

Serology of *Toxoplasma gondii* in academics of the 2nd year of medicine and its prevalence depending on eating habits



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ABSTRACT

Toxoplasma gondii, the etiological agent of toxoplasmosis, is an obligate intracellular parasite, opportunistic, with worldwide distribution, with the cat as the definitive host and the main responsible for transmitting the parasite through feces. The aim of this research is to find out through the data what are the possible means of contamination and how we can prevent these forms of transmission. This research was conducted at the Universidad Central del Paraguay - Ciudad del Este, Paraguay, during the period of 2021. A total of 114 students from the 2nd year of the medical career were evaluated, evaluated by the Microbiology Chair. The Rapid Test was carried out for the detection of anti-*Toxoplasma Gondii* antibodies, in addition to presenting a questionnaire to the students to assess their knowledge about the disease and foster research, the questionnaire covers questions to assist in the exploration of the subject were they about, the foods consumed, sausage or raw, drinking water intake, if there are cats near your home, if you sleep with pets, knowledge about the disease, family history of toxoplasmosis, form of transmission, clinical manifestations, among others. The serum prevalence found in this research was low, but it was noted that most of the students investigated have bad eating habits such as the consumption of vegetables and foods with poor hygiene, which may be associated with seropositivity for toxoplasma infection, thus encouraging methods for the prevention of the disease is extremely important since it allows us to understand the associated risk factors and develop strategies for the awareness of the general population.

Keywords: *Toxoplasma gondii*, Medical students, Serology, Food, Prevention.



1 INTRODUCTION

Toxoplasmosis is a disease characterized by affecting several organs, caused by the parasite *Toxoplasma gondii*¹, one of the zoonoses (diseases transmitted between animals and people), with the greatest spread throughout the world², where it has already been discovered in thousands of species including mammals and even birds, including some cold-blooded animals^{3,4}. If this parasite ends up contaminating individuals with a resistant immune system, it becomes a self-limiting and benign disease, since about 70% of the population has active serology for toxoplasmosis IgG, but it can be serious and even fatal if it infects immunocompromised people, adolescents and children through maternal-fetal transmission³.

The discovery of this parasite occurred in 1908 by Nicolle and Manceaux in *Ctenodactylus gondii*, a rodent, and soon in São Paulo, Brazil, the same microorganism was isolated in a rabbit, by Alfonso Splendore and other pioneers of parasitology research.⁵ After a period of discoveries, it was analyzed that this disease caused other complications such as congenital meningoencephalitis, myocarditis, myositis^{6,7}. It usually affects several different tissues since the microorganism has a tropism for the lungs, heart, lymphoid organs, CNS and eye.⁸ This disease also affects children who have no obvious clinical signs at birth.⁹

2 SOURCES OF INFECTION AND FORMS OF TRANSMISSION

This disease does not present itself definitively in humans, but in other mammals and birds as hosts^{6,8}, felines, from the domestic class, such as cats, to wild ones, such as tigers and lions, represent part of this population¹⁰. They are the environment conducive to sexual reproduction, and the possible dissemination of oocysts (infective form of the parasite) of the disease through feces², humans and other animals are intermediate hosts^{6,8}. As the cat is the living being that is most in contact with the population, it is believed that it is responsible for the transmission of the disease, however, it is necessary to understand that for the disease to propagate it is necessary some factors such as: being with depressed immunity, that is, sick, and also the oocysts released need to stay at least 3 days in the environment receiving heat and humidity necessary to sporulate and become a potential infector. In this way, the correct hygiene of litter boxes, good food and daily care of the pet reduces the risk of transmission.¹⁰

However, even though humans are not its definitive host, *Toxoplasma* is capable of causing worrying conditions in immunosuppressed people, pregnant women or very young individuals, in addition to these, contamination can still be a risk factor for professionals who may have contact with the parasite, such as doctors, veterinarians and butchers, who are consequently subject to contamination². The most frequent form of infection is the consumption of contaminated food or water, known as: Acquired Toxoplasmosis¹¹, occurs due to inappropriate food intake, such as vegetables, fruits and vegetables without proper preparation and hygiene, unpasteurized dairy products, uncooked eggs, and



is more common in scenarios of eating raw, undercooked or low-quality sausages¹⁰. Another means of transmission is Congenital Toxoplasmosis, which occurs vertically or transplacentally, when the pregnant woman is infected during or shortly before pregnancy or when there is prolonged immunosuppression, leading to susceptibility to reactivation and acute manifestation of toxoplasmosis. In addition to these, contamination can also occur through organ transplantation, blood transfusion, or laboratory accident^{3,5,7}.

3 CYCLE

The life cycle of *T. gondii* is well known, there are three main stages of the development of this parasite, namely tachyzoites, bradyzoites and sporozoites^{3,8}, which develop in two distinct phases: asexual phase and sexual phase²⁰. The Asexual phase is an intracellular process that occurs in the infected host, the parasite reproduces asexually by simple cell division generating tachyzoites that proliferate rapidly and destroy the host's cells during an acute infection, usually the host limits the growth of the parasite and keeps the infection under control^{3,8,12}. This stage is not responsible for the formation of oocysts and transmission to felines.²⁰ In the sexual phase of *T. gondii*, the intestine of cats and other felines is affected, and the formation of oocysts, structures that contain the male and female gametes of the parasite¹², occurs. Sporozoites develop inside the oocysts, which are excreted in the feces of infected cats^{3,6,9}

After the direct ingestion of these foods contaminated with animal feces, the oocysts will form bradyzoites in the tissues of the host⁴, these bradyzoites slowly multiply into tissue cysts, and can be found during chronic infection developing slowly in some organs such as the retina, brain, skeletal and cardiac muscles, among other organs. This parasite has a very complex biological cycle that begins when oocysts are released into the environment by cat feces and are ingested by people⁷; that is, their reproduction occurs in the intestine of a contaminated cat, which eliminates the oocysts in the feces and contaminates the environment. Humans are infected by direct ingestion of these foods. The host cell dies and releases tachyzoites, which invade adjacent cells and continue the process, bradyzoites and form tissue cysts, especially in skeletal muscle, myocardium and brain. These cysts can remain latent throughout the life of the host³.



4 SEROLOGY

We know that the immune system engages in a constant battle against an invader on a daily basis, it is in this battle that the parasite uses various strategies to defeat the host's defense troops and establish a lasting infection, while the host tries to respond to all these strategies to eliminate this evil, and prevent it from settling and causing damage.¹³ The immune response against *T. gondii* has been the focus of several studies carried out in recent decades, so that the participation of several immune cells and molecules has already been described in the control of infection by this parasite.^{12,13,33,34,35}

Until the advent of molecular biology techniques, the etiological diagnosis of toxoplasmosis was based almost exclusively on the detection of specific antibodies in serum, with inoculation techniques in mice being reserved.⁸ Thus, the diagnosis of toxoplasmosis is complex, and in some cases it is difficult to differentiate between acute and chronic infection, where the search for clinical manifestations and confirmation through serological studies is essential, based on indirect methods, such as serology, and on methods of direct detection of the parasite.^{14,29,30,31,32} In this study, the objective was to focus on indirect methods where there are several serological tests available for the detection of IgA, IgE, IgG and IgM immunoglobulins specific against *T. gondii*, detected in whole blood, plasma, but mainly in serum. Antibodies of the IgA, IgE and IgM classes (depends) are markers of recent or acute infection, while IgG antibodies are markers of past, chronic or latent infection.¹⁵ IgG antibodies appear after 1 or 2 weeks of infection where their levels slowly increase until they reach 4 to 6 months where their maximum peak occurred and again will have a slight drop, leaving circulating IgG levels for the rest of the individual's life. IgM antibodies appear after a primary infection by the parasite and can be detected in the first seven days, but it has been shown that these antibodies are gradually related to the peak of infection that occurs about one to two months after infection, but it can be uncertain and circulating levels of antibodies appear after months or years. Therefore, care should be taken when saying that IgM indicates a recent infection, whereas IgA antibodies are serological markers of recent infection, as they are produced only during the acute phase of a primary infection, before IgG antibodies, and are not observed during chronic infection, so they are excreted seven to ten days after infection and their levels are undetectable.¹¹ Therefore, the choice of the test and its interpretation should be associated with the clinic and the host investigated.^{15,20,22,26,27,28}

5 PROCEDURE FOR OBTAINING THE SAMPLE

A rapid test for the qualitative detection of IgG and IgM against *Toxoplasma Gondii* was obtained in blood samples performed by capillary puncture by medical students, who voluntarily participated in the research, in order to find out if they had contact with the disease and to obtain the results of the serological prevalence of *T. gondii* in the students. To obtain the sample, the Toxo IgG/IgM Combo Caset Test, lateral flow chromatographic immunoassay, blood sample from the distal



phalanges of the middle or ring finger was used. For the puncture, the skin was perforated with sterile lancets, the blood ran until it formed a complete drop and transferred to the rapid test, where for each drop of blood 2 drops of reagent were added, the timer was activated for 15 minutes, so that the lines of investigation appeared. The samples and materials used were properly disposed of after use.

6 APPLICATION OF THE QUESTIONNAIRE

A questionnaire was applied to the students in order to know their coexistence with animals with toxoplasmosis, their eating habits and knowledge about the disease. Students who had never had contact with the parasite had negative IgG and IgM tests in their tests, those who had a past infection had positive IgG and negative IgM results, and those with current acute *T. gondii* infection showed positive IgG and positive IgM.

7 COLLECTION RESULTS

In the table below, we can verify the data of the sample collected, and transferred to the respective work, identifying key points for diagnosis, risk factors, and history.

TABLE-1 Number of samples and their respective characters.

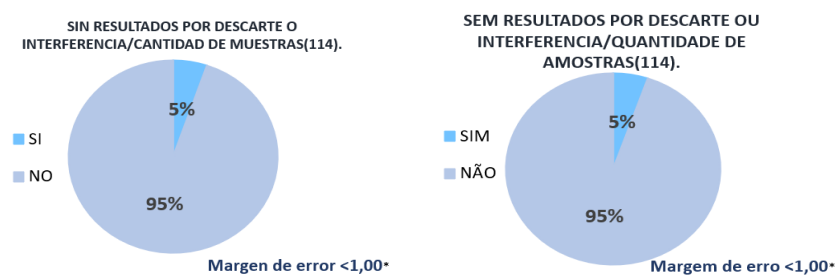
Question Title	Number	Yes	Percentage	No	Percentage
CATS AROUND THE HOUSE/ NUMBER OF SAMPLES(114). ²¹	1	56	49,12%	58	50,87%
CATS INSIDE THE HOUSE/ NUMBER OF SAMPLES(114). ²¹	2	23	20,19%	91	70,91%
DUERME WITH MASCOTS/ QUANTITY OF SAMPLES(114). ²¹	3	26	22,80%	88	77,19%
DRINK RUNNING WATER/ QUANTITY OF SAMPLES(114). ²¹	4	53	46,49%	61	53,50%
CONSUME RAW VEGETABLES/ QUANTITY OF SAMPLES(114). ²¹	5	92	80,70%	22	19,29%
CONSUME SEMI-RAW MEAT/ QUANTITY OF SAMPLES(114). ²¹	6	44	38,59%	70	61,40%



CONSUMPTION OF SAUSAGES/ QUANTITY OF SAMPLES(113). ²¹	7	86	75,43%	27	23,68%
HISTORY OF TOXOPLASMOSIS/ NUMBER OF SAMPLES(113). ²¹	8	14	12,28%	99	86,84%
KNOWLEDGE ABOUT THE DISEASE/QUANTITY OF MOSTRAS(113). ²¹	9	75	65,78%	38	33,33%
KNOWLEDGE ABOUT THE FORMS OF TRANSMISSION/QUANTITY OF SAMPLES(113). ²¹	10	86	75,43%	27	23,68%
KNOWLEDGE ABOUT CLINICAL MANIFESTATIONS/ NUMBER OF SAMPLES(113). ²¹	11	68	59,64%	45	39,47%
IGG/QUANTITY OF SAMPLES(106). ²¹	12	32	28,07%	74	64,91%
IGM/SAMPLE QUANTITY(108). ²¹	13	7	6,14%	101	88,59%

Margin of error to < 1.00*
Source: Material from the research.

No results by discard or interference. ²¹	6 Models	5.26% of the total number of samples, 114.
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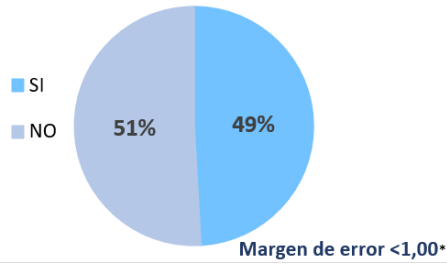


8 RESULTS

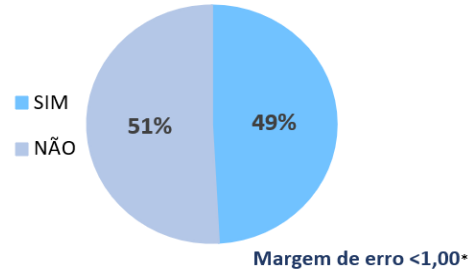
Among the analysis of the samples, we can observe that, in the first question where it addresses contact with cats around their homes, there were about 56 students who said that yes they have contact with cats around their homes, corresponding to 49.12% and 58 who did not correspond to 50.87%.



GATOS ALREDEDOR DE LA CASA/CANTIDAD DE MUESTRAS(114).

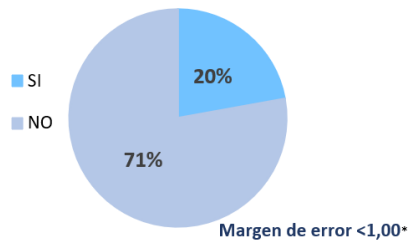


GATOS AO REDOR DE CASA/QUANTIDADE DE AMOSTRAS(114).

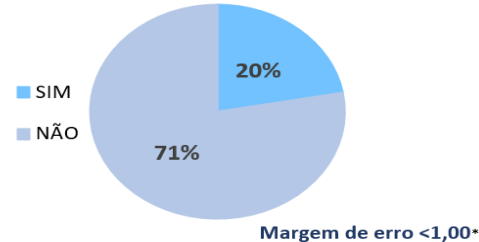


In the analysis of cats inside the house, it was observed that 23 students have the animal inside their homes, corresponding to 20.19% of the total samples, which are 114, and 91 students said that it was not referred to as 70.91%.

GATOS DENTRO DE LA CASA/CANTIDAD DE MUESTRAS(114).

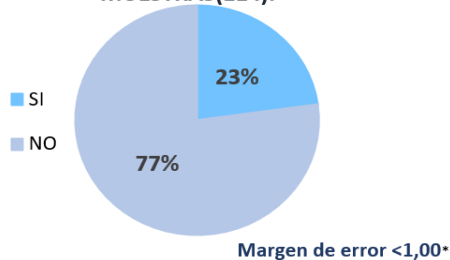


GATOS DENTRO DE CASA/QUANTIDADE DE AMOSTRAS(114).

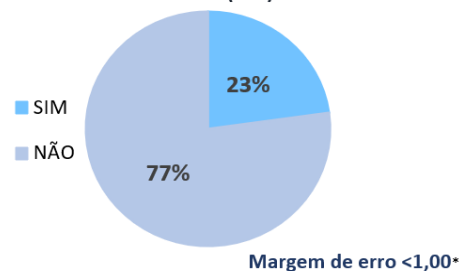


In question number three, which addresses the contact of animals during sleep, it was revealed that 26 students sleep with pets, being referred to as 22.80% of the general sample of 114 students, and 88 students said that they do not sleep with pets, corresponding to 77.19%.

DUERME CON MASCOTAS/CANTIDAD DE MUESTRAS(114).



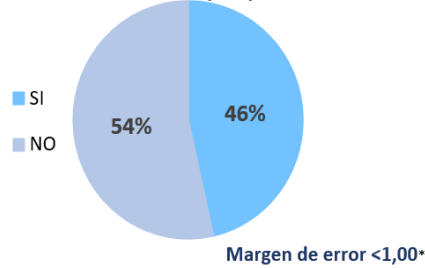
DORME COM MASCOTES/QUANTIDADE DE AMOSTRAS(114).



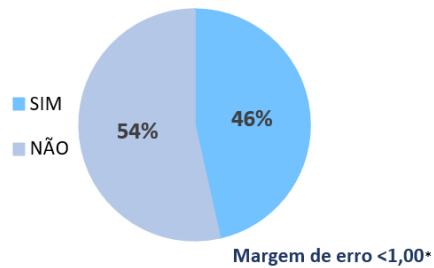
When approaching the students in the fourth question, where the intake of running water was evaluated, it was evidenced that 53 students or 46.49% of the total sample, of which 114 students were analyzed, drink running water, and 61 of the interviewees do not drink water from a corresponding running source in 53.50%.



BEBE AGUA CORRIENTE/CANTIDAD DE MUESTRAS(114).

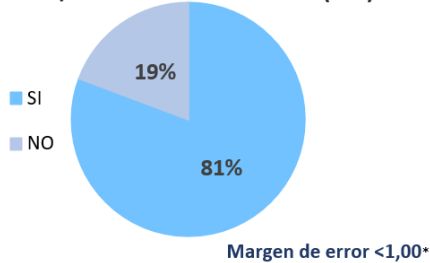


BEBE AGUA CORRIENTE/QUANTIDADE DE AMOSTRAS(114).

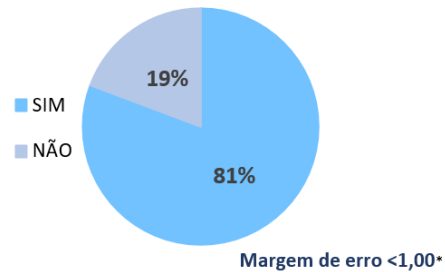


In question number five, the intake of raw vegetables was questioned, where 92 students said that they ingested raw vegetables, corresponding to about 80.70% of the general sample, which is 114, and 22 students said that they do not make or ingest raw vegetables, being referred to 19.29%.

CONSUME VERDURAS CRUDAS/CANTIDAD DE MUESTRAS(114).

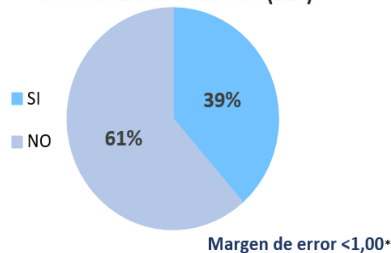


CONSUME VERDURAS CRUAS/QUANTIDADE DE AMOSTRAS(114).

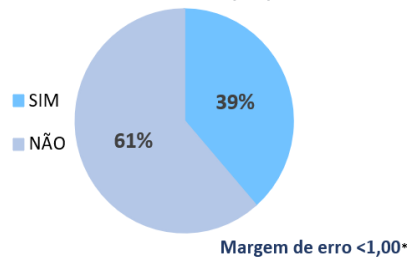


In the question of consumption of semi-raw meat, it was evaluated that 44 of the 114 samples confirmed the consumption of raw meat, corresponding to about 38.59%, and 70 samples claimed the non-consumption of raw meat, corresponding to 61.40% of the sample.

CONSUME CARNE SEMICRUDA/CANTIDAD DE MUESTRAS(114).



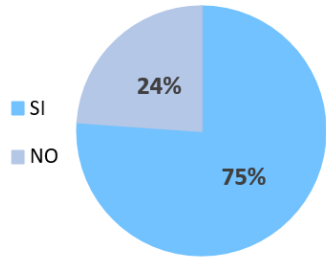
CONSUME CARNE MALPASSADA/QUANTIDADE DE AMOSTRAS(114).



In the point evaluated by the consumption of sausages, we can confirm that 86 samples confirmed their consumption and ingestion, corresponding to 75.43% and 27 said that it was not evidenced by 23.68% of the 113 samples.

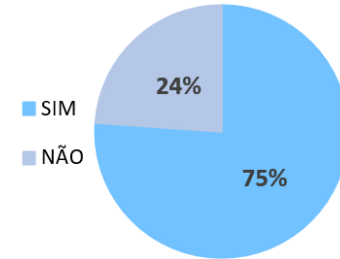


CONSUME EMBUTIDOS/CANTIDAD DE MUESTRAS(113).



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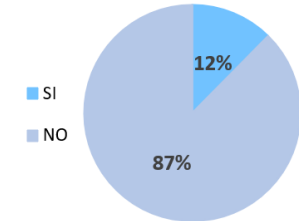
CONSUME EMBUTIDOS/QUANTIDADE DE AMOSTRAS(113).



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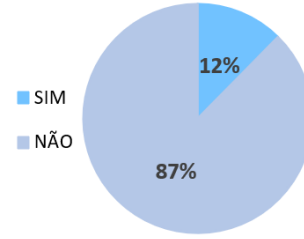
At the point of history of toxoplasmosis, 14 were confirmed, corresponding to 12.28% of the 113 samples, and 99 had no antecedents, being quantified in 86.84%.

ANTECEDENTE DE TOXOPLASMOSIS/CANTIDAD DE MUESTRAS(113).



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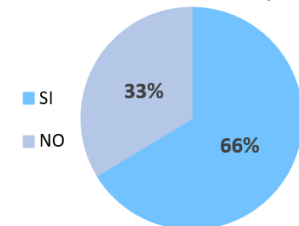
POSSUI ANTECEDENTES DE TOXOPLASMOSE/ QUANTIDADE DE AMOSTRAS(113).



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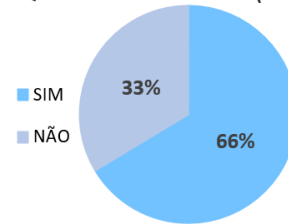
Regarding knowledge of the disease, 75 students confirmed knowing the pathology, corresponding to 65.78%, and 38 students said they did not know it, being 33.33% of the 113 samples.

CONOCIMIENTO SOBRE LA ENFERMEDAD/ CANTIDAD DE MUESTRAS(113).



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CONHECIMENTO SOBRE A DOENÇA / QUANTIDADE DE AMOSTRAS(113).

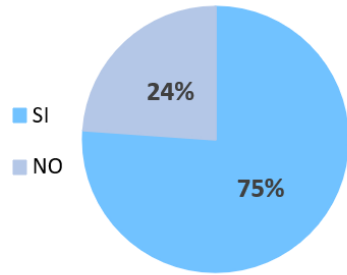


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Regarding the knowledge about the forms of transmission of the disease, it was 86, corresponding to 75.43% of the sample of 113 students and 27, 23.68%.

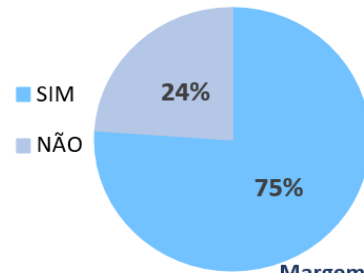


CONOCIMIENTO SOBRE LAS FORMAS DE TRANSMISION/CANTIDAD DE MUESTRAS(113).



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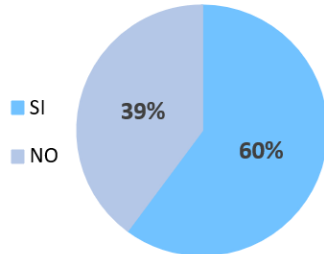
CONHECIMENTO SOBRE AS FORMAS DE TRANSMISSÃO/QUANTIDADE DE AMOSTRAS(113).



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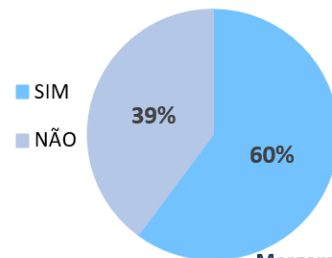
Knowledge about the clinical manifestations was of 68 students, being referred in 59.64% and 45 corresponding to 39.47% of the 113 samples.

CONOCIMIENTO SOBRE LAS MANIFESTACIONES CLINICAS/CANTIDAD DE MUESTRAS(113).



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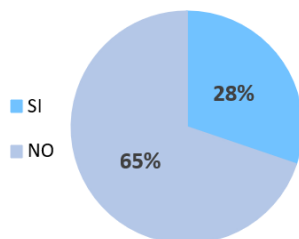
CONHECIMENTO SOBRE AS MANIFESTAÇÕES CLINICAS/QUANTIDADE DE AMOSTRAS(113).



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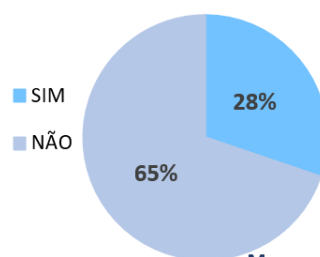
In the sampling of confirmed IGG immunoglobulin, the late infection of the pathology was 32, being 28.07% of the sample of 106 students in the upper Paraná region and 74 students, 64.91%.

IGG/CANTIDAD DE MUESTRAS(106).



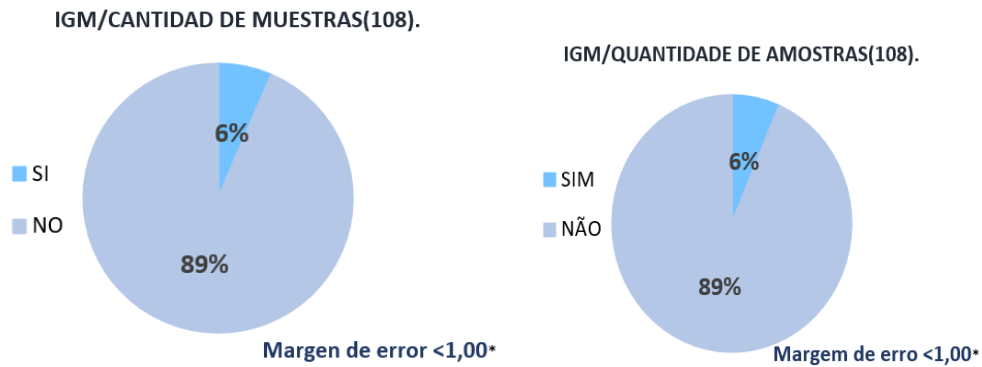
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IGG/QUANTIDADE DE AMOSTRAS(106).



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In the IGM immunoglobulin sample, which was responsible for rapid response to infectious agents, it was 7, 6.14% of the 108 students and 101, being reported in 88.59%, did not have active IGM for the disease.



Taking into account the data obtained, we can see that most of those involved in the research have bad eating habits, consume undercooked meats, sausages, and end up not washing fruits and vegetables properly before consumption, in addition to being largely unaware of the disease and its forms of transmission.

It is not the fact that the individual has contact with the cat in your residence that you will definitely have a toxoplasmosis infection, there are risks, but if preventive measures are properly followed the risks of contracting this disease gradually decrease, preventive measures for your animal They are: do not feed him raw or undercooked meat, remove his feces correctly, prevent him from hunting, and stay with feral or stray cats^{10,16}. The animal should also be taken to the veterinarian frequently and periodically examined to avoid infection and spread of the pathology¹⁷.

In general, to prevent toxoplasmosis in humans, it is important to take some precautions, such as: consuming potable, filtered or mineral water, cooking meat well avoiding the consumption of undercooked meats, washing kitchen utensils thoroughly, such as cutting boards or knives, after seasoning or cutting raw meat, to avoid contamination of other foods, Wash fruits and vegetables thoroughly, wear gloves when gardening or caring for plants, and avoid contact with cat feces.^{17,18,19,20} Herbs in urban environments such as sidewalks and flowerbeds should not be ingested or used, as the soil may be contaminated with animal defecation, being classified as a potential transmitting agent.^{19,20,23,24,25}

9 CONCLUSION

It is known that toxoplasmosis is a parasitic disease caused by *Toxoplasma gondii*, some habits such as drinking water from drinking fountains or public taps, handling or consuming raw or undercooked meat, not having the habit of washing hands or washing food, leaving domestic animals free, or as known in Brazil by the pejorative term "god will give", can be pointed out as responsible for the infection in a large part of the exposed and reactive population. Thus, in view of the need to disseminate knowledge about the disease and its prevention to the population, in order to guide them about the risk factors for the contamination of toxoplasmosis, this education and prevention is



generated through simple habits, such as eating well-cooked meat, washing hands and consuming treated water. It is worth mentioning that medical students are a group to be aware of, due to the exposure and educational approaches that are effective for the control and dissemination of the pathology. Studies along these lines should be stimulated in order to raise awareness among the future medical profession in order to improve and correspond more efficiently to the educational dissemination of this disease.



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