Original Research Article

Prevalence of *Toxoplasma gondii* and associated risk factors among pregnant women attending hospital centers in Penka-Michel, Cameroon.

Abstract

Aims: Toxoplasmosis is serious in the case of prenatal transmission. Congenital toxoplasmosis results in abortion or congenitally acquired disorders which primarily affect the central nervous system. The study was carried out to investigate the epidemiology of toxoplasmosis and associated predisposing risk factors in a rural setting of Cameroon.

Methodology: The survey took place from April to July 2014 at the District Medical Center of Balessing, the District Medical Center of Bansoa chefferie, the District Medical Center of Eglise Evangelique du Cameroun and the District Hopital of Penka-Michel, 4 reference hospitals in Penka-Michel, a sub-division in the west region of Cameroon.Serum samples were collected from 643 pregnant women attending the ante natal clinic after obtaining informed consent. *Toxoplasma gondii*-specific IgG antibodies were detected by indirect solid-phase enzyme immunoassay (EIA), immunoComb® Toxo lgG. A structured questionnaire was used to collect information on sociodemographic parameters and predisposing risk factors for toxoplamosis from each patient. The data were analyzed using GraphPad prism version 5.03.

Results: The age range of the women was 15-50 years with a mean of 27.1 ± 2.51 years. The mean gestational age was 6.22 ±1.93 months with, 9.8%, 39.5% and 50.7% of the women in the first, second and third trimester respectively. The overall IgG seroprevalence was 35.77% (230/643) of our sample population. There was a statistically significant association between Toxo IgG seropositivity status, educational level, professional status, had knowledge on toxoplamosis and frequency of raw meat consumption with a significantly higher risk of being seropositive amongst farmers and housewives (X^2 =13.28; P = .0100), among women with university level of education (X^2 =11.77; P = .0082), among women with knowledge on toxoplamosis (P = .0001) and those who frequently consume raw meat (P = .0426).

Conclusion: Our data found out a high risk of toxoplasmosis in pregnant women, and a general screening program for toxoplasmosis in pregnancy in Cameroon should be done.

Keywords: Seroprevalence, toxoplasmosis, risk factors, Penka-Michel, Cameroon.

1. Introduction

Toxoplasmosis is one of the most common parasitic zoonoses world-wide caused by *Toxoplasma gondii*, which establishes long-lasting infections in humans and animals [1]. *Toxoplasma gondii* is an intracellular Apicomplexan protozoan capable of infecting almost any cell type, making it one of the most 'successful' protozoan parasites on earth. Felids are the definitive hosts for *T. gondii* and warm blooded species, including humans, serve as intermediate hosts [2]. Infection in humans usually occurs via the oral or transplacental route, from a mother infected to the fetus during pregnancy. Consumption of raw or undercooked meat containing viable cysts, water contaminated with oocysts from cat feces, and unwashed vegetables are the primary routes of oral transmission; improper handling of undercooked meat or contaminated soil also may lead to hand-to-mouth infection [3]. Latent toxoplasmosis, i.e., the lifelong presence of cysts and anamnestic concentrations of anti-*T.gondii* antibodies in immunocompetent subjects, is considered asymptomatic and harmless,

although 10% of patients may present a self-limiting, mild, febrile illness characterized by lymphadenopathy, fever, fatigue, arthralgia, dermatosis, malaise, headache and myalgia [4, 5]. However, infection in immunocompromised patients and in fetuses whose mothers acquire acute infection during pregnancy can lead to very severe consequences [6]. Opportunistic toxoplasmosis infection or reactivation of a subclinical infection in immunocompromised patients may cause encephalitis, pneumonitis and myocarditis, often with lethal outcome [7]. The rate of congenital infection in fetus from women with acute infection ranges from 20% to 100% depending on which trimester the acute infection occurs in: 15% to 25% in the first trimester, 30% to 54% in the second trimester, and 60% to 65% in the third trimester; by the last week of gestation, the incidence approaches 100% [8]. The outcome is more severe if the infection occurs early in the pregnancy. In the congenitally infected fetus, the infection may spread to the central nervous system. The consequences include spontaneous abortions, stillbirth or serious birth defects when infection takes place during the first trimester of pregnancy, and chorioretinitis, visual impairment, hydrocephalus, intracranial calcifications, irreversible cognitive and other neurologic impairment in case of infection during the second or third trimester [9]. Quantitative screening for IgG antibodies to *T. gondii* is a pragmatic diagnostic approach for determination of the immune status in pregnant women and newborns. The IgG antibodies are detected within 1–2 weeks of infection, reaching peak after six to eight, and then declining to lower levels and remaining positive for the remainder of the individual's life, while IgM antibodies are detected within a few days to one week of infection [10-11]. It is important to highlight that serological tests for IgM may present persistently positive results for long periods; therefore a positive IgM test result in a pregnant woman requires caution and further confirmation of acute infection [12].

The prevalence of serologic evidence of *T gondii* infection changes according to social and cultural habits, geographic factors, climate, and transmission route, and it typically increases with age [13], with seropositivity seen in 10% of persons aged 10 years, 20% of persons aged 20 years, and 50% of persons aged 70 years in the U.S. and UK [5]. The prevalence of infection varies by country; in French population, toxoplasmosis seroprevalence decreased overtime from 54.3% in 1995 to 43.8% in 2003 and 36.7% in 2010 [14], about 12.5% of the Japanese population and 60% of the Dutch population are seropositive for *Toxoplasma gondii* antibodies by the fourth decade of life compared with only 22.5% of the U.S. population [5]. Seroprevalence in women of childbearing age also varies by country; for example, in the 1990s, 37% to 58% of women in Central Europe, Northern Africa, and Australia and as many as 51% to 77% of women in South and Central America and Sub-Saharan Africa were seropositive, whereas only 4% to 39% of women in India, Southeast Asia, and China were seropositive [2].

Diagnosis of acute *T. gondii* infection during pregnancy is particularly important because of the risks of congenital transmission of infection to the newborn. The birth prevalence of congenital toxoplasmosis ranges from 10 to 100 cases per 100,000 live births [5]. Pregnant women with newly acquired infection should receive treatment to help avoid transmission to the fetus and congenital infection. If the child is infected at birth or in early infancy, treatment should be initiated to prevent symptomatic infection or limit sequelae. Recent reports show increasing number of evidences linking *T. gondii* infection with schizophrenia [15], epilepsy [16] and traffic accidents [17]. If toxoplasmosis play etiological role or attributed to the aforementioned problems then the global burden of toxoplasmosis is likely to be much higher together with the life-long health care costs of congenitally infected babies [18].

The serological screening of pregnant women for toxoplasmosis and the follow-up until delivery are not routine procedures in Cameroon. In a few studies performed in our country, seroprevalence of *T. gondii* infection among pregnant women was found to be 77.1% in 1992

[19] and 65.5% in 2011 [5]. However those previous study on the prevalence of toxoplasmosis among pregnant women has been done only in urban setting. As a result, information is very scarce on the prevalence of toxoplasmosis among pregnant women in rural setting where some predisposal factors are more frequent than in urban area. The present study aimed to determine the seroprevalence of *Toxoplasma gondii* specific IgG antibodies among pregnant women and to identify the predisposing risk factors for toxoplasmosis in Penka-Michel, a rural area in West Cameroon.

2. Methodology

2.1. Study Area

The research was carried out in Penka-Michel, one of the five sub-divisions of Menoua division in the west region of Cameroon. Penka-Michel is located between latitude 21.52, 5^{o} and 31.41, 5^{o} north of the equator and longitude 7.39, 10^{o} and 20, 10^{o} east of the GreenWich Meridian. It has an altitude of about 1500 m above sea level. It has two distinct seasons, a short dry and a long rainy season. The highest rainfall registered in a year could reach 345.1 mm and the thermal amplitude between the hottest month of the year (March: 21.5^{o} C) and the coldest (August: 18.9^{o} C) is $2.6^{o}C$. It is a rural area near the University of Dschang, with most of the inhabitants being farmers. The population is about 124 880 people with a growth rate of 6.8% per year of which 'Bamilikes' constitute more than 90 % of inhabitants [20]. Most of the inhabitants do not have access to potable water and have resorted to wells or streams as their only source of drinking water which is not often treated. In addition, poor housing and poor hygienic conditions help in the spread of most parasitic infections. Penka-Michel has many secondary hospitals including 4 of reference with high capacity of reception and wide variety of patients; the District Medical Center of Balessing (CMA-B), the District Medical Center of Bansoa chefferie (CMA-BC), the District Medical Center of Eglise Evangelique du Cameroun (CAA-EEC) and the District Hopital of Penka-Michel. This work was carried out in the four reference hospitals listed above. By selecting this four reference hospital, we believe our sampling was largely representative of all categories of patients in this rural setting.

2.2. Study population

Pregnant women of ages 15-50 years attending the selected health centers from April to July 2014 participated in the study. Non cooperative patients who refuse to give their consent or to participle to the study were excluded to the study.

2.3. Data collection

Each pregnant woman was interviewed using a standard questionnaire. The questionnaire contained socio-demographic data on age of the women, age of the pregnancy, educational level, occupation, gravidity and related risk factors including obstetrical history (total number of pregnancy and abortions), frequency of meat consumption (a few meat in a week as more frequent, a few meat in a month as frequent and seldom/never) and type of meat (beef, lamb, chicken, pork, delicatessen), vegetables and fruits (raw or not), cooking preferences (raw or undercooking-if the center is still raw or if the center is still pink, well-done-if no pink meat is seen), owning cat (outdoor or indoor), soil exposure (occupation or hobby) and knowledge on toxoplasmosis.

2.4. Specimen collection and laboratory analysis

Venous blood was collected by venipuncture respecting all aseptic techniques. A blood sample of about 3-4ml was collected and rapidly transferred into a labeled dry tube. The samples were transferred to the laboratory and centrifuged at 3000 rpm for 5 min and serum separated from red cells, labeled and stored between - 2 to - 8 ^{o}C for samples that were to be processed 2-7 days from the collection date. Serum samples were analyzed using an indirect solid-phase enzyme immunoassay (EIA) using immunoComb® Toxo lgG set (Orgenics, France) in order to identify the presence of immunoglobulin IgG. Antibody levels were evaluated following the instructions of the set manufacturers. The level of anti-Toxo IgG in each specimen was assessed by comparing the color intensity obtains, with the color scale on the CombScale provided with the kit and were expressed in titers (<10, > 10, >50 and >100 IU/L). A titer more than 10 IU/mL was taken as positive results in the current study as recommended by the manufacturers. The test sensitivity in term of detection limit was 0.01 IU/mL.

2.5. Statistical assessment

The data collection forms were first checked for completeness, obvious errors and inconsistencies were corrected before they were entered into a computer, and double checked. The descriptive data was given as mean ± standard deviation (SD). Using GraphPad prism version 5.03, the data were analyzed with chi-square and presented as appropriate. The differences were considered to be statistically significant when the p-value obtained was less than 0.05. The analysis was focused on determining the prevalence of *Toxoplasma gondii* lgG antibodies among pregnant women in our study population and their association with socio-demographic and predisposing risk factors for maternal infection.

3. Results

3.1. Sociodemographic characteristics

A total of 643 participants were enrolled in the study. The age range of the women was 15-50 years with a mean of 27.1 ± 2.51 years. Over 92 % of the women possessed primary and secondary levels of formal education. Forty seven percent (47.43 %) of the total study participants were housewives followed by farmers (24.72 %). More than half (50.7%) of study participants was in their third trimester of pregnancy. In relation to gravidity, most of the subjects were multiparous (76.04%), whereas few of them had more than 6 children (18.20%) (Table 1).

3.2. Seroprevalence of toxoplasmosis

The prevalence of toxoplasmosis was found to be 35.77% (230/643) in the study population. This prevalence of *T. gondii* was subsequently used to test their association with socio-demographic parameters and known risk factors for toxoplasmosis infection.

3.3. Association of socio-demographic parameters and risk factors to *Toxoplasma* seropositivity

The strength of the association between women's occupation and Toxo IgG seropositivity status was statistically significant (P = .0100), with a significantly higher risk of being seropositive amongst farmers and housewives, relative to those in other occupation groups. Our findings showed that 41.66 % and 39.01 % of farmers and housewives were respectively seropositive for Toxo IgG (Table 2). Moreover, we observed a significant difference between the prevalence of toxoplasmosis and educational level (Table 2). The prevalence of *T. gondii* infection among women with university level of education was higher (70%) than that of the others educational groups (P = .0082) (Table 2).

As regards the age groups, the 21 to 25 years age group constitutes 25% of the total population. Toxo-IgG positivity was higher amongst women of age group 41+ (12/21; 57.14%), following by those of age group 26-30 (65/155; 41.93%) (Figure 1), however, this difference was not statistically significant (P = .0749).
The mean gravidity was 3.7 ±1.1 (Figure 2). The prevalence of Toxo-IgG was 34.41% (53/154) and 36.19 % (177/489) among primigravidae and multigravidae females respectively (Figure 2). One hundred and seventy seven (77 %) of the 230 pregnant women that were seropositive to Toxo-IgG were multiparous. There was a positive relationship between gravidity and Toxo IgG seropositivity status, which was not statistically significant (P = .6878).
In terms of gestational age, 63 (9.8%) of the women were in the first trimester of gestation while 254 (39.5%) and 326 (50.7%) were at secondary and tertiary trimester, respectively. The mean gestational age was 6.22 ±1.93 months. Among the 230 Toxo-IgG positive women 31.74, 37.79 and 34.96% were in the first, second and third trimester of gestation, respectively (Table 3). There was no a significant different between gestational age and seropositvity (P = .6640).

In our study, we observed the potential impact of risk factors on the prevalence of toxoplasmosis. Based on our epidemiological data, we observed a high frequency of raw vegetables or fruit consumption (145/374; 38.77%) in serologically positive women in comparison with women whom did not used to (85/269; 31.59%), but these difference were not statistically significant (P = .0667) (Table 4). We also observed an increased seropositivity in women that was related to history of abortion (58/148; 39.18%), although this was no statistically significant (P = .3813). No correlation was found between cat owners as risk factor and prevalence of Toxo-IgG (P = .5594). The seroprevalence was almost the same among those who were exposed (92/268; 34.32%) compared to those who were not exposed (138/375; 36.8%) to this risk factor. A similar result was obtained when considering the frequency of meat consumption as predisposing risk factor (P = .4281). There was no statistical difference on the relationship between type of meat consumption and toxo IgG seropositivity status with a higher risk of being infected amongst women who consumed one meat type regularly (76/185; 41.08 %), relative to those who consumed more than one meat type (154/458; 33.62%), (P = .0842). However, we observed a significant high frequency of raw meat consumption (71/156; 45.51%) in seropositive women in comparison with non exposed women (P = .0426). We also noticed a significant (P = .0001) inverse relationship between the knowledge on toxoplamosis and seroprevalence status. Women who had knowledge on toxoplasmosis showing the highest positivity (43/63; 68.25 %) than those without knowledge (187/580; 32.24%).

4. Discussion

The overall prevalence of toxoplasmosis was found to be 35.77% (230/643) in this study population. Previous studies done in Yaoundé, an urban setting of Cameroon by Ndumbe *et al.* in 1992 [19] and by Njunda *et al.* in 2011 [5] have shown the seroprevalence of 77.1% and 65.5% respectively, indicating that the prevalence of *T. gondii* appears to be more concentrated in high density areas especially cities and towns, like Yaoundé. The prevalence of toxoplasmosis can vary among different groups and these differences have also been seen between rural and urban regions. Some studies determined a higher prevalence in rural regions [21], while others did not show any difference between urban and rural inhabitants

[22]. The seroprevalence we found correlates with the results of some studies done in others countries. In Bobo Dioulasso-Burkina Faso, a serological analysis of toxoplasmosis during pregnancy showed Toxo-IgG seropositivity of 31% [23], in Setif-Algeria 32.6% [24], 30.1% in Aydin province-Turkey [25], 38.01% in Iran [26] and 44.8% in Malaysia [27] all among pregnant women. However, our results showed less incidence of the diseases when compare to those found in others study; a hemagglutination test found antibodies in 54% of blood donors in Kenya [4], in Gabon 56% at Franceville [28] and 60% at Libreville [29], in Dakar-Senegal 50% [30] all among pregnant women, and in Yopougon (Abidjan) 60% among the women in child-bearing age using indirect immunofluorescent test [31]. Moreover, an increased prevalence of toxoplasmosis was demonstrated in studies conducted in many others regions; in Brazil an EIA method found a prevalence of 79.9% in men and of 63.4% in women [32], in the Democratic Republic of Sao Tome 75.2% [33]. The differences in the prevalence observed between the present study and aforementioned studies could be due to differences in setting and study population which may probably correlate with dietary habits, as well as with improvements in food preservation quality or changes in nutrition. Moreover, this difference may also due to the availability of different appropriate conditions including high temperature and low humidity that favor the sporulation, longer infectivity and viability of the oocysts, since it has been reported that infection is more common in warm climate and at lower altitudes than in cold climates and mountainous regions [9]. The prevalence of toxoplasmosis in the human population is associated with exposure to risk factors. An increased prevalence of toxoplasmosis is detected in people who are often in contact with soil, who eat raw or insufficiently heat treated meat or raw vegetables, or who lack basic personal hygiene or have unhygienic food preparation [34].

In accordance with other studies showing that prevalence increases with age [13, 35], our results showed that the highest number of seropositive women was within the age group 41+ (12/21; 57.14%), followed by those within the age group 26-30 (65/155; 41.93%), however, this difference was not statistically significant (P = .0749) (Figure 1). This age group is made of the oldest pregnant women of our sample and thus indicates the possibility that the risk of exposure increases with age through continuously exposition. This result is in agreement with those obtained in France by Berger *et al.* 2007 [35], in Senegal by Coulibaly 2012 [30] and in Gabon by Mpiga *et al.* 2010 [28] where the highest number of seropositive women was within the age group 40-54 (58.2%), 40+ (66.6%) and 35-44 (62%) respectively.

We also found a positive relationship between gravidity and Toxo IgG seropositivity status, which was not statistically significant (P = .6878) (Figure 2). Seventy seven percent (177/230) of the 230 pregnant women that were seropositive to Toxo-IgG were multiparous. A similar relationship were obtained by Berger *et al.* 2007 [35] who found a seroprevalence of 46.1 % among multigravidae vs 39,4 % among primigravidae females in his study population. This once more highlights the fact that risk of exposure increase with age with is correlates with gravidity.

In the previous studies, lower educational level, soil-related occupations [13], eating raw or unwashed vegetables or fruits, cleaning the cat litter box [36], having poor hand hygiene [34], were all found as risk factors for toxoplasmosis. These factors were assessed in the current study; however, no relation was found among many of them. The assessment of risk factors was done according to information given by the participants. Some issues such as hygienic behaviour might be misrepresented (hidden) because of shaming or other factors. However, an improvement in the quality of data was attempted by using district midwifes who were familiar and trusted by the women during data collection.

In the current study, statistical difference was observed between professional groups for toxoplasmosis seroprevalence (P = .01) with the highest risk of being seropositive amongst housewives (39.01 %) and farmers (41.66 %), relative to those in other occupation groups

(Table 2). This may be interpreted by the fact that housewives are daily exposed to infection through direct contact with contaminated meat and vegetables during cooking, in addition to cleaning of house garden contaminated with cat feces containing *Toxoplasma* oocysts. Similarly, the highest risk of being seropositive amongst farmers (41.66 %) may be explained by continuous exposure of women to the risk factors of *T. gondii* infection through their routine works like gardening, contact with soil, eating of raw or unwashed vegetables and fruits and drinking water from contaminated reservoirs, in addition to the widespread of stray cats which play an essential role in the distribution of infection [9].

One would have expected a positive relationship between educational status and Toxo-IgG seropositivity with less educated women showing the highest positivity, since majority of women who had some knowledge on toxoplasmosis had university level of education.

However, the prevalence was significantly higher among women with university level of education (14/20; 70%) than those from the other formal educational groups (P = .0082) (Table 2). This distribution of prevalence was similar to the findings of Berger et al who found the highest prevalence of Toxo-IgG (46.2%) among women with university level of education. Such variations may imply that possession of formal education is not perceived as a risk factor for toxoplasmosis infection, since majority of women who had some knowledge on toxoplasmosis had university level of education. This indicates that after graduating, some women of our sample population may not apply their back ground knowledge in their daily lives, or that they have been infected before having knowledge concerning contraction routes or risk factors of toxoplasmosis infection. Moreover, we also observed a controversial significant increase in the frequency of Toxo-IgG antibodies with respect to knowledge on toxoplasmosis implying that those women might have known of toxoplasmosis before they became informed on their status. This distribution of prevalence was similar to the findings of Njunda *et al*. 2011[5] who found the highest prevalence of Toxo-IgG (87.5%) among women with knowledge on toxoplasmosis. This emphasizes once more on the need of sensitization and education activities of the Cameroonian population regarding the risks involved in toxoplasmosis transmission and the importance of preventive strategies by our health authorities.

Our findings show that women in the second (37.79 %) and third trimester (34.96%) of gestation were slightly more infected than those in the first term (31.74%) and the mean gestational age was 6.22 ± 1.93 months. This suggests that in the absence of therapy, there could be a possibility of transmission to neonates, since the risk of vertical transmission of *T. gondii* infection increases with gestational age and the incidence approaches 100% by the last week of gestation [8].This emphasizes the need to equip mothers with knowledge to prevent toxoplasmosis infection and to sensitize the Cameroonian population about toxoplasmosis infection, and the importance of preventive measures.

Frequent consumption and type of meat (pig, sheep, chicken and goat) were identified as the principle risk factor in several recent studies of *T.gondii* infections in humans [1, 35]. No relation was observed between seroprevalence and type of meat consumed in the current study although, in Penka-Michel, beef, chicken and pork are commonly consumed. The cooking temperature of meat is an important issue in the infection of *T. gondii*. Consumption of raw or undercooked meat containing viable cysts, water contaminated with oocysts from cat feces, and unwashed vegetables are the primary routes of oral transmission; improper handling of undercooked meat or contaminated soil also may lead to hand-to-mouth infection [3]. In the current study, we observed a significant high frequency of raw meat consumption (71/156; 45.51%) in seropositive women in comparison with not exposed seropositive women (P = .0426). Thorough cooking, as well as the habit of eating at home is always preferred in Penka-Michel. However, 'Bamilikes' who constitute more than 90% of

inhabitants of Penka-Michel usually consumed undercooked chicken meat in their traditional practice as 'bab si' which is a mixture of roasted chicken meat and palm oil.
In the current study, no relation was detected between cat owners as a risk factors and the prevalence of Toxo-IgG (P = .5594). The association of cat owners and human toxoplasmosis is difficult to assess by epidemiological surveys because soil, not the cats, is the main culprit. Oocysts are not found on cat fur and are often buried in soil along with cat feces, and soil contact is universal and difficult to avoid [1].

Conclusion

Of the 643 pregnant women enrolled in the study, 230 were Toxo-IgG positive, giving an overall prevalence of 35.77%. Our data shows that *Toxoplasma gondii* infection can be related to educational level, professional status and frequency of raw meat consumption.

Consent statement

Informed consent was obtained from all volunteers pregnant women who fulfilled the eligibility criteria for the study.

Ethical statement

The studies have been approved by the National Ethical Committee on human health research in Cameroon (Ethical clearance N^0 2014/03/425/L/CNESRH/SP) and have been performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

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Table 1: Demographic characteristics of the study participants (n = 643)

Demographic characteristics	Number (%)
Age (years) (Mean = 27.1; SD = 2.51)	
15-20	111 (17.3)
21 – 25	161(25)
26 – 30	155(24.1)
31 – 35	125(19.4)
36-40	70(10.9)
41+	21(3.3)
Educational status	
No formal education	29 (4.5)
Primary	232 (36.1)
Secondary	362 (56.3)
University or beyond	20 (3.1)
Occupation	
Housewives	305 (47.4)
Traders	31 (4.8)
civil servants	77 (11.97)
Students	74 (11.5)
Farmers	156 (24.7)
Gravid status	
Primigravidae	154 (23.95)
Multigravidae	489 (76.05)
Gestational age	
1st trimester	63 (9.8)
2nd trimester	254 (39.5)
3rd trimester	326 (50.7)

Table 2: Variation of *Toxoplasma gondii* seropositivity with educational and professional status in pregnant women (n = 643).

Socio demographic characters	Total tested No (%)	Positive No (%)	Negative No (%)	χ2 ; df	P-value
Educational status					
No formal education	29	13(44.82)	16(55.17)	11.77 ;	0.0082
Primary	232	77(33.18)	155(68.81)	3	
Secondary	362	126(34.80)	236(65.19)		
University or beyond	20	14(70)	6 (30)		
Occupation					
Housewives	305	119 (39.01)	186 (60.98)	13.28 ;	0.0100
Traders	31	8 (25.80)	23(74.19)	4	
civil servants	77	22 (28.57)	55 (71.42)		
Students	74	16 (21.62)	58(78.37)		
Farmers	156	65 (41.66)	91(58.33)		

Table 3: Seropositivity status of the women in accordance of the gestational age.

Gestational age	Total tested No (%)	Total Toxo-IgG+ No (%)	X^2	P value
1st trimester	63 (9.8)	20 (31.74)		
2nd trimester	254 (39.5)	96 (37.79)		
3rd trimester	326 (50.7)	114(34.96)	0.8182	0.6640
Total	643	230 (35.76)		

Table 4: Variation of *Toxoplasma gondii* seropositivity with predisposing risk factors in pregnant women (n = 643).

Toxoplasmosis risk factors	Total tested No (%)	Positive No (%)	Negative No (%)	OR (95% CI)	P value
History of abortion					
Abortion	148	58 (39.18)	90 (60.82)	1.189	0.3813
No abortion	495	172 (34.74)	323 (65.26)	(0.815-1.736)	
Knowledge on toxoplasmosis					
Had knowledge on toxoplasmosis	63	43 (68.25)	20 (31.75)	4.518 (2.585-7.898)	0.0001
Had no knowledge on toxoplasmosis	580	187 (32.24)	393 (67.76)		
Eating raw vegetable and fruits					
Yes	374	145 (38.77)	229 (61.23)	1.371	0.0667
No	269	85 (31.59)	184 (68.41)	(0.9847-1.908)	
Proximity to cats					
Contact with cats	268	92 (34.32)	176 (65.68)	0.8977	0.5594
No contact with cats	375	138 (36.8)	237 (63.2)	(0.6466-1.246)	

Eating raw or undercooked meat					
Yes	156	71 (45.51)	85 (54.48)	0.6170	0.0426
No	487	159 (32.64)	328(67.37)	(0.3900-0.9760)	
Meat consumption					
One meat type	185	76 (41.08)	109 (58.92)	1.376	0.0842
More than one meat type	458	154 (33.62)	304 (66.38)	(0.9686-1.958)	
Frequency of meat consumption					
more frequent	150	50 (33.33)	100 (66.66)	X^2 1.697	0.4281
Frequent	258	100 (38.75)	158 (61.24)		
Rare	235	80 (34.04)	155 (65.95)		

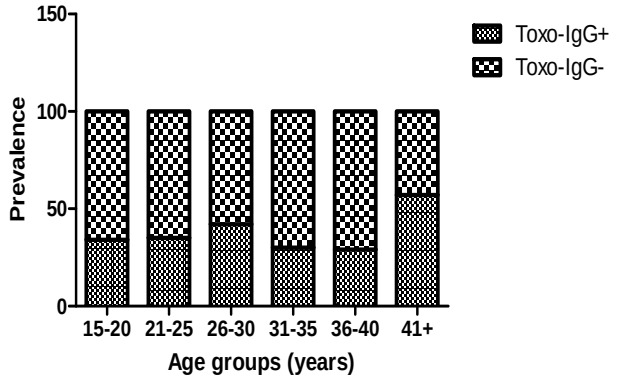

Figure 1: Relationship between age group and *Toxoplasma gondii* seropositivity status in the study population.

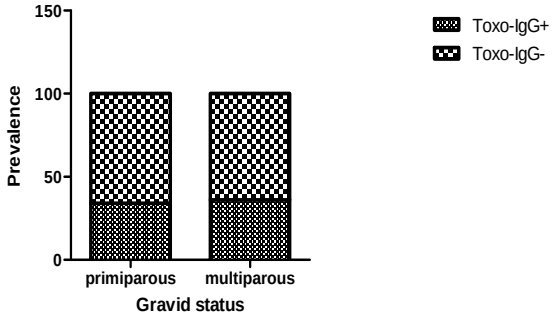

Figure 2: Relationship between gravidity and *Toxoplasma gondii* seropositivity status in the study population.