

# Role of Environment in Cross Species Transmission of *Toxoplasma gondii*, Current Status and One Health Approach in Pakistan

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Received: 03.Sep.2016; Accepted: 23.Sep.2016; Published Online: 24.Dec.2016

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## Abstract

Toxoplasmosis is important zoonotic disease. This disease infected multiple species of birds, mammals, reptile and amphibian. Moreover, multiple complications have been reported in human and livestock which is important in term of their health and adverse effects on economic of country. Role of environment is very important in cross-species transmission of said zoonotic disease. In Pakistan, studies are available on animal, human and detection of said parasites from environmental samples. But there is no single study available where one health approach has been used. That's why present review will focus on brief introduction toxoplasmosis, complications in human and animals, current status of *Toxoplasma gondii* infection in Pakistan and worldwide, transmission of *T. gondii* from environment to human, role of Wildlife in transmission of *T. gondii* in human and detection of *T. gondii* in environmental samples. Final, we will discuss that how can one health approach be useful for the control of environment role in transmission of infection in Pakistan.

**Keywords:** Toxoplasmosis, cross-species transmission of zoonotic disease, *Toxoplasma gondii*.

**To cite this article:** Ali, S., 2016. Role of Environment in Cross Species Transmission of *Toxoplasma gondii*, Current Status and One Health Approach in Pakistan. PSM Vet. Res., 01(2): 46-49.

## INTRODUCTION

*Toxoplasma (T.) gondii* cause infection in warm blooded organism including birds and humans. It is responsible for one of the most widespread zoonotic parasitic infection. Vertebrates become infected by ingesting sporulated *T. gondii* oocysts from the environment or by ingesting *T. gondii* tissue cysts present within the tissues of intermediate hosts (Hladikov *et al.*, 2008). Cats are the only definitive hosts because parasite completes its sexual stage of life cycle in it and cats excrete millions of oocysts of *T. gondii* in their faeces and thus contaminate the environment (Gennari *et al.*, 2014).

Moreover, feces of *T. gondii* positive birds contaminate the human's food like vegetables, fruits and water. Consumption of these contaminated food items is a source of infection of toxoplasmosis in humans. Furthermore, the ingestion of the infected bird's meat is considered an important source of infection in humans. Toxoplasmosis leads to abortions and neonatal anomalies in humans. Severely infected infants may have the complete series of pathognomonic signs like retinochoroiditis, intracerebral necrosis followed by cerebral calcification, convulsions, and hydrocephalus (Sakikaw *et al.*, 2012).

## Complications in human and animals

This parasite is the main cause of multiple abnormalities and complications related to reproductive and nervous systems of humans and animals. In case of humans abortions and other birth related defects are common. Livestock farmers suffer from heavy economic losses due to abortions in multiple livestock species caused by said parasite (Sibley *et al.*, 1999). Being zoonotic agent humans having close contact with livestock especially aborted animals are always at high risk.

In case of poultry birds they mostly don't show any specific clinical signs and symptoms. However, few clinical symptoms like feed refusal, lethargy, fever, diarrhea and dyspnea are common (Andreoletti *et al.*, 2007).

## Current status of *T. gondii* infection in Pakistan and worldwide

Prevalence rate of *Toxoplasma gondii* varies in different countries (Shah *et al.*, 2014). Toxoplasmosis is reported 30% in Europe and generally 10% is observed across USA (Hill and Dubey, 2002). The highest rate of toxoplasmosis is recorded across Serbia and Poland 58% and 60% respectively (Hasan, 2011). Apart from other countries, toxoplasmosis is also reported in humans and animals of Pakistan. Estimated, about 33% of the human

population may harbor this parasite; however its prevalence rate varies with climate and nutritional factors (Shah *et al.*, 2013b). Improved animal husbandry practices and increased awareness can minimize the potential hazards of *T. gondii* across the globe (Weiss and Dubey, 2009; Shah *et al.*, 2013a). The previous studies recorded *T. gondii* in goats (42.28%) and sheep (44.13%), respectively in district Mardan. However, overall infection recorded in district Mardan was 43.12 % (Shah *et al.*, 2013a). Similarly toxoplasmosis was recorded in federally administrated tribal area, in Mohammad agency with 32.29% in farm animals (Shah *et al.*, 2013). About 43.5% cattle were found to be positive for antibodies of *T. gondii* in district Khanewal, Punjab, Pakistan (Tasawar *et al.*, 2013). Recently, the seroprevalence of human *T. gondii* has been recorded in district Mardan, Pakistan (Shah *et al.*, 2014).

Backyard poultry is considered as an excellent source of protein and livelihood of rural peoples especially in under develop and developing countries. However, it is important source of many zoonotic diseases transmission in human population. As, *T. gondii* infection has been reported in backyard poultry in diverse countries like India, Brazil and Egypt (Devada *et al.*, 1998; El-Massry *et al.*, 2000; Silva *et al.*, 2003). Moreover, about 36.33% poultry birds were found to be positive for antibodies of *T. gondii* in district Faisalabad, Pakistan (Akhtar *et al.*, 2014).

#### **Transmission of *T. gondii* from environment to human**

Toxoplasmosis infects a large number of human beings in world (Dubey *et al.*, 2010). Infection usually transmitted in human beings by contaminated food and environment (Elmore *et al.*, 2010). In case of humans, congenital infections during pregnancy and diseases in immune compromised patients can be severe (Montoya and Liesenfeld, 2004; Zhou *et al.*, 2011). Transmission and spread of infection among humans is mainly through inhalation or ingestion of oocysts discharged in the faeces of infected cats, inoculation of trophozoites through the skin, drinking raw cow milk or contaminated water, ingestion of birds' eggs and by eating raw or undercooked infected meat (Sabin and Olitsky, 1937; Sadaruddin *et al.*, 1991). Cat is well-known as definite host for toxoplasmosis. Therefore humans or animals having close contact with cats are at high risk for acquiring said diseases. The transmission of toxoplasmosis from pet cats and dogs to humans (their owners) is investigated in Pakistan (Shahzad *et al.*, 2006). The possible reason of transmission of toxoplasmosis from these pets to humans is that people of urban areas of Pakistan like Lahore mostly own a pet but they don't have any knowledge about zoonotic diseases that are transmitted from pets to humans. Moreover, there are no rules and regulations for disease free or vaccinated pets availability in Pakistan. That's why owning a diseased or non-vaccinated pet increase the burden of disease on human population of a country like Pakistan.

The transmission of zoonotic *T. gondii* from animals (Buffaloes) to human (slaughter house worker) has been confirmed using serological (LAT = Latex Agglutination Test) and molecular methods (PCR = Polymerase chain reaction) in a study conducted in slaughter house of Lahore, Pakistan (Chaudhary *et al.*, 2006).

Apart from above mentioned animals, backyard poultry in a country like Pakistan is major source of *T. gondii* infection in humans. Because these poultry birds most feed from the ground and ground environment is mostly infected with cat feces having oocytes of said parasite which transferred to poultry and then ultimately to their end user human being (Dubey and Jones, 2008).

#### **Role of wildlife in transmission of *T. gondii* in Human**

*T. gondii* is responsible for the high morbidity and mortality in warm blooded organisms including mammals and birds (Dubey, 2002). The feces of toxoplasmosis positive birds contaminate the human food like vegetables, fruits and water. Consumption of these contaminated food items is a source of infection of toxoplasmosis in human.

Pet birds are important source of human infection and they are reservoirs of different disease causing agents naturally. Moreover, cats having contact with humans play important role in transmission of *T. gondii* to human when any cat eat on dead or live birds carry oocysts (Cong *et al.*, 2014).

Birds belong to various species have been reported having infection of toxoplasmosis on the basis of clinical sign and symptoms (Dubey, 2002; Tenter *et al.*, 2000; Aubert *et al.*, 2008; Dubey, 2010). Studies on wild birds are limited but there is need of usage of one health approach, in which we can monitor presence of oocysts in environment. One of ideal ways is the investigation of cause of dead birds which might be due to presence of specific pathogen in that environment (Dubey and Jones, 2008; Gondim *et al.*, 2010).

In Pakistan, antibodies of toxoplasmosis has been detected in wild animals (*Rattus rattus* and *Mus musculus*), these animals have close association with human beings. Moreover, humans from same localities were also found positive for toxoplasmosis. This is proof of possible transmission of toxoplasmosis from wildlife to humans (Ahmad *et al.*, 2013).

#### **Detection of *T. gondii* in environmental samples**

In case of one health approach, the role of environment is very important in term of reservoir and transmission of diseases from one host to another. Environmental surveillance and monitoring is very important for human and veterinary public health. Multiple tools are used for detection of burden of pathogen in any environment. Toxoplasmosis is detected in environment matrices i.e. raw meat, contaminated soil and water, vegetables and fruits in Pakistan and other countries using

PCR (Afonso *et al.*, 2008; Sroka *et al.*, 2006; Ajmal *et al.*, 2013; Khan *et al.*, 2013).

It is well-known that change in environmental factors i.e. urbanization, habitat loss, biodiversity deprivation, global warming and over population of human play important role in dispersal, incidence and spread of Toxoplasmosis (Yan *et al.*, 2016). However, still no study has been conducted in Pakistan in which role of such environmental factor has been evaluated for the spread of toxoplasmosis.

## Conclusion and Recommendations using One Health Approach

It is cleared from above review of literature that toxoplasmosis is prevalent in every part of world. Moreover, multiple species are infected with said disease. Being a zoonotic disease, its transmission from one species to other species is important in term of human and veterinary public health. Moreover, toxoplasmosis is detected in various environmental matrices from Pakistan like other countries. So condition is alarming with respect to toxoplasmosis. So there is dare need of usage of **ONE HEALTH APPROCH** for control and eradication of said disease from country like Pakistan. Studies based on **VECTOR, HOST AND ENVIRONMENT** monitoring will be ideal for surveillance of toxoplasmosis in Pakistan. Combined effort of scientific team belongs to medical doctor, epidemiologist, veterinarians and environmentalist will be ideal for such type of work in Pakistan.

Moreover, public awareness campaign is also critical part of **ONE HEALTH APPROCH**. General public should be trained for role of environment in spread of zoonotic diseases like toxoplasmosis. They should be educated that always use vegetables, fruits and other food stuffs after proper washing. Meat especially **Bush Meat** should be properly cooked before consumption. Contact with bird's especially wild birds should be limited. Cover food and water reserves of your houses because birds and other wild animals contaminated them via urination and their feces. Similarly, entry of wildlife and cats should be restricted in livestock and poultry farms because of their disease causing agent carrying ability.

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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