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Review on Toxoplasmosis in Animals and Human with Particular Emphasis to Ethiopian Situation

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Abstract: Toxoplasmosis is widely distributed in the world and prevalent among animals and humans with varied infection rate. It is an important cause of abortion, stillbirth and neonatal mortality in sheep and goats. Usually, it causes embryonic death and resorption, fetal death and mummification in animals. In goats and sheep abortion, stillbirth and neonatal death are common sequels of the infection. It causes heavy losses through abortion, stillbirth, neonatal mortality, encephalitis and pneumonia particularly in sheep and goats. Toxoplasmosis caused by the protozoan parasite, *Toxoplasma gondii*, is a worldwide zoonosis. In this paper toxoplasmosis in humans and other animals in Ethiopia is reviewed based on existing information. Limited data indicate that the prevalence of *T. gondii* in humans in Ethiopia is very high, up to 41% of children aged 1-5 years were reported to be seropositive. There is little information on sero-prevalence data in pregnant women and no data on congenital toxoplasmosis in children. About 1 million adults in Ethiopia are considered to be infected with HIV with less than one-third likely receives highly active antiviral therapy. Based on a conservative *T. gondii* sero-prevalence of 50%, thousands might die of concurrent opportunistic infections, including toxoplasmosis. However, exact figures are not available and most serological surveys are not current. Serological surveys indicate up to 79% of goats and sheep have *T. gondii* antibodies. However, there is no information on losses due to toxoplasmosis in livestock or the presence of viable *T. gondii* in any host in Ethiopia.

Key words: Epidemiology · Ethiopia · Humans · Sero-Prevalence · *Toxoplasma gondii*

INTRODUCTION

Toxoplasmosis affects up to one-third of the world's population. It can produce a wide range of clinical manifestations or, in most cases, progress asymptomatically [1]. Humans acquire the infection by the oral route through the consumption of undercooked meat contaminated with cysts, food products or water contaminated with oocysts [2]. Contamination of pregnant women may cause serious health problems if the parasite is transmitted to the foetus to cause congenital toxoplasmosis. The congenital form results in a severe systemic disease because if the mother is infected for the first time during gestation, she can present a temporary parasitemia that will infect the foetus. Congenital toxoplasmosis may cause abortion, neonatal death, or foetal abnormalities with detrimental consequences for the foetus [3, 4]. *T. gondii* tachyzoites have been detected in milk of ewes and goats and some occurrences of human toxoplasmosis have been attributed to the consumption of non-pasteurized goat milk [5, 6].

The epidemiological situation of *T. gondii* in domestic ruminants used as a source of milk and meat for human consumption in Ethiopia is found in sharp contrast with the lack of adequate information. The available data are limited to the central part of the country mainly focusing to small ruminants, where the sero-prevalence range from 22.9%-56% in sheep and 11.6%-74.8% in goats [7-9]. Similarly, in human few studies were conducted and Sero-prevalence of 60-96.7% have been documented by Negash *et al*. and Shimelis *et al*. and Guimarães *et al*. [10-12]. Certainly, this shortage of information will be a challenge for knowledge based control activities against *T.gondii* among humans and animals in the country.

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History of Toxoplasmosis: *Toxoplasma* was first discovered in the desert rodent *Ctenodactylusgundi* by Charles Nicolle and Louis Manceaux at the Institute of Pasteur in Tunis in 1908. At about the same time, Alfonso Splendore independently discovered *Toxoplasma* in a rabbit at Sao Paulo [13]. The name *Toxoplasma* (toxon = arc, plasma = form, in Greek) was derived from its crescent shape. The discovery of a *T. gondii* specific antibody test, Sabin-Feldman dye test, in 1948 led to the recognition that *T. gondii* is a common parasite of warm blooded hosts with a worldwide distribution. Also the *T. gondii* life cycle was completed by the discovery of the sexual phase of the parasite in the small intestine of the cat**.** Its medical importance remained unknown until 1939 when *T. gondii* was identified conclusively in tissues of a congenitally-infected infant in New York City**.** Likewise, the veterinary importance of *T. gondii* became known when it was found to cause abortion storms in sheep in 1957 [14]. *Toxoplasma gondii* is one of the most well studied parasites because of its medical and veterinary importance. It is used extensively as a model for cell biology of apicomplexan organisms [15]. *T. gondii* is ubiquitous parasite found in all classes of warm blooded vertebrates. Nearly one-third of humans have been exposed to this parasite Inimmunocompetent adults, acute infection normally results in transient influenza-like symptoms [16].

The Parasite: *Toxoplasma gondii* belongs to the Kingdom Animalia, Phylum Apicomplexa, Class Protozoa, Subclass Coccidian, Order Eucoccidia, Family Sarcocystidae and Genus *Toxoplasma*. It is an obligate intracellular protozoan parasite that has a characteristically polarized cell structure and a complex cytoskeletal and organellar arrangement at their apical end, the conoid, involved in cell invasion and numerous secretory organelles rhoptries (ROPs), dense granules and micronemes [17, 18]. *T. gondii* was previously considered that it consists various strains related to three clonal lineage, type I, II and III, which differ in virulence and epidemiological pattern of occurrence [19] while more recent studies on *T.gondii* strains revealed the presence of a higher genetic variability of the parasite [20, 21]. In spite of the fact that many protozoan parasites have a zoonotic transmission, toxoplasma considered to be the most successful parasite due to its efficient transmission through ingestion of infective oocysts in contaminated food and water or ingestion of tissue cysts in undercooked meat [23].

Three infectious stages of *T. gondii* could be found in all hosts, Tachyzoites are often crescent shaped and 2×6 µm in size, their anterior ends are pointed and the posteriors are round [28]**.** Tachyzoites enter host cells by active penetration of host cell membrane and become surrounded by a parasitophorous vacuole (PV). In PV, tachyzoite replicates asexually by repeated binary division (endodyogeny) until the rupture of the host cells, then quickly changes to a slow growing phase and give rises to bradyzoite (tissue cysts). Bradyzoites enclosed in tissue cyst have slender and crescent-shaped each measuring 7 µm to 1.5 µm. Tissue cysts contain hundreds and thousands of bradyzoites vary in size from 5µm to 70µm and have a high affinity for neural and muscular tissues. Hence, they are more prevalent in the central nervous system (CNS), the eye as well as skeletal and cardiac muscles. However, they may also be found in visceral organs, such as lungs, liver and kidneys. Oocysts (sporozoites) are spherical in shape, 10×12 ìm in size. *T. gondii* in the small intestine of the definitive host undergoes a typical coccidian development, resulting in the shedding of unsporulated and noninfectious oocysts in cat feces. The oocysts sporulated within 1-5 days after shedding in cat feces and produced eight sporozoites that are highly infectious to animals and humans. Oocysts containing sporozoites are infective when ingested by mammals (including man), multiply in reticuloendothelial cells and give rise to the tachyzoite stage [24]**.** The oocyst wall is an extremely robust multilayer structure protecting the parasite from mechanical and chemical damages. It enables the parasite to survive for long periods, up to more than a year, in a moist environment [25].

Life Cycle: The life cycle involves two developmental stages, an enteroepithelial, in cats and other felines and the extra-intestinal stages both in cats and other intermediate hosts. The sexual reproduction occurs only in the intestine of cats. After the ingestion of tissue cysts by cats, the tissue cyst wall is dissolved by proteolytic enzymes in the stomach and small intestine. The released bradyzoites penetrate the epithelial cells of the small intestine and initiate the development of numerous generations of *T. gondii*. Five morphologically distinct types (A to E) of *T. gondii* develop in intestinal epithelial cells before gametogonybegins. The sexual cycle starts two days after ingestion of tissue cysts by the cat. The origin of gamonts has not been determined, but the merozoites released from schizont types D and E probably initiate gamete formation. Gamonts occur throughout the small intestine but most commonly in the ileum, 3 to 15 days after inoculation [26]. Microgametes use their flagella to swim to, penetrate and fertilize mature macrogametes to form zygotes. After fertilization, an oocyst wall is formed around the parasite. Infected epithelial cells rupture and discharge oocysts into the intestinal lumen subsequently shedding with cat feces to the environment. Infected cats can shed more than 100 million oocysts in their feces [27].

The asexual reproduction of *T. gondii* undergoes two phases of development in various tissues of intermediate hosts. In the first phase, tachyzoites (or endozoites) multiply rapidly by repeated endodyogeny. The last generation of tachyzoites gives rise to the second phase of development which results in the formation of tissue cysts. They found predominantly in the central nervous system (CNS), the eye as well as skeletal and cardiac muscles. Bradizoites (or cystozoites) multiplies slowly by endodyogeny within the tissue cyst [28].

Epidemiology of Toxoplasmosis: *Toxoplasma gondii*, can infect almost all the homeothermic animals, including human beings throughout the world, the prevalence of the disease in different species varies depending on the epidemic area, socio-cultural habits, geographical and climatic factors. Prevalence rate may also be associated with the presence of cats that excrete oocysts, which after sporulation become infectious to man and animals [29, 30]. *Toxoplasma gondii* oocyst are shed by domestic cats and other felines resulting in wide spread contamination of the environments, where the sporulated oocysts survive in moist soil for months to years [31, 32, 28].

Prevalence and transmission of *T. gondii* in animals and humans in Ethiopia: In Ethiopia, different authors reported the sero-prevalence of *T.gondii* in domestic ruminants that ranges from 22.9%-54.7% in sheep and 11.6%-74.8% in goats [34-37]. The most recent report from the eastern part of Ethiopia by Berhanu Tilahun *et al*. [37] revealed the overall prevalence of *T. gondii* infection in domestic ruminants 22.2% (302/1360).

Toxoplasma gondii in human have showed variation among different groups of people, where the sero-prevalence range from 74.4% to 96.7 [38, 41]. Humans become infected with *T. gondii* mainly by ingesting food or water contaminated with oocysts and by ingesting uncooked meat containing viable tissue cysts. Infected animals usually bear cysts of *T. gondii* in different body tissues and human can take infection due to consumption of raw or undercooked meat. Consumption of cattle and sheep meat as well as raw milk from goats and camel infected by *T.gondii* could be a risk for congenital transmission in pregnant woman [37, 39, 40, 42]. Fresh consumed home-made cheeses produced in small family-based farms from contaminated milk without previous milk pasteurization can represent a risk factor for public health [43]. In humans, vertical transmission has been associated with abortions, stillborn and variable morbidity [44]. Recently water-born transmission of *T. gondii* was considered uncommon but a large human outbreak linked to contamination of a municipal water reservoir in Canada by wild felids has been reported [45]. Oocysts in soil can be spread mechanically by flies, cockroaches, dung beetles and earthworms. They are known to survive on fruits and vegetables for long periods [46].

Conclusion and Perspectives: It could be concluded that *T. gondii* infection is more common and widespread among domestic ruminants and human in Ethiopia. Thus, the higher sero-prevalence encountered in animal used as a food source revealed the potential risk of *T. gondii* infection to people might be through consumption of their raw meat and milk. Therefore, awareness creation works should be conducted among public on the means of transmission and prevention of *T. gondii* infection. The prevalence of *T. gondii* in humans in Ethiopia should further be conducted to determine the source of infection too. The exact figure on toxoplasmosis of animals and human are not available and most serological surveys are not current. Strategic and planned survey is needed for *T. gondii* prevalence in different age groups, especially pregnant women. Attempts should be made to isolate viable *T. gondii* from food animals, cats and humans since nothing is known of the genetic diversity of *T. gondii* strains prevalent in humans and other animals in Ethiopia.

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