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Prevalence of toxoplasmosis in Khyber Pakhtunkhwa: A Decade-Long review in Humans and Animals

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Toxoplasmosis is a zoonotic disease caused by a protozoan parasite known as Toxoplasma gondii, which can infect all warm-blooded animals, including humans. There are three forms of T. gondii: tachyzoite, bradyzoite (an intermediate host), and oocyst (found in cats). Current study reviews data for the past 10 years (2012-2022) regarding prevalence of toxoplasmosis in Khyber Pakhtunkhwa, Pakistan. The review involved both humans (both males and females, and women in different trimesters of pregnancy) and animals in the area. It was concluded that the prevalence of toxoplasmosis was higher during the first trimester of pregnancy compared to the second and third trimesters. Additionally, the highest prevalence of the disease was observed among individuals aged between 30 and 55 years, while the younger age group (15-30 years) showed a lower prevalence. Regarding animals, the prevalence of toxoplasmosis in sheep, goats, buffaloes, cows, and chickens in Khyber Pakhtunkhwa. The study revealed that the disease was more prevalent in sheep and goats but less so in chickens. Furthermore, in terms of gender-wise prevalence, female animals (sheep, goats, buffaloes, cows, and caged chickens) showed a higher rate of toxoplasmosis compared to their male counterparts. Based on the findings, the study suggests extending this research to other provinces of Pakistan to gain a comprehensive understanding of the overall status of toxoplasmosis in the country.

Keywords: Toxoplasmosis, Khyber Pakhtunkhwa, Zoonotic Diseases

INTRODUCTION

Zoonotic diseases nowadays is a burning issue and matter of great concern. *Toxoplasma gondii* is the leading cause of toxoplasmosis, which is a zoonotic disease with worldwide prevalence. One third of human population is infected by *T.gondii* globally (Sadiqui et al. 2018; Schlüter & Barragan, 2019; Vieira et al. 2019). It is believed that the parasite has ability to infect all warm blooded animals worldwide (Arranz-Solís et al., 2019). Infertility in domestic ruminants is also caused by this protozoan parasite (Kakooza et al., 2018). The disease is asymptomatic in case of acute infection; in immune-competent hosts 80% of primary *T. gondii* infections are asymptomatic. Following primary infection, *T. gondii* establishes suppressed infection, tachyzoite convert into the inactive bradyzoite form inside the tissue cysts. *T. gondii* primary infections are controlled by host immune system but when the cyst resides in eye region, it is activated and cause ocular toxoplasmosis, leading to vision loss. Toxoplasma encephalitis is caused in severe case which consists of multiple discrete brain lesions. Trans-placental toxoplasmosis (congenital toxoplasmosis) may also occur. In congenital toxoplasmosis mostly brain and eye becomes infected however extra-cranial pathology also occurs in up to half of neonates (Alday & Doggett, 2017). Disease may be ocular toxoplasmosis (infection of the eye) and congenital toxoplasmosis. Toxoplasmosis acquired in the immune-competent patient is mainly asymptomatic while toxoplasmosis acquired or reactivated toxoplasmosis in the immune-deficient (immune system

not fully functioning) patient is symptomatic (symptoms like headache, fever, muscle pain and respiratory tract infection that last for more than a month appear) (Ben-Harari & Connolly, 2019).

Tissue cysts (cysts that contain bradyzoites) sometime reside near or in the eye tissue that cause ocular toxoplasmosis. In this case patient loses vision because of damage to retinal tissues by *T. gondii*. Blurred vision or loss of vision is caused by destruction of Macula tissues in the eye. Lesions develop on the retina (Furtado et al., 2011). Vertical trans-placental transmission leads to congenital toxoplasmosis (CT), in which tacyzoite form of *T. gondii*, transfer from infected mother to fetus through placenta. In case of CT severe infection occurs in newborn baby at time of birth or later in life. Abnormalities like low mental development, encephalitis, vision problem and liver disability to perform function (Mustafa et al., 2019). Cat is the definitive host of this parasite. The life cycle of this parasite consist of three stages tachyzoite, bradyzoite and oocyte which consist of sporozoites. Tachyzoite is fast dividing form responsible for rapid spread of the parasite between cells and tissues and appearance of symptoms in patient. Bradyzoite is slow dividing form that exists dormant in tissue cyst unless the individual becomes severely immune compromised. Oocytes are shed in cat feces which becomes risk factor for the spread of diseases (Watson & Davis, 2019). The sexual cycle occur in the gastrointestinal tract of cats, cats infected when ingest tissue cysts containing bradyzoite. Oocyte rupture epithelium and release, finally shed in cat feces (Hill & Dubey, 2018; Kochanowsky & Koshy, 2018).

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Toxoplasmosis In Humans

(Khan et al., 2011) studied the prevalence of toxoplasmosis in Kohat. Out of the total obtained samples 14.4% (n=26) sample were seropositive for IgM while 85.5% (n=154) were seronegative for IgM Toxoplasmosis. The prevalence was high in first trimester i.e. about 20% (n= 12/60). Another study was designed to check the prevalence of *T. gondii* in the women of Malakand Agency, and Khyber Pakhtunkhwa, Pakistan. Out of 420 females, 276 females were infected. Highest rate of infection was about 63.77%, found in the age group of 21-30 years where as low prevalence was 0.72%, found in the age group of 41- 50 years and no patients were above 50 years. Out of 276 positive females, 51.44% (142) had contact with cats and 48.55% (134) females had no contact (Khan et al., 2014). (HasnainJan et al., 2018) conducted a study in Chitral Khyber Pakhtunkhwa. Out of 300 tested samples, 74 were found infected with *T. gondii* showing an overall 24.7% prevalence. Infection rate was higher in women aged 25 years, infection rate was almost double (33.1%) in women from Upper Chitral, rural areas than from Lower Chitral, i.e. urban areas 18.8%.

Sero prevalence of Toxoplasmosis in inborn was studied in District Swabi, KPK. Among 100 pregnant women 12% were reported positive for T. gondii. It was found that women at the third trimester were at greater risk to be positive for congenital toxoplasmosis. The prevalence was about 6.45% (n=2), 8.82% (n=3) and 20% (n=7) in the 1st, 2nd and 3rd trimester respectively. According to age wise distribution of toxoplasmosis, the females were divided into three age groups i.e. from 17-23 years old with prevalence about 18%, second age group was 24-30 years with prevalence of 2% and the third age group was from 31-36 years old in which 25% prevalence was recorded. Regarding age factor, women at the age of 31-36 showed high prevalence i.e. 25% for toxoplasmosis (Shah et al., 2017).

Another study reported the seroprevalence of *T. gondii* in pregnant women in district Swat, KP, Pakistan. The prevalence was 47.2%. In association of age with toxoplasmosis the population was divided into two groups i.e. from 18-25 years and 26-33 years. The highest seropositivity i.e. about 54.7% was observed among individual of the age group 26-33 years as compared to 38.8% amongst the age group of 18-25 years. A significant difference was observed in seroprevalence between educated 22.07% and uneducated 66.01% females. As for the trimester wise relation of this disease, at the 1st trimester prevalence was 61.7%, while at the 2nd and 3rd trimester the prevalence was 58.4% and 27.7% respectively (Aleem et al., 2018). The overall prevalence of toxoplasmosis in pregnant women with reference to each trimester as well as age wise prevalence has been shown in table 1 and 2 respectively.

Toxoplasmosis in Animals

The prevalence in animals was about 51.30% (n=275), 52.4% (n=247), 33.9% (n=60), 72% (n=72), 18.84% (n=101) in sheep, goats, buffaloes, cows and chickens, respectively. The highest prevalence was recorded in sheep 51.30% and goats 52.4%, however little difference occurred in their prevalence. Gender wise, highest prevalence of about 44.9% was recorded in females as compared to male gender with prevalence of 35.4% of the respective animals (Table 3).

Table 1: Prevalence of Toxoplasmosis in pregnant women

District	1st trimester %age (n)	2nd trimester %age (n)	3rd trimester %age (n)	Total Prevalence	References
Kohat	20% (12)	18.6% (13)	2% (1)	14.4%	(Kochanowsky & Koshy, 2018)
Swabi	6.45% (2)	8.8% (3)	20% (7)	12%	(Shah et al. 2017)
Swat	61.7% (71)	58.4% (59)	27.7% (40)	47.2%	(Aleem et al. 2018)

Table 2: Prevalence of Toxoplasmosis in human

District	Age Group (year)	High Prevalence (%)	Age Group (year)	Low Prevalence (%)	References
Malakand Agency	21-30	63.77%	41-50	0.72%	(Khan et al. 2014)
Chitral	25	High	Above 25	Low	(Hussain Shah et al. 2016)
Swabi	31-36	25%	24-30	2%	(Shah et al. 2017)
Swat	26-33	54.7%	18-25	38.8%	(Aleem et al. 2018)
Charsadda	26-40	54.55%	41-55	21.87%	(Faisal et al. 2018)
Mardan	31-45	29.41%	Below 15	10%	(Kamal et al. 2019)
Charsadda	46-55	35.41%	15-25	8.33%	(HasnainJan et al. 2018)

Table 3: Prevalence of Toxoplasmosis in Animals

Animals	Total	Infected (%)	Male	Infected	Prevalence	Female	Infected	Prevalence	Reference
Sheep	290	44.13 %	120	55	45.83%	170	73	42.94%	(Shah et al. 2013)
Sheep	103	86.40 %	33	25	84.78%	70	64	91.42%	(Kamal et al. 2019)
Sheep	143	40.55 %	78	26	33.33%	65	32	49.23%	(Kamal et al. 2019)
Total	536	51.30 %	231	106	45.88%	305	169	55.40%	
Goats	350	42.3%	150	39	26%	200	109	54.5%	(Shah et al. 2013)
Goats	121	80.9%	29	21	72.41%	92	78	84.78%	(Kamal et al. 2019)
Total	471	52.22 %	179	60	33.51%	292	187	64.04%	
Buffaloes	50	76%	13	10	76.92%	37	28	75.67%	(Kamal et al. 2019)
Buffaloes	127	17.32 %	40	5	12.5%	87	17	19.54%	(Kamal et al. 2019)
Total	177	33.9%	53	15	28.30%	124	45	36.3%	
Cows	100	72%	39	27	69.23%	61	45	73.8%	(Kamal et al. 2019)
Chickens (caged)	68	5.9%	10	0	0%	58	4	6.89%	(Mahmood et al. 2014)
Chickens	468	20.72	152	27	17.80%	316	70	22.20%	(Mahmood et al. 2014)

CONCLUSION

We concluded significant trends in the prevalence of toxoplasmosis in various populations. Firstly, among pregnant women, the disease is more prevalent during the first trimester, necessitating targeted awareness and preventive measures during this crucial period of pregnancy. Regarding age, a notable concentration of cases was observed in the age group of 30-55 years, while the younger age group of 15-30 years exhibited a lower prevalence of toxoplasmosis. In the animal population, we found that toxoplasmosis is more common in sheep and goats, while chickens displayed a lower prevalence. Additionally, among animals, females were more susceptible to the disease compared to males, indicating a potential gender-related influence on disease transmission.

Considering that toxoplasmosis is more prevalent in pregnant women during the first trimester, it is essential to prioritize educational campaigns and awareness programs

targeted at this specific group. These initiatives should focus on the modes of transmission, preventive measures, and the potential risks posed to the developing fetus. Given the low prevalence of toxoplasmosis in younger women (15-30 years), it is prudent to establish early screening protocols for pregnant women in the age group of 30-55 years, which was identified as having the highest number of cases. Early detection can lead to timely interventions and reduce the risk of severe consequences for both the mother and the unborn child. Since the disease is more prevalent in sheep and goats and less so in chickens, there is a need for targeted interventions in high-risk animal species. These may include improved management practices, vaccination programs, and regular monitoring to control the transmission of the parasite and reduce the risk of transmission to humans.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

AK presented the idea, IU has supervised and wrote the manuscript, IK, MI and SU did the experiment. SU reviewed and reform the manuscript. All authors read and approved the final version.

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