

Toxoplasmosis knowledge and preventive behavior among pregnant women in the city of Imperatriz, Maranhão, Brazil

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Abstract *The aim of this study was to assess toxoplasmosis knowledge and preventive behavior, and relate these to socioeconomic, pre-natal and environmental issues among pregnant women served by the Family Health Strategy in the municipality of Imperatriz, Maranhão, Brazil. This is a cross-sectional study performed by applying a structured and pre-tested questionnaire to a sample of 239 pregnant women. Only 23.4% of the pregnant women had good knowledge of the disease, primarily in the area of prevention, and 58.9% adopted suitable preventive behaviors. The results obtained show a significant association of various toxoplasmosis risk factors, such as drinking untreated water (OR = 2.1245; IC95% = 1.20-3.73; p = 0.0128), contact with cats (OR = 7.6875; IC95% = 4.22-13.97; p < 0,0001), cleaning cat feces (OR = 6.8738; IC95% = 3.02-15.60; p < 0.0001), eating raw meat (OR = 5.7405; IC95% = 3.21-10.24 and handling sand/cat litter OR = 10.7376; IC95% = 4.64-24.85; p < 0.0001). This shows a need for continued education on toxoplasmosis for the pregnant women seen by the Imperatriz FHS, and for more comprehensive preventive measures, with public health and education policies that take into consideration economic, social, environmental and cultural issues.*

Key words *Toxoplasmosis, Knowledge. Attitude, Pregnant women*

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Introduction

Toxoplasmosis is a global zoonosis caused by *Toxoplasma gondii*¹⁻³, a single-cell obligate protozoa. In a pregnant woman the disease is a serious public health program and the vertical rate of transmission is proportional to the gestational age at first infection, ranging from 6 to 10% in the first trimester to 70 to 90% in the third trimester^{1,4,5}. However, the disease is more serious at the start of gestation^{6,7}, at which time it can cause serious clinical manifestations in the fetus^{8,9}.

T. gondii is one of the microorganisms that can be transmitted perinatally, a group that includes cytomegalovirus, HIV, Herpes simplex, rubella and hepatitis B, among other viruses¹⁰. In light of this possibility, more importance should be assigned to knowledge and prevention of such diseases among pregnant women.

Most of the studies on toxoplasmosis in pregnancy attempt to estimate the prevalence of the disease or infection and the associated risk factors¹⁻³. Knowledge and prevention of toxoplasmosis during pregnancy can contribute to the start of primary prevention activities, which are essential to build public policies^{6,11,12}.

In light of this, some studies have analyzed toxoplasmosis-related knowledge, showing that pregnant women are unaware of how the disease is transmitted and do not adopt preventive behaviors^{11,13,14}. In the US there is little knowledge of the risk factors, even though a large percentage of the pregnant women claim to practice good preventive behaviors¹⁵.

Assuming that healthy behavior is based on a sequential process that starts with acquiring scientifically accurate knowledge, leading to a favorable attitude and adopting healthy practices¹⁶. We find that the lack of knowledge about toxoplasmosis could be significantly associated with disease incidence, and is considered an important risk factor¹⁷.

Given the importance of this disease and its impact on pregnancy, we felt it important to investigate the theme of toxoplasmosis knowledge and preventive behavior among pregnant women in northeast Brazil, specifically in a municipality of the state of Maranhão. This location was chosen in part as it offered the structured logistics of the Family Health Strategy, which aims to develop basic care prevention measures in pre-natal care.

We attempted to answer the following fundamental questions: (1) Are pregnant women potentially at risk for toxoplasmosis, given the low-level of knowledge and failure to take pre-

ventive measures? (2) Are pregnant women adopting disease-prevention behavior?

Method

This is a cross-sectional, analytical, descriptive study employing a quantitative approach. It was performed between June 2016 and February 2017 in the city of Imperatriz-MA (5°31'32" S and 47°26'35" W). The city has some 252,123 inhabitants, 27 primary healthcare units (PHU) and 38 Family Health (FH) teams in the urban perimeter, which is where this study took place. It was approved by the University of the State of Pará Ethics Committee for Research on Human Beings.

The study population consisted of pregnant women under pre-natal care at the PHU and considered by the Ministry of Health as being at risk for infection by *T. gondii* and consequent placental transmission, leading to a congenital form of the disease^{18,19}. The sample "n" is based on the expected 50% frequency of women with knowledge of toxoplasmosis and who display preventive behaviors among the finite population of 876 pregnant women registered in the urban area of Imperatriz in 2016 (source: SIAB, primary care information system). This enabled estimating the parameter with a 5% sample error and 95% confidence level. The ideal size was 275 pregnant women, however five of the primary care units do not use the same routine for pre-natal visits, so we were left with 239 randomly selected pregnant women meeting the inclusion criteria (aged 18 or over, registered with an urban FH team, residing in the district of the respective PHU, willing to sign the Free and Informed Consent Form FICF). We excluded women in their first pre-natal visit and those registered with a PHU in a rural area.

Data was gathered using a structured, pre-tested questionnaire made up of sociodemographic, environmental and pre-natal care questions, as well as questions related to the disease. The questionnaire was comprised of 24 items in four domains to assess knowledge of disease transmission, clinical symptoms, congenital toxoplasmosis and infection prevention^{1,14,15,20}. Closed questions were used with possible answers being True, False or Don't Know. A correct answer in the knowledge section was assigned a score of 1, and an incorrect answer or Don't know was assigned a score of 0.

Additional data, such as the date of first pre-natal care, number of visits and serological

tests during pre-natal care were obtained from the records in the patient card. This field was populated when the card contained the information.

For quantitative analysis of toxoplasmosis knowledge and behavior among pregnant women we applied descriptive and inferential statistical methods. The qualitative variables are presented as absolute and relative frequency distributions. The quantitative variables are presented as central trend and variations. Distribution was assessed using the D'Agostino-Pearson test.

To quantify knowledge and preventive behavior among the pregnant women we assigned a scale that varies with the number of correct answers regarding suitable knowledge and behavior. The knowledge score ranges from 0% (all questions wrong) to 100% (all questions right). The behavioral score ranges from 0% (all inadequate behaviors) to 100% (all adequate behaviors). We defined the level of knowledge as follows: Good ($\geq 70\%$), Fair ($> 51\%$ and $< 69\%$) and Poor ($\leq 50\%$). Behavior was classified as Suitable ($\geq 70\%$), Fair ($> 51\%$ and $< 69\%$) and Poor ($\leq 50\%$). The criteria chosen to indicate pregnant women at higher potential risk for toxoplasmosis was a score of less than 70% in both the knowledge and behavior scales.

In order to assess potential risk, the sample ($n = 239$) was split into two groups: GA (poor or inadequate knowledge and behavior, $n = 84$ - High Risk) and GB (good or adequate knowledge and behavior, $n = 155$ - Low Risk). We applied G and Chi-squared tests, followed by the Odds Ratio test. For rejection of the null hypothesis Alpha was previously set at 0.5 (Alpha Error 5%). For statistical processing we used SAM (Statistical Analysis Model) and BioEstat version 5.3.

Results

Sociodemographic characteristics

The average age of the 239 pregnant women participating in the study was 24.4. Most (77.8%) were married or living with their partner, 41.8% had completed secondary school, 52.3% claimed not to be employed (formally or informally) and 34.3% claimed they did not work to take care of the home. For 77.3% of the subjects, household income ranged from 1 to 2 minimum salaries. The number of people living with them ranged from one to eight. No significant association was found between the group at risk for toxoplasmosis and the sociodemographic variables (Table 1).

Pre-natal characteristics

For 38.1% of the subjects this was their first pregnancy, and the average age of first gestation was 23.9 ± 4.8 . Gestational age ranged from 5 to 40 weeks (average of 26.8 ± 8.0); 6.7% were in the first trimester, 48.9% in the second and 43.9% in the third trimester). The number of visits ranged from one to eight pre-natal visits (average of 4.1 visits). Only 23.0% of the pregnant women went to six or more pre-natal visits. Pre-natal care started on average at 2.5 months of gestation. 86.2% started pre-natal care in the first trimester. A gestational complication was miscarriage, mentioned by 12.6% of pregnant women.

Most of the pregnant women (93.7%) were submitted to toxoplasmosis serology, 62.8% in the first trimester. Only 7.9% had the test more than once. The share of pregnant women by toxoplasmosis risk group does not differ statistically regarding the pre-natal variables (Table 2).

Environmental characteristics

Regarding environmental characteristics, 98.7% of the pregnant women used town water. For drinking water, 64.1% filtered the water (OR = 0.4705; IC95% = 0.27-0.81; $p = 0.0098$), 28.7% were in the group of pregnant women with adequate knowledge and behavior (low risk), whereas 71.3% were in the group with inadequate knowledge and behavior (high risk). 31.6% used untreated water (OR = 2.1245; IC95% = 1.20 - 3.73; $p = 0.0128$). Analyses show that filtering water is a factor of protection against the disease, and using untreated water is a risk factor.

Regarding sewage, 35.1% mentioned being hooked up to the city sewage system, (OR = 0.5323; IC95% = 0.29 a 0.95; $p = 0.0463$) and 4.2% claimed their sewage went directly to rivers or streams (OR = 4.6061; IC95% = 1.15 - 18.30; $p = 0,0434$). There was no significant difference in risk for toxoplasmosis among pregnant women for destination of solid waste and the condition of the street they live on (Table 3).

Knowledge of toxoplasmosis

Most of the pregnant women (55.6%) claimed not to know anything about toxoplasmosis. Those claiming to be aware of the disease said things like: "It's a disease caused by cats" (28.3%), "you get it from cat feces" (17.9%), "you get the disease by eating contaminated food" (5.6%); 64.0% claim they have received no in-

Table 1. Distribution of sociodemographic elements among pregnant women served by the Family Health Strategy in Imperatriz-MA in 2016, classified as GA (poor or inadequate knowledge and behavior - High Risk) and GB (good or suitable knowledge and behavior - Low Risk).

	GA		GB		Total		p-value
	N	%	n	%	N	%	
Marital status**							1,0000(ns)
Single	20	23.8	28	18.1	48	20.1	
Married	35	41.7	69	44.5	104	43.5	
Stable Union	27	32.1	55	35.5	82	34.3	
Separated	1	1.2	1	0.6	2	0.8	
Divorced	1	1.2	2	1.3	3	1.3	
Windowed	0	0.0	0	0.0	0	0.0	
Goes to School*							0.0827(ns)
Yes, goes to school	10	11.9	34	21.9	44	18.4	
Does not go to school	74	88.1	121	78.1	195	81.6	
Years of schooling**							0.3345(ns)
Illiterate	0	0.0	0	0.0	0	0.0	
Primary school grades 1 to 3	1	1.2	0	0.0	1	0.4	
Primary school grades 4 to 7	1	1.2	5	3.2	6	2.5	
Primary school graduate	12	14.3	17	11.0	29	12.1	
Did not finish Secondary School	21	25.0	34	21.9	55	23.0	
Secondary School graduate	38	45.2	62	40.0	100	41.8	
Did not finish university	8	9.5	29	18.7	37	15.5	
University Graduate	3	3.6	8	5.2	11	4.6	
Stated income*							0.7886(ns)
Yes	77	91.7	139	89.7	216	90.4	
No	7	8.3	16	10.3	23	9.6	
Household Income**							0.2656(ns)
Less than 1 minimum salary	7	9.5	12	8.5	19	8.8	
1 minimum salary	35	47.3	49	34.5	84	38.9	
1-2 minimum salaries	25	33.8	58	40.8	83	38.4	
2-3 minimum salaries	5	6.8	19	13.4	24	11.1	
3-4 minimum salaries	1	1.4	4	2.8	5	2.3	
Over 4 minimum salaries	1	1.4	0	0.0	1	0.5	
How many people in household**							0.1446(ns)
Lives alone	6	7.1	8	5.2	14	5.9	
1 or 2 people	23	27.4	44	28.4	67	28.0	
3 or 4 people	51	60.7	82	52.9	133	55.6	
5 or more people	4	4.8	21	13.5	25	10.5	
Ethnicity*							0.8933(ns)
White (Caucasian)	15	20.0	32	21.1	47	20.7	
Black	12	16.0	22	14.5	34	15.0	
Yellow	7	9.3	19	12.5	26	11.5	
Brown	41	54.7	79	52.0	120	52.9	
Religion**							1,0000(ns)
Religion	58	24.3	112	46.9	170	71.2	
Catholic	36	62.1	60	53.6	96	56.5	
Evangelical	22	37.9	51	45.5	73	42.9	
Spiritism	0	0.0	0	0.0	0	0.0	
Umbanda (Afro similar to Santeria)	0	0.0	0	0.0	0	0.0	
Other	0	0.0	1	0.9	1	0.6	

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Table 1. Distribution of sociodemographic elements among pregnant women served by the Family Health Strategy in Imperatriz-MA in 2016, classified as GA (poor or inadequate knowledge and behavior - High Risk) and GB (good or suitable knowledge and behavior - Low Risk).

	GA		GB		Total		p-value
	N	%	n	%	N	%	
Employment status**							0.7778(ns)
Civil servant	3	3.7	6	3.9	9	3.8	
Employed and registered	15	18.5	35	22.6	50	20.9	
Employed and not registered	5	6.2	8	5.2	13	5.4	
Independent	15	18.5	26	16.8	41	17.2	
Employer	1	1.2	0	0.0	1	0.4	
Does not work	45	53.6	80	51.6	123	52.3	
Reason for not working**							1.0000(ns)
Housewife	28	33.3	54	34.8	82	34.3	
Unable to find work	5	6.0	8	5.2	13	5.4	
Unpaid work	0	0.0	0	0.0	0	0.0	
In school	3	3.6	12	7.7	15	6.3	
Ill	1	1.2	0	0.0	1	0.4	
Other	6	7.1	8	5.2	14	5.9	

*The current minimum monthly wage is R\$ 880.00. Tests applied: Chi-squared, G**.

Table 2. Distribution of pre-natal data among pregnant women served by the Family Health Strategy in Imperatriz-MA in 2016, classified as GA (poor or inadequate knowledge and behavior - High Risk) and GB (good or suitable knowledge and behavior - Low Risk).

	GA		GB		Total		p-value	OR	95% CI
	n	%	N	%	N	%			
First pregnancy	42	50.0	73	47.1	115	48.1	0.7693	1.1233	0.66 - 1.91
Previous pregnancies	42	50.0	82	52.9	124	51.9	0.9257	0.9885	0.58 - 1.68
Weeks Pregnant	25±8		26±8		26±8		0.7256	---	---
Number of visits	4±2.1		4±2.2		4.1±2.2		0.8087	---	---
Start of pre-natal care (months)	3.0±2.0		2.5±1.5		2.5±2.0		0.5614	---	---
Complications	13	15.5	19	12.3	32	13.4	0.6181	1.3106	0.61 a 2.80
Miscarriages	14	16.7	16	10.3	30	12.6	0.2267	1.7375	0.80 a 3.76

Tests applied: Chi-squared and Odds Ratio.

structions from healthcare professionals on how to avoid the disease. Among those who received some instruction, 51.2% claim they were told to wash fruits and vegetables very well, not feed cats raw or underdone meat, not have any contact with cats and not have any contact with cat feces. Nurses were the health professionals who most often shared this information (65.1%); 43.9% claimed to know that toxoplasmosis during pregnancy can affect the baby. The problems mentioned were: “mental disease”, “the baby can get it”, “malformation”, “blindness”, “impairment”, “eats their eyes”.

Analyzing knowledge of toxoplasmosis shows that 17 of the 24 items showed a statistically significant relationship with protection factors. There was no significant difference in the groups of pregnant women by toxoplasmosis risk factors and the items in the clinical status domain. There were more correct answers in the prevention area of the knowledge domain than in the disease transmission and congenital toxoplasmosis areas. The total knowledge score ranged from 0 to 22 (out of 24 points). Only 23.4% of the pregnant women had good knowledge about the disease (Table 4).

Table 3. Distribution of housing condition elements among pregnant women served by the Family Health Strategy in Imperatriz-MA in 2016, classified as GA (poor or inadequate knowledge and behavior - High Risk) and GB (good or suitable knowledge and behavior - Low Risk).

	GA		GB		Total		p-value	OR	95% CI
	n	%	n	%	N	%			
Sanitation									
Water use									
Public sewage system	H	98.8	153	98.7	234	98.7	0.4820	0.3529	0.05 - 2.15
Artesian well	0	0.0	2	1.3	2	0.8	0.7628	---	---
Open well	1	1.2	0	0.0	1	0.4	---	---	---
Filtered water	43	52.4	107	70.4	150	64.1	0.0098*	0.4705	0.27 - 0.81
Untreated water	35	42.7	39	25.7	74	31.6	0.0128*	2.1245	1.20 - 3.73
Bottled mineral water	4	4.9	6	3.9	10	4.3	0.9921	1.2417	0.34 - 4.52
Sewage									
Public sewage system	22	26.2	62	40.0	84	35.1	0.0463*	0.5323	0.29 - 0.95
Septic Tank	47	56.0	81	52.3	128	53.6	0.6811	1.1605	0.68 - 1.97
Open air	8	9.5	9	5.8	17	7.1	0.4215	1.7076	0.63 - 4.60
River/Stream	7	8.3	3	1.9	10	4.2	0.0434*	4.6061	1.15 - 18.30
Destination of solid waste									
City waste collection	74	88.1	148	95.5	222	92.9	0.0632	0.3500	0.12 - 0.95
Vacant lot	4	4.8	4	2.6	8	3.3	0.6041	1.8875	0.45 - 7.74
Back yard	1	1.2	1	0.6	2	0.8	0.7628	1.8554	---
Burnt	5	6.0	2	1.3	7	2.9	0.1012	4.8418	0.91 - 25.52
Conditions of the street the live on									
Paved	41	48.8	84	54.2	125	52.3	0.5093	0.8059	0.47 - 1.37
Unpaved	40	47.6	64	41.3	104	43.5	0.4205	1.2926	0.75 - 2.20
Flooded	3	3.6	7	4.5	10	4.2	0.9921	0.7831	0.78 - 3.11

Tests applied: Chi-squared and Odds Ratio.

Toxoplasmosis-related preventive behaviors

Regarding pets, 53.1% of the women claim to have a pet. Of those with cats, 35.3% had more than one cat, and more than half of them (63.6%) were kittens. 38.6% claim they clean up pet feces, none of them using gloves. Over 43.0% of the pregnant women feed their cats raw meat and allow them out of the house (48.8%).

Regarding eating rare meat, 38.1% claim they eat rare meat an average of 1.9 times a week, 5.5% eat rare meat daily. The type of meat eaten most often is beef (72.7%).

Washing fruits and vegetables with water only, and cleaning kitchen utensils were mentioned by 84.% and 24.7% of the pregnant women respectively. Sixteen point three percent of the women mentioned having direct contact with sand/soil, and 48.7% of them had a vegetable garden at home.

Behavior to prevent toxoplasmosis was adopted by 58.9% of the pregnant women, while 41/1% did not present this behavior.

If we compare toxoplasmosis behavior between pregnant women we found a positive association for protection against toxoplasmosis for: = washing kitchen utensils with warm water and detergent after contacting raw meat or unwashed fruits and vegetables (OR = 0.4547; IC95% = 0.25-0.80; $p < 0.0093$) and not going fishing or swimming (OR = 0.4910; IC95% = 0.25-0.94; $p < 0.0488$). However, other behavioral items are associated with disease risk factors, and the proportion of pregnant women by risk for toxoplasmosis group is statistically different regarding these behaviors (Table 5).

Discussion

There have been studies on toxoplasmosis in several parts of the world, given the importance of this disease if acquired during pregnancy. This is the first primary care study that explores toxoplasmosis in relation to knowledge and preventive behavior among pregnant women in the municipality of Imperatriz and in the state of

Table 4. Distribution of knowledge of toxoplasmosis among pregnant women served by the Family Health Strategy in Imperatriz-MA in 2016, classified as GA (poor or inadequate knowledge and behavior - High Risk) and GB (good or suitable knowledge and behavior - Low Risk).

	GA		GB		Total		p-value	OR	CI 95%
	n	%	N	%	N	%			
Risk and transmission factors									
Q1 - Toxoplasmosis is an infectious disease	38	45.2	111	71.6	149	62.3	0.0001*	0.3275	
Q2 - Toxoplasmosis is caused by a toxin	32	38.1	99	63.9	131	54.8	0.0002*	0.3481	0.18 - 0.56
Q3 - Toxoplasmosis can be found in cat feces	53	63.1	127	81.9	180	75.3	0.0022*	0.3769	0.20 - 0.60
Q4 - You can get toxoplasmosis when you clean up cat feces	47	56.0	105	67.7	152	63.6	0.0954	0.6049	0.20 - 0.68
Q5 - Toxoplasmosis can be caused by eating raw or undercooked meat	28	33.3	100	64.5	128	53.6	< 0.0001*	0.2750	0.35 - 1.04
Q6 - Toxoplasmosis can be caused by touching raw meat	17	20.2	34	21.9	51	21.3	0.8883	0.9030	0.15 - 0.48
Q7 - You can get toxoplasmosis by touching sand/soil (garden, yard)	31	36.9	85	54.8	116	48.5	0.0120*	0.4817	0.46 - 1.73
Clinical Status									0.27 - 0.83
Q8- Pregnant women with toxoplasmosis always present symptoms of the disease	15	17.9	45	29.0	60	25.1	0.0808	0.5314	
Q9 - In pregnant women toxoplasmosis can cause fever or "flu-like symptoms"	24	28.6	63	40.6	87	36.4	0.0870	0.5841	0.27 - 1.02
Q10 - In pregnant women toxoplasmosis can cause swollen lymph nodes in the neck and/or body	19	22.6	52	33.5	71	29.7	0.1059	0.5790	0.32 - 1.03
Congenital toxoplasmosis									0.31 - 1.06
Q11 - A pregnant woman can only pass along toxoplasmosis to the fetus if she acquires the disease while she is pregnant	9	10.7	24	15.5	33	13.8	0.4099	0.6550	
Q12 - Women who have toxoplasmosis before they get pregnant will rarely transmit it to the baby	26	31.0	64	41.3	90	37.7	0.1513	0.6374	0.28 - 1.48
Q13 - A baby with toxoplasmosis can be born without any symptoms of the disease	19	22.6	77	49.7	96	40.2	< 0.0001*	0.2961	0.36 - 1.11
Q14 - In newborns, the signs of toxoplasmosis can appear months after delivery	19	22.6	73	47.1	92	38.5	0.0004*	0.3283	0.18 - 0.59
Q15 - Babies with toxoplasmosis can have vision problems	24	28.6	93	60.0	117	49.0	< 0.0001*	0.2667	0.15 - 0.47
Q16 - Toxoplasmosis in pregnant women can be treated	45	53.6	105	67.7	150	62.8	0.0430*	0.5495	0.31 - 0.94
Q17 - Toxoplasmosis in the baby can be treated	38	45.2	103	66.5	141	59.0	0.0023*	0.4171	0.24 - 0.71

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Table 4. Distribution of knowledge of toxoplasmosis among pregnant women served by the Family Health Strategy in Imperatriz-MA in 2016, classified as GA (poor or inadequate knowledge and behavior - High Risk) and GB (good or suitable knowledge and behavior - Low Risk).

	GA		GB		Total		p-value	OR	CI 95%
	n	%	N	%	N	%			
Prevention									
Q18 - Pregnant women who feed cats only cat food can avoid toxoplasmosis	20	23.8	67	43.2	87	36.4	0.0045*	0.4104	0.22 - 0.74
Q19 - Cats who eat rats can cause toxoplasmosis in pregnant women	29	34.5	88	56.8	117	49.0	0.0016*	0.4014	0.23 - 0.69
Q20 - Pregnant women who avoid contact with stray cats can avoid toxoplasmosis	37	44.0	115	74.2	152	63.6	< 0.0001*	0.2738	0.15 - 0.48
Q21 - Pregnant women who allow others to replace the cat litter can avoid toxoplasmosis	30	35.7	92	59.4	122	51.0	0.0008*	0.3804	0.21 - 0.65
Q22 - Cat litter should be replaced daily	53	63.1	121	78.1	174	72.8	0.0198*	0.4804	0.26 - 0.86
Q23 - Pregnant women who eat well-done meat can avoid toxoplasmosis	48	57.1	110	71.0	158	66.1	0.0442*	0.5455	0.31 - 0.94
Q24 - Carefully washing and peeling all fruits and vegetables before eating can avoid toxoplasmosis	51	60.7	125	80.6	176	73.6	0.0014*	0.3709	0.20 - 0.67

Tests applied: Chi-squared and Odds Ratio.

Maranhão. The importance of the theme derives from the fact that unawareness of the disease and failure to engage in toxoplasmosis prevention behavior can increase the risk of becoming ill^{10,12,20}.

Many authors claim sociodemographic factors reveal risk factors for toxoplasmosis. These include low income^{12,21} and few years of schooling^{3,10}. However, unlike previous studies, in this case we found no significant association between sociodemographic factors and toxoplasmosis. Most (42.7%) of the pregnant women in this study were between the ages of 18 and 22, and 41.8% had completed secondary school. The vast majority (83.3%) came from households with incomes of between 1 and 2 minimum salaries. These results are very close to those in a similar study in the state of Tocantins, which also found no correlation between toxoplasma infection and age, years of schooling or origin².

It is important to point out that although there is no statistical association with demographic profiles, previous reports show that education is an important risk factor for *T. gondii*

infection. As a rule, people with more years of schooling have more knowledge of infection and prevention². Another study in Rio Grande do Sul shows that fewer years of schooling and pre-natal care in the public healthcare system are associated with less information about the disease among pregnant women²².

Even though years of schooling did not show any significant association with risk of infection, a study in Niteroi-RJ showed that completing secondary was a factor of protection against a positive serum test for *T. gondii*⁸. Most of the pregnant women in this study claimed to have completed secondary school, which may be associated with more information about toxoplasmosis prevention.

Pre-natal care is considered the best time to implement measures to prevent diseases capable of maternal-fetal transmission, such as toxoplasmosis^{3,23}. The first pre-natal visit should be as early as possible, and pregnant women should go to at least 6 pre-natal visits, as per Ministry of Health²⁴ recommendations, which to a large

Table 5. Distribution of toxoplasmosis prevention behavior among pregnant women served by the Family Health Strategy in Imperatriz-MA in 2016, classified as GA (poor or inadequate knowledge and behavior - High Risk) and GB (good or suitable knowledge and behavior - Low Risk).

	GA		GB		Total		p-value	OR	CI 95%
	N	%	N	%	N	%			
Contact with animals	72	85,7	55	35,5	127	53,1	< 0,0001*	10,9091	5,44 a 21,8
Cats	56	66,7	32	20,6	88	36,8	< 0,0001*	7,6875	4,22 a 13,97
Cats around the home	4	4,8	5	3,2	9	3,77	0,8105	1,5000	0,39 a 5,74
Birds	4	4,8	3	1,9	7	2,93	0,4035	2,5333	0,55 a 11,59
Litter of kittens	4	4,8	2	1,3	6	2,51	0,2283	3,8250	0,68 a 21,33
Dogs	46	54,8	38	24,5	84	35,1	< 0,0001*	3,7271	2,11 a 6,55
Dogs running loose in street	27	32,1	9	5,8	36	15,1	< 0,0001*	7,6842	3,40 a 17,34
Cleaning cat feces	25	29,8	9	5,8	34	14,2	< 0,0001*	6,8738	3,02 a 15,60
Uses glove to clean feces	0	0,0	0	0,0	0	0	---	---	---
Gats under a year old	39	46,4	17	11,0	56	23,4	< 0,0001*	7,0353	3,63 a 13,63
Cat goes outside	33	39,3	10	6,5	43	18	< 0,0001*	9,3824	4,31 a 20,38
Cat eats raw meat	27	32,1	11	7,1	38	15,9	< 0,0001*	6,2010	2,88 a 13,32
Does not own cats but cats appear	4	4,8	3	1,9	7	2,93	0,4035	2,5333	0,55 a 11,59
Eats raw or rare meat	54	64,3	37	23,9	91	38,1	< 0,0001*	5,7405	3,21 a 10,24
Beef	50	59,5	30	19,4	80	33,5	< 0,0001*	6,1275	3,39 a 11,05
Pork	2	2,4	9	5,8	11	4,6	0,3771	0,3957	0,08 a 1,87
Chicken	10	11,9	9	5,8	19	7,95	0,1575	2,1922	0,85 a 5,62
Lamb	0	0,0	0	0,0	0	0	---	---	---
Other meats	1	1,2	3	1,9	4	1,67	0,9208	0,6104	---
Eats raw fruits and vegetables	76	90,5	136	87,7	212	88,7	0,6719	1,3272	0,55 a 3,17
Washes fruits and vegetables before eating them	70	83,3	132	85,2	202	84,5	0,8527	0,8712	0,42 a 1,79
Eats raw ground beef	0	0,0	2	1,3	2	0,84	0,7628	0,0000	---
Washes kitchen utensils after contact with raw meat and with unwashed fruits and vegetables									
Washes with water	29	34,5	30	19,4	59	24,7	0,0147*	2,1970	1,20 a 4,00
Washes with warm water and soap	49	58,3	117	75,5	166	69,5	0,0093*	0,4547	0,25 a 0,80
Does not wash	6	7,1	8	5,2	14	5,9	0,7381	1,4135	0,47 a 4,22
Drinks unpasteurized milk	41	48,8	55	35,5	96	40,2	0,0618	1,7336	1,01 a 2,97
Boils the milk	38	45,2	52	33,5	90	37,7	0,1008	1,6363	0,94 a 2,81
Cow's milk	40	47,6	55	35,5	95	39,7	0,0907	1,6529	0,96 a 2,83
Goat's milk	1	1,2	0	0,0	1	0,42	---	---	---
Eats artisanal sausage	59	70,2	86	55,5	145	60,7	0,0366*	1,8935	1,07 a 3,33
Eats fresh cheese	69	82,1	85	54,8	154	64,4	< 0,0001*	3,7882	1,99 a 7,19
Handles sand/soil	31	36,9	8	5,2	39	16,3	< 0,0001*	10,7376	4,64 a 24,85
Goes fishing or swimming in river	20	23,8	16	10,3	36	15,1	0,0095*	2,7148	1,32 a 5,58
Goes fishing or swimming in lake	0	0,0	0	0,0	0	0	---	---	---
Goes fishing or swimming in reservoir/dam	1	1,2	4	2,6	5	2,09	0,8075	0,4548	0,05 a 4,13
Does not normally go fishing or swimming	62	73,8	132	85,2	194	81,2	0,0488*	0,4910	0,25 a 0,94
Prepares food	53	63,1	101	65,2	154	64,4	0,8595	0,9141	0,52 a 1,58
Does not prepare food	4	4,8	12	7,7	16	6,7	0,4525	0,5958	0,19 a 1,90
Sometimes prepares food	27	32,1	42	27,1	69	28,9	0,5013	1,2744	0,71 a 2,27
Has a vegetable garden at home	12	14,3	7	4,5	19	7,95	0,0157*	3,5238	1,33 a 9,33

Tests applied: Chi-squared and Odds Ratio.

extent is the number of visits among the pregnant women in the study sample. The average number of pre-natal visits was 4.1 and, for the most part, pre-natal care started in the first trimester (86.2%)/ Only 23.0% of the women in the sample went to six or more visits. The number of visits in the present study was smaller than those found in studies conducted in Belo Horizonte and Goiânia, where the average was 7^{25,26}.

It was encouraging to find that 62.8% of the pregnant women were tested for toxoplasmosis in the first trimester, a far larger number than in Belo Horizonte (34.7%)²⁵, Mato Grosso do Sul (35.4%)²⁷ and Goiânia (54.6%)²⁶.

Although this study found no significant association with pre-natal variables, the percentages reflect that starting pre-natal care in the first trimester is essential, including serology tests for early identification of acute gestational toxoplasmosis. Pregnant women with a negative test in the first trimester should repeat the test in the second trimester¹⁹. These guidelines are in disagreement with the data revealed in this study, where only 7.9% of the pregnant women were tested a second time. Furthermore, it is assumed that the more pre-natal visits the more information pregnant women will receive regarding congenital toxoplasmosis, risk factors and prophylaxis^{25,26}.

Regarding environmental conditions, we found a significant association between drinking untreated water and sewage discarded in rivers/streams as a risk factor for toxoplasmosis. Drinking treated and filtered water and sewage disposal in a city sewage system were considered factors of protection against the disease, unlike other studies that found no significant association between sanitation and the pregnant women in the study^{1,2,11}.

The fact that the pregnant women in our sample drank potable water differs from the results of a study performed in Michelena, Venezuela where more of the participants drank non-potable water²⁸, a fact associated with a 4.5 times larger risk of infection by *T. gondii*²⁹. In fact, there are numerous reports of toxoplasmosis outbreaks in Brazil and elsewhere in the world where water was associated as a factor for infection by *T. gondii*. Town water contamination with the feces of infecting cats disseminates oocytes, potentially leading to epidemics^{8,30,31}.

The analysis was also negative regarding lack of general knowledge, given that only 44.4% of the interviewees had read about, seen or heard about the disease. Looking each domain of knowledge of toxoplasmosis in the study, the

number of pregnant women with good knowledge was Quite small (23.4%).

Similar studies show limited knowledge on parasite infections, such as the study in the state of Paraná, where most pregnant women were unaware of measures to prevent congenital toxoplasmosis¹¹, and in Belo Horizonte, where fewer than 10% of the pregnant women were aware of the disease²⁵.

Knowledge of toxoplasmosis among pregnant women was also the topic of study in three Asian countries, where most interviewees did not know or were unsure about infection with toxoplasma¹⁰. The same is true among pregnant women in the United States¹⁵.

Another important piece of evidence was the small percentage (36.0%) of pregnant women receiving instructions regarding toxoplasmosis. This corroborates other studies with a smaller percentage of women receiving instructions^{7,25}. In terms of knowledge of toxoplasmosis risk and transmission factors, the number of correct answers, statistically associated with protection against the disease, was largest (75.3%) the item "toxoplasmosis can be found in cat feces". Andippan *et al.* (2014) showed that only 19.4% of the pregnant women interviewed correctly identified contact with cat feces as the main mechanism of toxoplasmosis transmission¹⁰. In a study conducted in the US, 61.0% of the pregnant women associated cats with toxoplasmosis transmission, but only 30.0% were aware of the risk of infection from consuming raw or rare meat¹⁵.

The item with the largest number of correct answers in the congenital toxoplasmosis domain were "toxoplasmosis can be treated in pregnant women and in the newborn". Even though these are statistically considered as a protective factor, it is likely that the pregnant women were encouraged to provide a correct answer by believing that the disease is treatable, regardless of pregnancy. Still in this domain, 39.0% of the pregnant women were aware that toxoplasmosis can lead to vision problems in the infant. A study of pregnant teenagers found little knowledge regarding the problems it can cause to the infant²⁰.

Among the domains investigated, there was more knowledge of prevention, estimated as a statistically significant protection factor. Pregnant women mentioned that washing and peeling all fruits and vegetables before eating them and thoroughly cooking meats can avoid toxoplasmosis. Most were aware of the role of cats and cat litter in disease prevention. Contrary to the results of the present study, in the study

of pregnant women conducted in the state of Paraná there was a lack of knowledge of preventive measures against congenital toxoplasmosis¹¹. Pregnant women in the Netherlands mentioned that not changing the cat litter, not eating under-done meats and washing and peeling fruits and vegetables can help prevent toxoplasmosis¹³.

Although there is a lack of knowledge of toxoplasmosis in several of the items investigated in this study, the pregnant women claim to practice behaviors that help avoid toxoplasmosis. In general, this study shows that pregnant women have a good amount of knowledge of preventive measures. This was corroborated by a study in the US, where most of the pregnant women interviewed revealed correct preventive measures to avoid infection¹⁴. Some studies show that suitable knowledge of toxoplasmosis risk factors supports preventive behaviors against severe complications resulting from congenital infection, and that it is only this knowledge that enables pregnant women to reduce the risk of fetal infection^{10,14}.

Another analysis of the potential risk for toxoplasmosis revealed that a significant number of the pregnant women (n = 155) had good or suitable knowledge and behavior (>70%). Although most did not receive suitable instructions regarding the disease during pre-natal care, it is likely that the pregnant women behaved appropriately as they were aware of the possibility of contracting an infectious disease during pregnancy, a fact that helped determine changes in behavior as normally women take better care of themselves when they are pregnant^{13,32}. Since most of the pregnant women claimed good preventive behavior, we wonder if these women were motivated to answer correctly as they are enrolled in a healthcare unit¹⁵.

Understanding the preventive behavior of pregnant women can help provide advice, which is essential to reduce fetal risk¹⁴. In this study, contact with cats and dogs was similar to that reported in other studies, with a statistically significant association with the risk of toxoplasmosis^{2,8,33}. However, another study of pregnant women revealed different results, finding no association between contact with cats and the possibility of infection with *T. gondii*³⁴.

Among pregnant women who had contact with cats and picked up their feces, none used gloves for this, which is considered a strong risk factor for infection. Unlike the results of the pres-

ent study, Costa et al.¹² reported that pregnant women used gloves to clean cat litter boxes. Contact with kittens was statistically associated with toxoplasmosis transmission, likely increasing the risk of infection as infected kittens eliminate millions of oocytes, which can remain in the environment, sporulate and become infecting^{34,35}.

Another behavior considered a statistically significant risk is eating rare or poorly cooked beef, and artisanal sausage. Infection with toxoplasmosis during pregnancy is strongly associated with consumption of rare or raw beef^{33,36}, and although more than half the pregnant women claimed to be aware of this, only a small percentage said they avoided this behavior. A study in northeast Brazil failed to show any association between a positive serum test for *T. gondii* in pregnant women and artisanal sausage¹.

Contact with soil and having a vegetable garden at home were associated with the risk of infection with toxoplasmosis. The habit of handling soil or sand should also be considered for infection with toxoplasmosis^{34,36}. Unlike the present study, results in Niterói (Rio de Janeiro) found no such association⁸, although it is widely mentioned in the literature as a risk factor for the disease. Washing kitchen utensils with warm water and soap is statistically associated with protection against the disease. Similar results were found among Saudi Arabian pregnant women¹⁴.

Studies on this theme have shown that toxoplasmosis education increased knowledge of the disease and prevention among pregnant women^{12,14,32}. In Belgium, there was a significant decrease in toxoplasmosis seroconversion after intense counseling of pregnant women was instituted³⁷.

This study provides information to better understand toxoplasmosis knowledge and preventive behavior among pregnant women in the region. It also reiterates the importance of continued health education in this target group, as suitable awareness about health and toxoplasmosis can help decrease the incidence of the disease and the burden of the effects of congenital toxoplasmosis¹⁰. Health education in infectious diseases is essential from the very start of pre-natal care, especially for those with severe complications such as toxoplasmosis, in the form of campaigns, lectures and other educational programs to teach women how to avoid contact with potentially contaminated materials^{3,15,32}.

Conclusion

In general, there was limited knowledge among the interviewees of this study, however a considerable number was aware of measures to prevent and avoid toxoplasmosis during pregnancy. Most of the pregnant women practiced suitable preventive behaviors, in particular food hygiene (washing kitchen utensils with warm soap and water after contact with raw meats or unwashed fruits and vegetables) and refraining from swimming or fishing. However, non-preventive behaviors are strongly associated with risk factors such as contact with cats, eating raw or rare meat, contact with kittens in the home, cleaning cat feces or handling cat litter.

Sociodemographic and pre-natal characteristics show no significant association with the risk of toxoplasmosis among pregnant women. However, this does not exclude the possibility that these may facilitate contact with *T. gondii* during

pregnancy. Among environmental conditions, drinking untreated water and sewage disposed of in rivers and/or streams are important risk factors for disease transmission.

Given the limited amount of knowledge of the disease, continued education on toxoplasmosis and other infectious diseases with the potential for congenital transmission for pregnant women seen by the primary care system would be helpful for disease prevention and hence congenital toxoplasmosis.

It is important to stress the need for serological follow-up of pregnant women as a routine in healthcare units, where pregnant women will receive more detailed instructions from healthcare professionals on the importance of this test, risk factors and preventive behaviors. Furthermore, more comprehensive preventive measures are required, with public healthcare and education policies that bear in mind economic, social, environmental and cultural aspects.

Collaborations

IPS Moura helped design the study, field work, data tabulation, analyses and drafting. CNC Bichara helped design, analyze and draft the article, and approved the version for publication. IP Ferreira and AN Pontes did a critical review of the article.

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