	57,84	43
Preterm Delivery	0	226		0	0	22	0	0	102	0	0	102
Anemia	7	219		0	0	22	0	0	102	7	3,09	95
Death	12	214		1	4,54	21	0	0	102	11	10 ,78	91
Total	152	752		9	40.9	79	66	64.70	342	77	71.71	331
	P-value			**0,020**			0,127			0,099		

Table 7. Mothers' knowlege on pathological consequencees of toxoplasmosis in relation to the level of education

Pathological consequence	Mothers' knowlege			Primary education			Secondary education			University education		
	Yes	No	p-value	Yes	%	No	Yes	%	No	Yes	%	No
Spontanous abortion	36	190	**0.04**	1	4,54	21	4	3,92	98	31	30,39	71
Hydrocephalous in babies	16	210		0	0	22	6	5,88	96	10	9,80	92
Mental retardation	17	209		1	4,54	21	4	3,92	98	12	11,76	90
Blindness	8	218		0	0	22	3	2,94	99	5	4,90	97
Death	5	221		0	0	22	4	3,92	98	1	4,54	101
Total	82	1048		2	9.08	108	21	20.58	489	59	61.35	451
P-value				**1,70**			**0.019**			**0,001**		

3.6 Knowledge of Pregnant Women on the Pathological Consequences of Toxoplasmosis in

3.6.1 Mother and baby

In relation to mother's knowlege on the pathological consequences of toxoplasmosis in mother and baby, it was observed that in total, 36.25% of the women had knowlege distributed as follows : 15.92% of the women knew about spontaneous abortion, 7.07% about hydrocephally, 7.52% about mental retardation, 3.53% about blindness and 2.21% about death (Fig. 4). The majority of participants had significantly low level of knowledge of the consequences of toxoplasmosis (p = 0.03, p < 0.05) in mother and baby.

In relating the level of knowledge of pregnant women on the pathological consequences of toxoplasmosis and the level of education, it was observed that, except for 4.54% of pregnant women with primary education who knew about spontaneous abortion and 4.54% about mental retardation, the rest (90.92%), did not know any consequences of toxoplasmosis; we note that the level of knowledge of women in this category is significantly low (p < 0.05) (Table 7). On the other hand, among women with secondary education, 3.92% knew about spontaneous abortion, 5.88% about hydrocephalus, 3.92% about mental retardation, 2.94% about blindness, and 3.92% about death. We note that the level of knowledge of these women is significantly low (p < 0.05) (Table 7). Women with secondary education had lower knowledge of the consequences of toxoplasmosis compared to those with university education. Among women with university education, 30.39% knew about

spontaneous abortion, 9.80% about hydrocephalus, 11.76% about mental retardation, 4.90% about blindness, and 4.54% about death. There was a significant relationship between knowledge level and educational level. (p < 0.05) (Table 7).

3.7 Pregnant Women's Knowledge on the Pathological Consequences of Malaria and Toxoplasmosis Co-Infection in Mother and Baby

In relation to the pathological consequences of malaria and toxoplasmosis co-infection, it was found that 58.84% of women knew about spontaneous abortion and non knew about premature delivery. Some (7.07%) knew about hydrocephaly, 7.52% knew about mental retardation. A few (7.52%) knew about blindness, and 5.30% knew about death giving an overall percentage of 85.39% that had knowlege on some pathological consequences of the two diseases when they co-exist in one individual. There was therefore a significantly high level of knowledge in this population (p = 0.003, p < 0.05) (Table 8) in relation to the different manifestations compaed to those who did not know any pathological consequence (14.6%).

Education played a vital role in knowlege relating to pathological consequences. In all three groups of women, knowlege on spontaneous abortion was most common, and that on pre-term delivery was least common. The difference in the proportion of knowledge on pathological consequences in relation to educational levels was statistically significant (p < 0.05) among the different groups and taking into consideration the detdifferent aspects as shown in Table 9.

Table 8. Pregnant women's knowledge of the pathological consequences of malaria and toxoplasmosis co-infection

Pathological Consequence	Knowlege of pathological consequences of malaria and toxoplasmosis co-infection on mother and baby			
	Yes	%	No (%)	p-value
Spontaneous abortion	133	58.84	93	
Hydrocephally in babies	16	7.07	210	
Mental retardation	17	7.52	209	
Blindness	8	7.52	218	
Pre-term Delivery	0	0	226	
Amemia	7	3.09	219	
Death	12	5.30	214	
Total	193	85.4	33 (14.6)	**0,003**

Table 9. Mothers' knowlege on pathological consequencees of co-infection of malaria and toxoplasmosis in relation to the level of education

Pathological consequence	Mothers' knowlege			Primary education			Secondary education			University education		
	Yes	No	p-value	Yes	%	No	Yes	%	No	Yes	%	No
Spontanous abortion	133	93	**0,002**	8	36 ,36	14	66	64,70	36	59	57,84	43
Hydrocepahally	16	210		0	0	22	6	5,88	96	10	9 ,80	92
Mental retardation	17	209		1	4 ,54	21	4	3,92	98	12	11,76	90
Blindness	8	218		0		22	3	2 ,94	99	5	4,90	97
Pre-term delivery	0	226		0	0	22	0	0	102	0	0	102
Anemia	7	219		0	0	22	0	0	102	7	6,86	95
Mort	12	214		1	4 ,54	21	0	0	102	11	10,78	91
P-Value				**0,0001**			**0,0049**			**0,002**		

4. DISCUSSION

This study involved 226 pregnant women attending antenatal clinics at the Biyem-Assi Hospital. The age group 21 to 30 years was the most predominant. The vast majority of these women were Christian and few had not had any formal education.

The prevalence of malaria among pregnant women was 39.38% in Biyem-Assi. This rate is high considering the various actions implemented by the Cameroon Ministry of Public Health and the WHO to eradicate malaria. The high prevalence of malaria has also been reported in some West African countries such as Nigeria, where in some localities such as Aba the prevalence was 40.1% [18]. In Ghana, prevalence values of 42% have been reported [19,20]. In Ethiopia, the prevalence was 44.6% [21]. The prevalence obtained in this study is close to that reported by Elime et al in 2019 [22]. This could be explained by the fact that there is the existence of stagnant pools of water and waste water accumulated in the gutters, which could be real hotbeds for the development of mosquito larvae. Also, there was the non-renewal of impregnated mosquito nets after long period of use, leading to reduced effectiveness of the nets.

The prevalence of toxoplasmosis in Biyem-Assi was 23%. This is low compared to the results of previous studies conducted in Yaoundé by Ndumbé et al in 1992 [23] and by Njunda et al in 2011 [24], which obtained a seroprevalence of 77.1% and 66.5% respectively. Nguefack et al in 2016 had obtained a prevalence of 78.6% in Douala [25]. Mabeku et al in 2018 obtained

prevalence of 35.77% [26]. This difference could be explained by the increase in awareness among mothers compared to past years. As time goes on, awareness increases and practices such as the pasteurization of milk gain grounds. Also, there is improvement with respect to personal and household hygiene measures especially those enacted by the town halls in the framework of hygiene and salubrity and with the support of the Hygiene and Salubrity Society of Cameroon.

Regarding the co-infection with malaria and toxoplasmosis, the prevalence was 8.40% which was therefore very low compared to that obtained by Nambile et al in 2016 [13] in their work on the effects of toxoplasmosis and malaria in children aged 0-6 years at Nkolbison Hospital in Yaoundé. They found a prevalence of 20% which is higher than what has been obtained in this study (8.4%). Their higher prevalence could be explained by the fact that mothers are more apt to respect hygiene measures, whether in the kitchen or with products intended for consumption, in general. In addition, toxoplasmosis can be transmitted congenitally. Immunocompetent young children have little knowledge of diseases to which they are exposed, are negligent and are much more exposed in the environment [27] and contract the diseases but will only present with symptoms during pregnancy.

When we compared these prevalences with the level of education of the participants, we found that although previous studies have shown that the level of education influences the risk of developing malaria in pregnant women [22], our

results showed the opposite. In our study, there was no significant association between malaria prevalence and education level. We can therefore postulate that the overall prevalence of 39.8% would be influenced by other parameters such as the age of the pregnant woman, the age of the pregnancy, the parity, the profession of the pregnant woman [22].

Furthermore, with regard to the link between toxoplasmosis and the level of education, the prevalence is relatively high, although it is decreasing in comparison with the results obtained previously by other researchers, but it is not significantly related to the level of education. Nguefack et al in 2016 [25] found that a low level of education is significantly associated with an increase in the prevalence of Toxoplasma gondii and that a high level of education can be associated with a level of hygiene that can reduce the risk of contamination. This rate obtained during our work could be associated with the socio-economic level, the profession, and the eating habits. Women with small jobs (fruit, vegetable, fresh meat sellers) have a high prevalence of infection [28]. Similarly, toxoplasmosis is detected in people who are in contact with the soil, who eat raw or undercooked meat, who do not have good hygiene in the preparation of meals [29].

The prevalence of co-infection with malaria and toxoplasmosis (8.40%) was not significantly associated with the level of education. Correlated with the results of Mensah [28] who had obtained a rate of co-infection with *Toxoplasma gondii* and *Plasmodium falciparum* equal to 2.2% lower than ours, and would be due to opportunistic parasitism by these two parasites related to a strong immunodepression during gestation.

After analysis of our different results, most (67.25%) of the participants have a good knowledge of the pathological consequences of malaria. Similar results obtained by Kimbi et al in 2014 [30] showed that 66.4% of participants knew at least one consequence of malaria in pregnant women. One of the most cited consequences was spontaneous abortion. This could be explained by the fact that the majority of women follow and understand television news, radio announcements, reading material, and are also informed during prenatal visits.

Regarding the level of knowledge of women about the pathological consequences of toxoplasmosis, the consequences most frequently mentioned were spontaneous abortion, hydrocephalus, mental retardation and blindness. This value is low compared to that obtained by Smereka et al in 2018 in Poland [31], and by Willame et al in 2015 in Geneva and Switzerland which were 94.4% and 87% respectively [31,32]. This difference could be explained by the fact that many women in Cameroon are under informed about toxoplasmosis, even during prenatal visits, they are not sufficiently educated about this silent disease, and in the educational system, this pathology is not emphasized.

In this study, 85.85% of correct answers were obtained regarding the level of knowledge of pregnant women about the pathological consequences of malaria and toxoplasmosis co-infection. Although in the literature few studies have been done on malaria and toxoplasmosis co-infection, this significantly high value could be justified by the fact that a large majority of women are more aware of spontaneous abortion as a negative effect of any disease that may occur in a woman at the beginning of and during pregnancy.

When the level of knowledge of the woman is compared with her level of education, it can be seen for malaria that whatever the level of education, there is a significant link between the level of knowledge of disease pathology and the level of education. This is in agreement with the results obtained by Kimbi et al in 2014 who found in the course of their work that knowledge of malaria was strongly associated with the level of study.

In the case of toxoplasmosis, we found in the course of our work that the level of knowledge of women, whatever their level of education, is low and that statistically there is a significant association between knowledge and level of education. This result may correlate with that of Smeraka et al. [31] who found a significantly high association between knowledge of toxoplasmosis and education level. This could be due to the fact that during school curricula, teachings are more focused on diseases with symptomatic character such as malaria, AIDS, tuberculosis, and cholera. It should also be noted that the ability to understand the information read or heard depends on the level of education. When we analyze the link between the level of knowledge of co-infection and the level of education, we find that whatever the level of education of these women, the knowledge

balance remains low, there is a significant association between the level of knowledge and the level of education. Although there are few studies on co-infection with malaria and toxoplasmosis, this result can be justified by the fact that during their schooling, the focus is not on toxoplasmosis because it is asymptomatic and therefore low-key, but rather on diseases such as malaria, tuberculosis, HIV/AIDS and tropical diseases.

5. CONCLUSION

The general objective of this study was to determine the rate of infection linked to co-infection by Toxoplasma gondii and Plasmodium falciparum among pregnant women in Biyem-Assi hospital as well as the state of knowledge of the latter on the pathological consequences of this co-infection in Biyem-Assi. The study focused specifically on: determining the prevalence of malaria in pregnant women in Biyem-Assi, toxoplasmosis and co-infection, assessing the knowledge of pregnant women on the pathological consequences of co-infection in the mother and baby. The results obtained showed that the prevalence of malaria, toxoplasmosis, and co-infection does not necessarily depend on the level of education but on other parameters as well. The prevalence of co-infection is associated with parasitism favored by a strong immunodepression of the patient. However, it appears that the level of knowledge of the pregnant woman on the pathological consequences of the co-infection is associated with the level of education. The level of knowledge of the pregnant woman is not satisfactory as regards toxoplasmosis and co-infection but quite good as regards malaria.

CONSENT AND ETHICAL APPROVAL

For the realization of this study, authorizations were obtained: An authorization was obtained from the Department of Biological Sciences of the Ecole Normale Supérieure of Yaoundé and a research authorization from the Ministry of Public Health was also obtained through the research directorate of the Biyem-Assi district hospital. The study was conducted in accordance with the ethical principles of the Ministry of Public Health of Cameroon, relating to good practices in human clinical research. The target population in this study were voluntary pregnant women who had given their written informed consent. As a motivation, the rapid diagnostic tests for IgM and IgG and the thick drop were performed free of charge in all participants. All positive cases were sent to the gynaecologist doctor in the same hospital facility for promt and efficient treatement.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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