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PREVALENCE AND ASSOCIATED RISK FACTORS OF TOXOPLASMOSIS AMONG WOMEN IN PARACHINAR DISTRICT KURRAM, KHYBER PAKHTUNKHWA

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Abstract

Toxoplasmosis, caused by Toxoplasma gondii, primarily affects warm-blooded animals, including humans. Cats are definitive hosts. It's zoonotic with public health concerns, linked to mental, behavioral, and physiological changes, and adverse pregnancy outcomes like premature births, miscarriages, stillbirths, and fetal abnormalities. This study aimed to estimate the prevalence and associated risk factors of toxoplasmosis among pregnant women in Parachinar. Data was collected using a pre-designed questionnaire, and blood samples were collected and tested for the detection of anti-T. gondii IgM and IgG antibodies by enzyme-linked immunosorbent assay. The current study was conducted to assess the prevalence and associated risk factors of toxoplasmosis among pregnant women in Parachinar, involving a sample of 460 participants. The statistical tests were applied to the data of the different categories by using STATA (V.13). The p-value <0.05 was considered statistically significant. In the study, toxoplasmosis was found in 23% of pregnant women. The age group 29 to 38 had the highest cases, but this wasn't statistically significant. Significant risk factors included living in rural areas (82.9%), being illiterate (35.2%), and working as a housewife (67.6%). Blood type O had a prevalence of 35.2%. The first trimester had the highest incidence at 38.1%, but no significant associations. Drinking tap water (70.5%) and having cats and dogs (65.7%) increased the risk. Activities like disposing of cat litter (42.9%), handling manure (61%), cattle rearing (39.1%), and consuming uncooked/raw meat (38.1%) didn't show significant associations, but beef consumption (47.6%) was a risk factor. Raw vegetables and fruits (77.1%) and milk (61%) were associated with toxoplasmosis, but not statistically significantly. Gardening soil contact had a prevalence of 75.2%.

This study highlights a high prevalence of toxoplasmosis in Parachinar among pregnant women. Significant factors include habitat, education, pets, beef consumption, and soil contact, emphasizing the importance of public health interventions for pregnant women.

Keywords:
Toxoplasmosis, Toxoplasma gondii, zoonotic disease, trimester, livestock, public health.

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INTRODUCTION

Toxoplasmosis is caused by *Toxoplasma gondii*, a well-known intracellular protozoan parasite. (Yamada *et al.*, 2011). This infection may affect all animals and birds. It's also a major zoonotic infection source (Polley *et al.*, 2009). *T. gondii* is an entirely obligate protozoan parasite that may cause toxoplasmosis in animals, including humans. Toxoplasmosis is one of the most common infections, affecting one-third of the world's population (Jones et al., 2001). Two microbiologists, Nicolle and Manceaux, in 1908 initially discovered and separated the *T. gondii* from the blood sample and tissue pieces identified out of a Northern African-based rodent, the *Ctenodactylus gondii* (Nicolle and Manceaux, 1908). *T. gondii* is reported to infect various animals and birds, including terrestrial and aquatic mammals and birds. Because of the asexual division in these animals, they are known as intermediate hosts for *T. gondii*. The sexual reproductive phases are best seen in Felidae species, including the domestic cat. Therefore, they are called the definitive host of *T.gondii* (Dubey, 2009). The intermediate hosts can be infected by the following routes which included; ingestion of water, contaminated vegetables, and fruits with possible oocysts sporulated after the previous removal in the faeces of cats, undercooked meat consumption supposedly possessing tissue cysts, congenital transmission from the mother through the placenta, transfusion of blood, organ transplantation, where the organs can also include cysts or tachyzoites. Carnivores (including mammals and birds) or ingestion of sporulated oocysts can infect definitive hosts, such as cats. Oocysts may also remain for a long time in oysters and mussels, keeping their infectious properties (Coupe *et al.*, 2019). Toxoplasmosis can be transmitted by small ruminant meat, especially in regions where sheep and goat meat are commonly consumed regularly (Garca-Bocanegra *et al.*, 2013; Garcia *et al.*, 2006). Infection can also be spread through milk from affected animals (Boughattas, 2017). Children who suffer from allergies to cow milk and buffalo milk prefer to have an intake of small ruminant milk, such as goat milk, in various parts of the world (Latif *et al.*, 2017; Tasawar *et al.*, 2020).

Toxoplasmosis is a disease that can be passed down through the placenta during pregnancy. Although most women with toxoplasmosis have no symptoms (asymptomatic), infection during pregnancy can cause disease transmission through the placenta, resulting in hazardous consequences such as stillbirth, abortion, and exceptional levels of intellectual or physical retardation, blindness, and hydrocephalus (Elsheikha, 2008). The level of congenital transmission of toxoplasmosis, as well as its severity in the fetus, varies depending on the stages and conditions of pregnancy. Its transmission is lower in the first trimester of pregnancy and increases in severity to higher levels in the last trimester (Lopes *et al.*, 2012). So the early detection of *T. gondii* infection is mandatory for keeping safe as well as preventing congenital toxoplasmosis. The risk of this congenital infection ranges from 10-25% in the first trimester, while during the second trimester it ranges within 30-54% however, the range may be higher up to 60-65% in the third and last trimester. On the other hand, even though *T. gondii* infection during embryogenesis is rare, it has a great impact on the fetus. In comparison, asymptomatic newborns are often affected by the maternal disease in the third trimester. If not treated adequately, these babies' retinochoroiditis and neurologic impairments may aggravate in childhood or early adulthood (Assouline *et al.*, 2010). *T. gondii* is a parasite that may infect all nucleated cells of a wide range of worm-blooded animals and causes the most commonly found parasitic zoonosis in the world (Ferreira *et al.*, 2009). Toxoplasmosis has infected more than 6 billion people across the globe. The occurrence of toxoplasmosis in humans differs within and among countries, the previous research indicates the incidence rates of 6.7% in Korea, 12.3% found in China, 23.9% noted in Nigeria, 46.0% pointed out in Tanzania and with the highest range level of 98.0% in some poorly unhygienic segments of other regions (Fromont *et al.*, 2009; Xiao *et al.*,2010).

Toxoplasma infection rates vary depending on geographic location, dietary patterns, and socioeconomic conditions. The studies conducted on pregnant women for the infection of IgG

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seropositivity of *T. gondii* were found to be 44.4% in Izmir, 35.8% noted in Istanbul, 30.7% identified in Ankara, 39.6% quoted in Malatya, 30.1% conveyed in Aydan, and 19.2% pointed out in Samsun. It was Indonesia, toxoplasmosis in livestock is expected to be 51.0% in goats, 8.8% in cattle, and 45.0% in sheep. In some locations of Indonesia, the
Incidence of human toxoplasmosis has been estimated to range from 43 to 88% (Artama *et al.*, 2007).
T. gondii is found worldwide and reported in Parachinar city and its surrounding areas. Because of the high illiteracy rate and a lack of information and knowledge about Toxoplasmosis, some patients are turned into very chronic conditions. This virus is spread by eating undercooked or contaminated meat, coming into contact with infected cat faeces, passing it down from mother to fetus during pregnancy, and dignified that the *T. gondii* infection is about 42.3% in Black Sea Region, 31-37% in Anatolia, and 69.5% highlighted in Anatolia (Cekin *et al.*, 2011). In

several other routes. Congenital toxoplasmosis can cause hazardous consequences in children, such as hearing loss, mental disability, and blindness. Keeping in view the existing situation, it was important to recognize the incidence and risk factors that are responsible for the infectious toxoplasmosis in different areas of Parachinar, District Kurram, Khyber Pakhtunkhwa. Objectives of the study are;

1: To examine the prevalence of toxoplasmosis among the women of Parachinar.
2: To access the risk factors responsible for causing toxoplasmosis in pregnant women.

MATERIALS AND METHODS

Study Area

This study was conducted in Parachinar, the administrative headquarters and largest urban center of District Kurram, Khyber Pakhtunkhwa (KPK), Pakistan. Data were collected from both urban and rural communities of Parachinar to ensure representative coverage of the district. Geographically, Parachinar is located on a narrow strip of Pakistani territory west of Peshawar, sharing a boundary with Afghanistan. It lies approximately 110 kilometers (68 miles) from Kabul, the capital of Afghanistan, making it the nearest Pakistani city to Kabul. The district is characterized by diverse socio-cultural practices, varying levels of urbanization, and close interaction with livestock and agriculture, all of which may influence exposure to zoonotic infections such as toxoplasmosis.

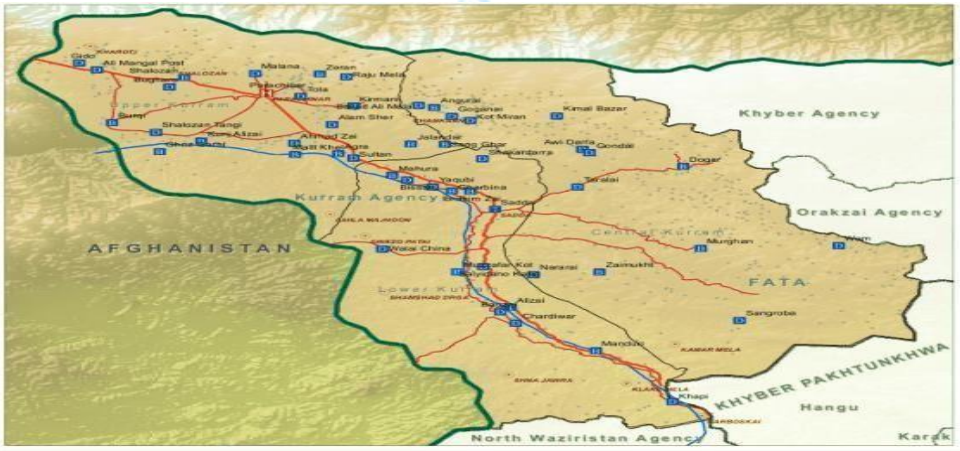

Figure 1 Map of Parachinar, District Kurram, Khyber Pakhtunkhwa

Study Duration and Design

This study investigated the prevalence of Toxoplasma gondii infection among pregnant women in Parachinar between April and September 2021. Data were collected using a structured questionnaire, which facilitated systematic gathering of socio-demographic, behavioral, and environmental risk factors. This method provided reliable information within a

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limited timeframe, and the findings were presented through tables and graphs for clarity and statistical analysis.

Study Centers

Data were collected from multiple healthcare and diagnostic facilities across Parachinar to ensure representative coverage of the study population. The primary sites included the District Headquarter Hospital (DHQ), Parachinar, and Mahmood Hospital, Parachinar. In addition, several maternity centers and clinical laboratories were visited, such as Dr. Masooma Hospital and Maternity Center, Dr. Rubab Maternity Center, Dr. Bahar Hussain Clinic, Kabir Hussain Clinical Laboratory, Raiz Hussain Clinical Laboratory, Ok Laboratory (opposite DHQ Hospital), Musharaf Hussain New Bangash Clinical Laboratory, and the Bangash Clinical Laboratory and X-Ray Center near DHQ Hospital, Parachinar. These centers were personally visited for data collection, providing access to a diverse sample of pregnant women for the study.

Data Collection

Information and Data were collected from a total of 460 patients. 105 of these patients were identified for toxoplasmosis. The questionnaire was filled out by Toxoplasma-positive patients.

Questionnaire Survey

Under the supervision of a research advisor, a structured questionnaire was developed to assess the prevalence of Toxoplasma gondii infection and associated risk factors. It included socio-demographic details (age, residence, education, profession, blood group), obstetric data (stage of pregnancy), environmental and behavioral exposures (water source, contact with cats/dogs, litter disposal, manure handling, livestock rearing, soil contact), and dietary habits (meat, vegetables, fruits, milk, beef consumption).

Data Analysis

Data obtained from the questionnaires were initially entered into Microsoft Excel to construct a database, which was subsequently imported into STATA version 13 for statistical analysis. Risk factor assessment was performed using the Chi-square (χ^2) test, with seronegative individuals serving as controls. Pearson's Chi-square test was applied to evaluate categorical variables and determine the likelihood of associations between risk factors and Toxoplasma gondii infection. Associations were considered statistically significant at a p-value < 0.05.

RESULTS

This research work aims to identify the occurrence and existence, as well as associated risk factors of toxoplasmosis among the women of Parachinar. Toxoplasma gondii is a protozoan parasite with a single cell that can infect animals, including humans. This parasite is found throughout the world and reported in Parachinar city and its surrounding areas because of the high illiteracy rate and a lack of information and knowledge about Toxoplasmosis. About 460 patients were interviewed through a questionnaire in different hospitals, laboratories, and healthcare centers in Parachinar. Among them, 105 (23%) patients were identified for toxoplasmosis (Table 1).

Table 1: Prevalence of toxoplasmosis in Parachinar

Toxoplasmosis	Patients	Percentage (%)
Negative	355	(77)
positive	105	(23)
Total	460	(100.00)

The following risk factors, which are responsible for toxoplasmosis, are;

Age as a Risk Factor for Toxoplasmosis

In this study, the highest percentage of toxoplasmosis is present in the 29- 38 age group (56.2%). Age is divided into three groups (19-28, 29-38, and 39-48). In the age groups, the prevalence of toxoplasmosis is 37.1% in the age group of 19 to 28, about 56.2% in

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the age group of 29 to 38 (6.7% in the age group of 39 to 48. However, the result showed that these age groups do not significantly affect acquiring toxoplasmosis (P = 0.436) (Table 2).

Table 2: Distribution of Toxoplasmosis Cases Across Age Groups

Age	Frequency (%)
19-28	39 (37.1)
29-38	59 (56.2)
39-48	7 (6.7)
Total	(100.00)

Pearson χ^2 (6) = 5.8867 P = 0.436

Area as a Risk Factor for Toxoplasmosis

The study showed the occurrence and existence of toxoplasmosis in different areas of Parachinar. According to the study, the occurrence of toxoplasmosis is higher in villages / rural areas (82.9%) than in urban areas. Rural areas are divided into four groups (north, south, east, and west). The prevalence of toxoplasmosis is 29.5% in southern areas, 25.7% in eastern areas, 22.9% in western areas, and 4.8% in northern areas. In Urban (city), the prevalence of toxoplasmosis is 17.1%. However, the result showed that habitat significantly increased the risk of acquiring toxoplasmosis (P = 0.018) (Table 3).

Table 3: Area-wise Prevalence of Toxoplasmosis in Parachinar

Residential Area	Frequency (%)
Parachinar City	18 (17.1)
Northern Areas	5 (4.8)
Southern Areas	31 (29.5)
East Areas	27 (25.7)
West Areas	24 (22.9)
Total	(100.00)

Pearson χ^2 (12) = 24.3420 P = 0.018

Education as a Risk Factor for Toxoplasmosis

According to the study, the prevalence of toxoplasmosis is higher in those people who have no education or were illiterate (35.2%), followed by SSC and HSSC (23.8 %), graduate and above (21%), and primary and middle education (20 %). Results showed that illiteracy significantly increased the risk of acquiring toxoplasmosis (P = 0.000) (Table 4).

Table 4: Distribution of Toxoplasmosis Cases Across Different Education Levels

Education	Frequency (%)
Illiterate	37 (35.2)
Primary and Middle	21 (20)
SSC and HSSC	25 (23.8)
Graduate and above	22 (21)
Total	(100.00)

Pearson χ^2 (6) = 99.2814 P = 0.000

Profession as a Risk Factor for Toxoplasmosis

According to the present study, the prevalence of toxoplasmosis was higher in housewives with a percentage of about 67.6%), followed by teachers (21%), then health workers (11.4%). However, the result showed that types of professions significantly

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increased the risk of acquiring toxoplasmosis (0.000) (Table 5).

Table 5: Distribution of Toxoplasmosis Cases by Profession

Profession	Frequency (%)
House wife	71 (67.6)
Teachers	22 (21)
health worker	12 (11.4)
Total	(100.00)

Pearson χ^2 (6) = 99.2814 P = 0.000

Blood Group as a Risk Factor for Toxoplasmosis

According to the present study, the prevalence of toxoplasmosis is the highest percentage in O blood group patients (35.2%), followed by A group (33.3%), B group (17.1%), and AB group (14.3%). However, the result showed that blood group types did not show a significant risk for acquiring toxoplasmosis (P = 0.089) (Table 6).

Table 6: Distribution of Toxoplasmosis Cases by Blood Group

Blood group	Frequency (%)
o group	37 (35.2)
A group	35 (33.3)
B group	18 (17.1)
AB group	15 (14.3)
Total	(100.00)

Pearson χ^2 (9) = 15.0591 P = 0.089

Stages of Pregnancy as a Risk Factor for Toxoplasmosis

The result revealed that the highest percentage of toxoplasmosis was identified in 1st trimester of the gestation period. The gestation period is divided into three trimesters (1st, 2nd, and 3rd trimesters). The incidence of toxoplasmosis was 38.1% in the 1st trimester, 36.2% in the 3rd trimester, and 25.7% in the 2nd trimester. However, the result showed that stages of pregnancy did not reflect any significant association with acquiring toxoplasmosis (P = 0.779) (Table 7).

Table 7: Distribution of Toxoplasmosis Cases by Stage of Pregnancy

pregnancy stages	Frequency (%)
1st trimester	40 (38.1)
2nd trimester	27 (25.7)
3rd trimester	38 (36.2)
Total	(100.00)

Pearson χ^2 (6) = 3.2335 P = 0.779

Source of Drinking Water as a Risk Factor for Toxoplasmosis

According to the study, the incidence of toxoplasmosis is present in the highest percentage (70.5%) in those patients who drink tap water, while 29.5% present in those patients who drink tube well water. However, the results reflect that the drinking water source does not significantly reduce the risk of acquiring toxoplasmosis (P = 0.326) (Table 8).

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Table 8: Distribution of Toxoplasmosis Cases Across Different Water Sources

source of drinking water	Frequency (%)
Tap water	74 (70.5)
Tube well	31 (29.5)
Total	(100.00)

Pearson χ^2 (3) = 3.4629 P = 0.326

Presence of Cats and Dogs at Home as a Risk Factor for Toxoplasmosis

The study showed that the highest range (65.7%) of toxoplasmosis was described in those patients who possessed household cats and dogs, while (34.3%) in those who didn't possess domestic cats and dogs. However, the result presented that the existence of cats and dogs at residential units significantly increased the risk of acquiring toxoplasmosis (P = 0.035) (Table 9).

Table 9: Distribution of Toxoplasmosis Cases in Relation to Cats and Dogs at Home

Presence of a dog and a cat at home	Frequency (%)
Yes	69 (65.7)
No	36 (34.3)
Total	(100.00)

Pearson χ^2 (3) = 8.6285 P = 0.035

Contact with Cats and Dogs as a Risk Factor for Toxoplasmosis

Most patients (73.3%) claimed that they have direct contact with the cats and dogs, which is the major risk factor for toxoplasmosis because the cats and dogs are the definitive hosts for the parasite of toxoplasmosis. At the same time, (26.7%) of patients argued that they have no direct contact with dogs and cats. However, the result showed that contact with dogs and cats significantly increased the risk of acquiring toxoplasmosis (P = 0.005) (Table 10).

Table 10: Distribution of Toxoplasmosis Cases in Relation to Contact with Cats and Dogs

Contact with dogs and cats	Frequency (%)
Yes	77 (73.3)
No	28 (26.7)
Total	(100.00)

Pearson χ^2 (3) = 1.7688 P = 0.005

Litter Boxes in the Household as a Risk Factor for Toxoplasmosis

Among the total patients, the majority (67.6%) claimed that they did not have any litter boxes for the cats in their houses, while (32.4%) argued that they have litter boxes in their places. However, the result showed that the presence of cat litter boxes in the home significantly increased the risk of acquiring toxoplasmosis (P = 0.039) (Table 11).

Table 11: Distribution of Toxoplasmosis Cases in Relation to Household Litter Boxes

litter Boxes	Frequency (%)
Yes	34 (32.4)
No	71 (67.6)
total	(100.00)

Pearson χ^2 (3) = 8.3724 P = 0.039

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Responsibility for Disposing Cat Litter as a Risk Factor for Toxoplasmosis

About 42.9% of patients claimed that they had the responsibility of disposing of the cat litter, while the remaining (57.1%) of respondents claimed they did not have any such responsibility. However, the results reflect that statistically, the responsibility of disposing of cat litter does not show any significant risk of acquiring toxoplasmosis (P = 0.133) (Table 12).

Table 12: Distribution of Toxoplasmosis Cases in Relation to Cat Litter Disposal Responsibility

cat litter responsibility	Frequency (%)
Yes	45 (42.9)
No	60 (57.1)
Total	(100.00)

Pearson χ^2 (3) = 5.6002 P = 0.133

Manure Handling as a Risk Factor for Toxoplasmosis

The majority of the patients (61%) argued that they had the responsibility for manure handling, while 39.1% said they didn't handle the manure. However, the results reflect that statistically, manure handling does not show any significant risk for acquiring toxoplasmosis (P = 0.503) (Table 13).

Table 13: Distribution of Toxoplasmosis Cases According to Manure Handling

Manure handling	Frequency (%)
yes	64 (61)
No	41 (39.1)
Total	(100.00)

Pearson chi2 (3) = 2.3517 P = 0.503

Cattle Rearing as a Risk Factor for Toxoplasmosis

In the present study, about 39.1% of patients declared that they reared the cattle; the remaining claimed that they did not domesticate the cattle. However, the result showed that the cattle rearing did not display any remarkable association with acquiring toxoplasmosis (P = 0.523) (Table 14).

Table 14: Distribution of Toxoplasmosis Cases According to Cattle Rearing

Cattle reared	Frequency (%)
Yes	41 (39.1)
No	64 (61)
Total	(100.00)

Pearson χ^2 (3) = 2.2470 P = 0.523

Contact with Gardening Soil as a Risk Factor for Toxoplasmosis

About 75.2% of positive patients with toxoplasmosis have direct contact with the gardening soil. The remaining (24.8%) claimed that they had not had any contact with the gardening soil. However, the result showed that contact with gardening soil significantly increased the risk of acquiring toxoplasmosis (P = 0.014) (Table 15).

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Table 15: Distribution of Toxoplasmosis Cases According to Gardening Soil Exposure

Gardening soil	Frequency (%)
Yes	79 (75.2)
No	26 (24.8)
Total	(100.00)

Pearson χ^2 (3) = 6.4627 P = 0.014

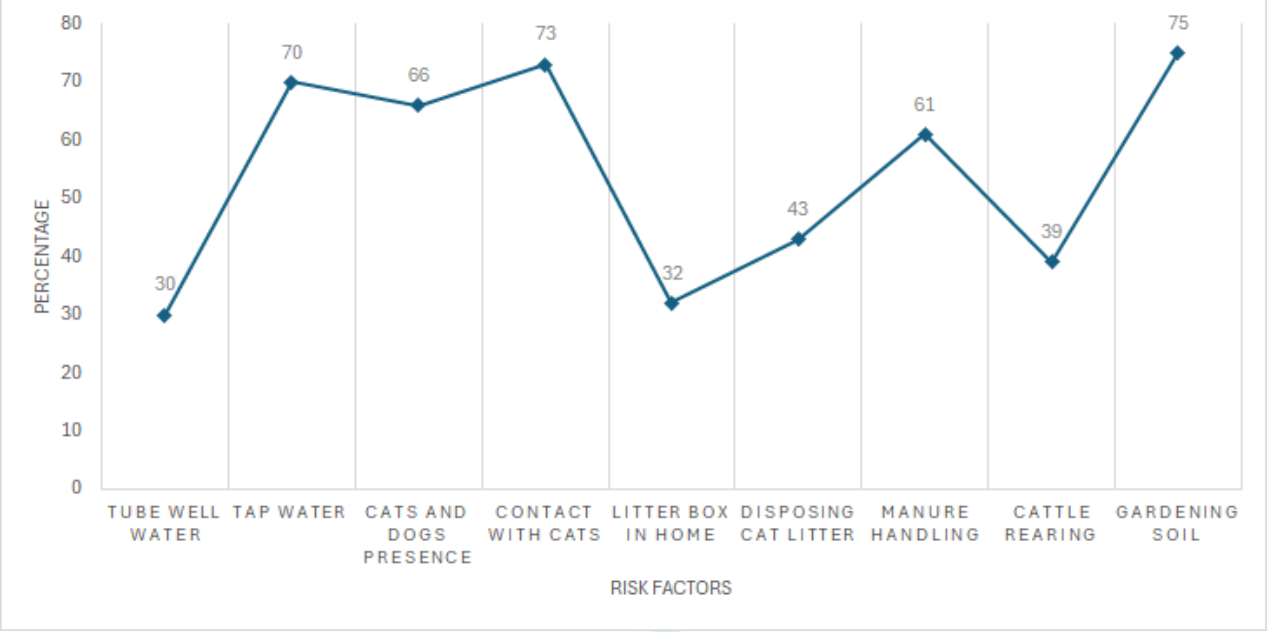

Figure 2: Risk factors responsible for toxoplasmosis.

Consumption of Undercooked/Raw Meat as a Risk Factor for Toxoplasmosis

In the present study, the highest percentage (38.1%) of toxoplasmosis was identified in those patients who consumed meat every week, while (34.3%) every quarter, and the remaining (27.6%) patients consumed meat every month. However, the result displayed that uncooked/raw meat consumption did not show any significant association with acquiring toxoplasmosis (P = 0.689) (Table 16).

Table 16: Distribution of Toxoplasmosis Cases According to Meat Consumption

consumption of meat	Frequency (%)
weekly	40 (38.1)
Quarterly	36 (34.3)
Monthly	29 (27.6)
Total	105 (100.00)

Pearson χ^2 (6) = 3.9095 P = 0.689

Consumption of Raw Vegetables and Fruits as a Risk Factor for Toxoplasmosis

The study showed that a high incidence (77.1%) of toxoplasmosis was described in those patients who digest vegetables and fruits every week, while (16.2%) was described in those patients who digest vegetables and fruits every quarter, and the remaining (6.7%) in those who digest vegetables and fruits every month. However, the result disclosed that consumption of fruits and vegetables did not show any significant risk of acquiring toxoplasmosis (P = 0.094) (Table 17).

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Table 17: Distribution of Toxoplasmosis Cases According to Vegetable and Fruit Consumption

Consumption of vegetables and fruits	Frequency (%)
Weekly	81 (77.1)
Quarterly	17 (16.2)
Monthly	7 (6.7)
Total	105 (100.00)

Pearson χ^2 (6) = 10.8276 P = 0.094

Milk Consumption as a Risk Factor for Toxoplasmosis

In the study, most of the patients (61%) claimed that they used milk every week, while 21.9% argued that they used milk every quarter, and the remaining 17.1% used it every month. However, the result showed that milk consumption did not show any significant risk for acquiring toxoplasmosis (P = 0.555) (Table 18).

Table 18: Distribution of Toxoplasmosis Cases According to Milk Consumption

Milk consumption	Frequency (%)
weekly	64 (60.95)
Quarterly	23 (21.90)
Monthly	18 (17.14)
Total	105 (100.00)

Pearson χ^2 (6) = 4.9158 P = 0.555

Beef Consumption as a Risk Factor for Toxoplasmosis

In this study, about 47.6% of patients claimed that they digest beef every week, (41% of patients argued that they digest beef every quarter, while the remaining (11.4%) of patients consumed beef every month. Results suggested that the habit of frequent consumption of beef significantly increased the risk of acquiring toxoplasmosis (P = 0.018) (Table 19).

Table 19: Distribution of Toxoplasmosis Cases According to Beef Consumption

Beef consumption	Frequency (%)
weekly	50 (47.6)
quarterly	43 (41)
monthly	12 (11.4)
Total	105 (100.00)

Pearson χ^2 (6) = 8.7588 P = 0.018

Details	Consumption of Meat	Consumption of Vegetables and Fruits	Milk Consumption	Beef Consumption
Weekly	38%	77%	61%	48%
Quarterly	34%	16%	22%	41%
Monthly	28%	7%	17%	11%

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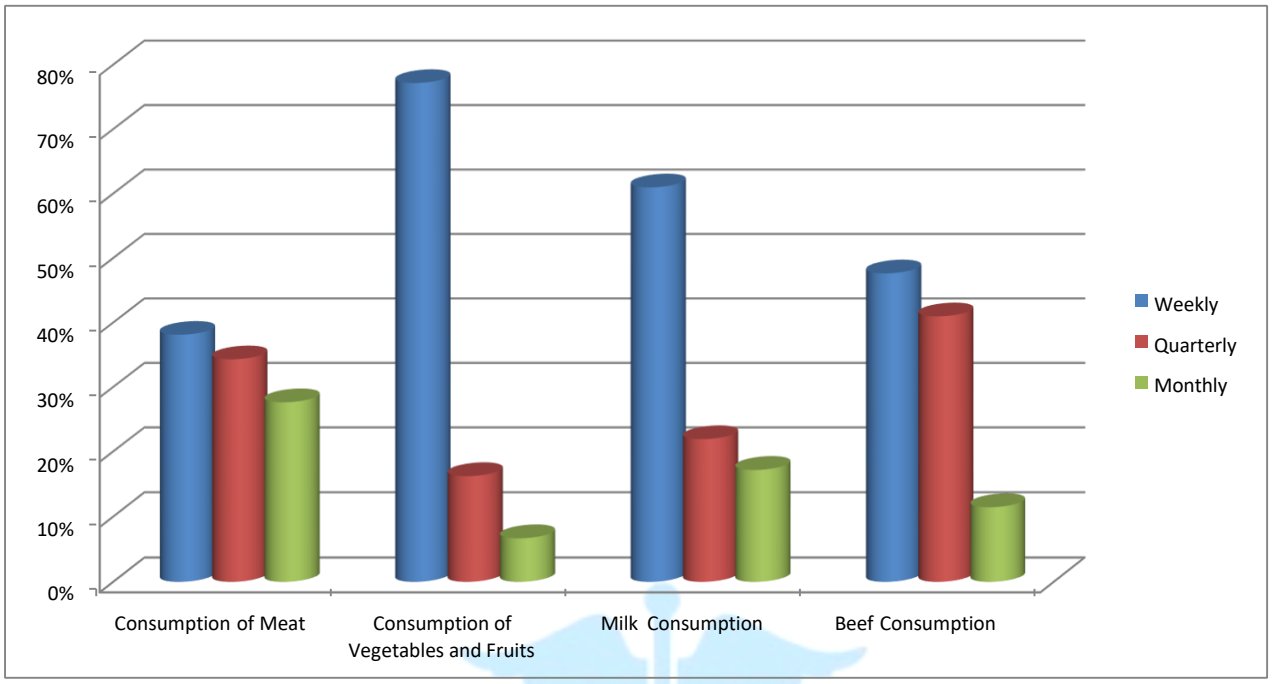

Figure 3: Oral transmission routes responsible for toxoplasmosis

DISCUSSION

This study aimed to investigate *T. gondii* infection in pregnant women and its possible risk factors. The population was selected in my hometown, Parachinar. To evaluate the prevalence of *T. gondii* infection among pregnant females, the relevant data were collected from both urban and rural areas of Parachinar through a Questionnaire survey. Because of its complicated nature and transmission, *T. gondii* infection poses a major human hazard. The prevalence of *T. gondii* disease in pregnant females and control subjects has been found at 23%, respectively.

According to epidemiological reports, *T. gondii* infection in females of childbearing age differs greatly between countries. In Europe, *T. gondii* infections in pregnant females range from 9% to 67% (Meerburg and Kijlstra, 2009). In contrast, in Asian countries, however, Korean and Vietnamese research studies indicated a low frequency of *T. gondii* infection, that is, 0.8% and 11.2%, respectively. In comparison, the occurrence of *T.gondii* in pregnant females has been recorded as high as 41.8-55.4% in Indian, Malaysian, and Nepalese populations (Song *et al.,* 2005; Buchy *et al.,* 2003; Rai *et al.,* 1998). The previous report in Ghana found the Occurrence rates of 67.9% and 82.1% in pregnant females aged 15–25 and 31–40 years, respectively (Anteson *et al.,* 1978). In contrast, our study showed that the incidence of *T.gondii* infection is 56.2%) the age range of 29 to 38 years age group but not statistically significant (P = 0.436). The percentage of our results indicates that this age group represented the most active age group among adults (marriage age and childbearing age).

According to some studies, toxoplasmosis is more common in temperate climates and less common in cold, hot, and dry climates. Unsuitable environmental conditions for oocyte development and growth in hot and dry climates could explain the low occurrence of toxoplasmosis in these areas (Mousavi *et al.,* 2012; Fallah *et al.,* 2008). According to (Mahmoudvand *et al.,* 2015) study, the occurrence of *T. gondii* infection is a significant risk factor for both people who are living in rural and urban areas, which is similar to our study because our result showed that the prevalence of *T. gondii* positivity was higher in those participants whose living in villages and rural areas (82.9%) than those whose living in cities (17.1%). These findings revealed that those

people living in rural areas or farming had a higher possibility of exposure to *T. gondii* because people who

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are associated with gardening and farming are more likely to become infected. So, our study suggested that habitat is a significant risk factor for acquiring toxoplasmosis (P =0.018).

Keeping in view the possible factor, i.e., education, the initial prevention of toxoplasmosis aims to strengthen pregnant females' knowledge and possible information of the causing agents, factors, and routes of transmission. The study has established that illiteracy significantly increased the risk for toxoplasmosis (P = 0.000) because, in the present study, most pregnant women were illiterate or unaware of toxoplasmosis (35.2%). In previous investigations, common toxoplasmosis knowledge was observed nationwide. Only 9.9% in Egypt had a decent understanding of toxoplasmosis, according to a study by Abdalla *et al.* (2014). Similar findings were found in Ethiopia and Tanzania, showing that 5% and 5.7% of pregnant females, respectively, were aware of this infection (Onduru *et al.*, 2019; Hdush, 2015). Toxoplasmosis awareness was particularly poor (11%) in Asian countries, i.e., Malaysia, the Philippines, and Thailand (Andiappan *et al.*, 2014). However, our result demonstrated that (67.6%) of positive patients are housewives. Furthermore, the present results contradict the profession and also seem significant risk factors for toxoplasmosis unawareness (P = 0.000). Not knowing about the disease has put pregnant women unaware of toxoplasmosis at a higher risk of infection. They are more likely to contract.

T. gondii infection when pregnancy, resulting in severe infection and increasing the risks of congenital transmission. So, an equipped knowledge and thorough understanding of toxoplasmosis's transmission routes is critical for preventing infection during pregnancy.

According to the study (Borna *et al.*, 2013) Iranian review, the occurrence of hereditary contagion in the days of pregnancy was projected to be 1–8 per 1000 pregnancies. Toxoplasmosis is the most common fatal infection and a significant risk agent for brain damage and intellectual retardation in the young fetus. *T. gondii* infection can bring abortion and even stillbirth during the initial months of pregnancy. Our findings demonstrated that about 38.1% of Toxoplasma infections were identified in 1st trimester of the gestation period, which did not show any significant association with acquiring toxoplasmosis (P = 0.779). Hence, it can be concluded that adequate treatment for acute infection is extremely required during pregnancy to keep the patient recovered and safe.

T. gondii infection can also be spread by contaminated drinking water (Bowie *et al.*, 1997). *T. gondii* oocysts have been found in wells located on farms (Sroka et al., 2006) and can live in soil and water for long periods (Torrey and Yolken, 2013). According to a study conducted in Nigeria (Ishaku *et al.*, 2009), pregnant women who drank pipe water had a greater prevalence rate than packaged water. Our study found an increased risk of *T. gondii* positivity among participants who used tap water sources for drinking purposes (70.5%) than tube well water (29.5%), but statistically, the result reflected that the drinking water and its source do not have a significant association with acquiring toxoplasmosis (P = 0.326). This finding revealed that *T. gondii* contamination of drinking water is prevalent and that drinking boiled water is a good approach to avoid *T. gondii* infection.

The definitive host of *T. gondii* is the cat; the oocysts are regularly spread through infected cat faeces, serving as a significant source of infection for *T. gondii* in humans (Dubey, 2010). According to previous findings, *T. gondii* is thought to be present in 30–40% of domestic cats globally (Dubey and Beattie, 2010; Webster and Dubey, 2010). However, more people are keeping pets, such as cats and dogs, which may increase the risk of zoonotic diseases like Toxoplasmosis. Our findings estimated that about 65.7% of positive patients who possessed domestic cats and dogs, which significantly increased the risk of acquiring toxoplasmosis (P = 0.035). Previous epidemiologic research has consistently shown that contact with cats is a risk factor (Cong *et al.*, 2015; Zemene *et al.*, 2012; Rodrigues *et al.*, 2015; Chiang *et al.*, 2012; Agmas *et al.*, 2015). According to our questionnaire survey, (73.3%) of Toxoplasma-positive patients directly contact cats. However, contact with cat faeces due to owning a cat and/or availability of cats in the immediate surrounding area has been linked to a significantly increased risk of Toxoplasma infection (P = 0.005). Because Toxoplasma antibodies were found in higher quantities in pregnant females who had domestic cats at home than in pregnant

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women who did not have domestic cats, the majority of the infected / carrier cats may excrete oocysts.

According to Angulo *et al.* (1995), the hygiene of litter boxes is the most important precaution to prevent the transmission of toxoplasmosis from pet cats. Our result revealed that the presence of litter boxes in the home significantly increased the risk for toxoplasmosis (P = 0.039); about 32.4% of positive participants in our study argued that they have cat litter boxes in their home. Our analysis also finds (42.9%) positive patients who are responsible for the removal of cat faeces or cleaning litter boxes, but statistically, the responsibility of disposing of cat litter doesn't show any significant risk for acquiring toxoplasmosis (P = 0.133). The litter box found within the environment is expectedly contaminated by infected cats that shed the parasite through faeces. The infected cat can easily contaminate the soil and water in the surroundings. It is suggested to clean the Litter boxes regularly and keep the kitchen as well as the dining areas neat and clean.

The inexistence of manure dandling and cattle rearing is also a risk factor for *T. gondii* positivity. Our study found that (61%) of positive patients were responsible for manure handling, and (39.1%) of patients declared that they reared the cattle. But the present survey did not suggest that the manure handling (P = 0.503) and cattle reared (P = 0.523) are significant factors in disease transmission. According to (Tzanidakis *et al.*, 2012), the availability of manure can be a possible risk factor for *T. gondii*. It can also be expected with a high ratio in grazing areas, and the humidity they provide may help oocysts survive in the soil. In indoor and outdoor husbandry systems, *T. gondii* prevalence has been linked to higher animal density.

Other studies (Liu *et al.*, 2009; Fromont *et al.*, 2009; Baril *et al.*, 1999) have shown another risk factor for rural areas with more soil exposure for pregnant females. The Oocysts can survive for years in some environments (Torrey and Yolken, 2013). Our study finds that contact with gardening soil significantly increased the risk for disease transmission (P = 0.014), with an incidence of 75.2%. Therefore, all soil and sand should be regarded as potential sources of human infection. This factor increases the chance of *T. gondii* disease and possible infection in pregnant females, especially in those living in rural villages and suburban areas of the country. Hence, women with more contact with soil get easily infected as compared to those who have fewer contacts.

All of the evidence shows that the oral route is the most common mode of infection involving food preparation and consumption, with raw meat accounting for 30 to 63% of all infections (Cook *et al.*, 2000). The main risk factor for Toxoplasma infection consistently identified in all centers is undercooked or raw meat (Dubey, 2004). Meat consumption was also responsible for 30 to 63% of diseases in different European locations (Cook *et al.*, 2000). Our study demonstrated a risk of toxoplasmosis (38.1%) in positive patients who consumed Raw/undercooked meat, but not statistically significant (P = 0.689). About 47.6% of patients argued that they consumed beef every week. However, the consumption of beef is a significant risk factor for infection with toxoplasmosis in the study (P = 0.018). According to (Lass *et al.*, 2012). *T. gondii* oocysts were found in leafy greens. *T. gondii* infection can be spread by eating contaminated, unwashed vegetables and fruits or washing with contaminated water. Our findings also investigated the eating of raw vegetables and fruits, with a percentage of 77.1%, but they did not show any significance in our study (P = 0.094). However, it can be a factor for preventive measures and an awareness campaign if health issues are addressed to patients.

According to (Robert-Gangneux and Dardé, 2012), unpasteurized milk or milk products were responsible for 14% of infections in Lausanne, but just 5% or below elsewhere. In European countries, a considerable number of infections (14%to 49%) have remained unexplored and unexplained. Our study described that (61%) of total patients consume untreated/unboiled milk, but statistically, the result did not suggest milk consumption as a significantly remarkable risk factor for getting toxoplasmosis (P = 0.555). *T. gondii* has been isolated from the unpasteurized milk received from goats, sheep, and cows. Therefore, taking and using unpasteurized milk can lead to getting infected with toxoplasmosis.

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RECOMMENDATIONS

Routine antenatal screening for *T. gondii* to ensure early detection and management in pregnant women.

- Community-based health education focusing on hygienic practices, safe food handling, and awareness of pet- and soil-related risks.
- Promotion of food safety measures, particularly thorough cooking of beef and proper washing of vegetables and fruits.
- Counseling for pregnant women on minimizing exposure to cats, cat litter, and contaminated soil.
- Integration of toxoplasmosis prevention strategies into maternal and child health programs at the policy level.

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