Parasitic zoonoses in India: an overview

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Summary
Parasitic zoonotic diseases are prevalent throughout India at varying rates. First reports of zoonotic parasites and new emerging diseases have been recorded in both the human and animal populations in recent decades. The prevalence of zoonotic parasites is likely to be an underestimate, owing to the lack of proper surveillance and the shortage of information about the existence of asymptomatic animal carriers. Emergence of diseases such as human echinococcosis/hydatidosis, neurocysticercosis, cryptosporidiosis and toxoplasmosis in those with acquired immune deficiency syndrome, together with the re-emergence of cutaneous leishmaniosis, poses a serious threat in India and the prevention and control of these parasitic zoonoses, and others, is a great challenge.

Keywords
Epidemiology – India – Parasitic zoonosis.

Introduction
India is the seventh-largest country in the world; an unimaginable disparity exists in the geography, ethnicity, religion, food and personal habits, level of education and standards of living within the country (83). The 2001 census showed that 72.2% of the population lived in villages and over 70% of the rural population owned livestock. Thus, livestock plays a pivotal role in the socio-economic life of India. Parasitic zoonoses affect human and animal health directly, and consequently affect livestock production. Zoonoses of parasitic origin are prevalent throughout India at varying rates (62). Factors such as poverty, lack of personal hygiene, defecating in open spaces, scarcity of potable water, abundance of stray animals, high population density, and certain culinary habits are responsible for the rising prevalence of zoonoses in India. These factors have a direct bearing on the frequency of parasitic infection(s), and consequently the prevalence of infection varies in different states of India. Protozoa are the best-represented group of parasites that infect humans and other animals, of which Cryptosporidium parvum, Toxoplasma gondii, Leishmania spp., Giardia duodenalis, Sarcocystis spp. and Entamoeba histolytica are the major examples. The main helminth zoonoses include echinococcosis and cysticercosis, as discussed later in this review. The emergence of diseases such as echinococcosis, cysticercosis, cryptosporidiosis and toxoplasmosis and the re-emergence of diseases such as leishmaniosis are a serious threat and their prevention and control is difficult. This review focuses on the major parasitic zoonotic infections that are prevalent in India.

Cryptosporidiosis
Cryptosporidiosis has been reported worldwide. Cryptosporidium parvum (genotype 2) is widespread in humans and other mammals. Cryptosporidium parvum is an emerging zoonotic protozoan parasite of calves, and is associated with diarrhoea in children (47). Cryptosporidiosis in India has been reported from the north (90), south (43), east (16) and west (71), with prevalence values of 4.3%, 13.0%, 5.5% and 5.6%,
respectively. The rate of Cryptosporidium infection has been found to be significantly higher in urban slum areas (49) and in patients with diarrhoea (15, 48). Cryptosporidium parvum has been reported to be the most common parasite observed in individuals positive for human immunodeficiency virus (HIV) (46). Cryptosporidium oocysts have also been detected in drinking water supplies (3). The infection in bovids has been found to be more prevalent (35.4%) in the northern parts of the country than in the eastern or southern parts (64). A recent two-year study in Kolkata that tested 470 bovine faecal samples per year reported the prevalence to be 17.46% in the first year and 18.04% in the second (68). The shedding and intensity of shedding have been found to be significantly higher in calves with diarrhoea (82). Genotype surveys are required to determine whether calves or other bovids serve as a major reservoir for C. parvum infection in humans.

Toxoplasmosis

Toxoplasma gondii is an intestinal coccidium of felids, with an unusually wide range of intermediate hosts that include sheep, goats, pigs, and humans. Central nervous system toxoplasmosis in individuals with acquired immune deficiency syndrome (AIDS) is an emerging disease in India (44). In the first national serological survey of T. gondii in India (21), a total of 23,094 serum samples were tested for antibodies to the parasite. Immunoglobulins (Ig) IgG and IgM were detected with the use of a solid-phase immune capture enzyme-linked immunosorbent assay; IgG and IgM antibodies were found in 24.3% and 2% of the samples, respectively. The lowest seroprevalence values were obtained in the northern parts of India, with the highest in the south. The data probably reflect the effect of significantly drier conditions in the north and, therefore, reduced survivability of T. gondii oocysts. Other workers have also reported the seropositivity to one or both classes of antibodies to vary from 17.2% to 22.6% (31, 51).

The rate of toxoplasmosis in India shows a wide variation, and one study has reported a figure as high as 77% in women of reproductive age (85). This might be due to the fact that the study was conducted in patients clinically suspected to have toxoplasmosis. There are very few reports of the prevalence of this parasitic infection among pregnant women from north-east India; however, one report showed that the seroprevalence of T. gondii infection among pregnant women in the area, measured using enzyme immunoassay kits, was 44.6% in women with a history of pregnancy loss (n = 112) and 36.8% among those with no such history (n = 68) (8). A higher prevalence of T. gondii infection has been recorded in women belonging to low socio-economic groups. It has also been observed that the seroprevalence of T. gondii in humans is low, compared with that in Western countries (24). This may be due to a preference for pet dogs rather than cats and a large vegetarian population. The overall prevalence measured using the indirect haemagglutination antibody test (titre 1:64 or more) varied between 2.2% and 4.8% in buffaloes, cats, cattle, dogs and horses (as well as mules and donkeys). Higher seroprevalence was observed in pigs (14.0%), sheep (7.9%), goats (8.8%) and camels (7.5%) (cited in 22). The prevalence of T. gondii in cats (2.5%) is low when compared with that in Western countries (cited in 22).

Overall, the seroprevalence of 8% in sheep and goats in India is also low compared with that in other countries (23, 25). The prevalence of T. gondii antibodies in sera from naturally infected pigs varies from around 14% to 31% in different parts of India (24).

Higher titres and seropositivity were observed frequently in older ewes and does (10). A prevalence of approximately 10% has been reported in pigeons. A study was conducted to isolate and genotype T. gondii from free-range chickens (Gallus domesticus) in villages in the Maharashtra and Tamil Nadu states of central and south India, respectively (87). Genotyping using the SAG 2 locus identified isolates of types II and III. Antibodies to T. gondii, as assayed with the modified agglutination test (≥1.5), were found in 133 chickens (17.9%).

Leishmaniosis

Leishmaniosis is a complex group of syndromes which are endemic throughout the world and affect 88 countries (50).

Cutaneous leishmaniosis

Cutaneous leishmaniosis (CL), caused by Leishmania tropica, was confined to hot dry north-western regions of India and it is endemic in the western Thar deserts of Rajasthan (50), with reports of sporadic cases from Punjab, Delhi, Haryana and Gujarat (41, 75). There are reports of new foci of infection in various parts of India (7, 77), for example, CL was not reported from Kerala State before 1988, but many cases have been recorded since then (7, 40). This is of considerable public health interest in view of a newly recognised reservoir area of CL in south India. Further investigations are required to identify potential vectors and the reservoir host. Both dogs and rodents serve as the zoonotic reservoir for CL in the Thar desert (1). In Bikaner, in dogs, a major reservoir, incidence rates of 6.8% and 6.12% were recorded during 1985 (53) and 1999 (11), respectively.
Taeniosis and cysticercosis

The prevalence of taeniosis in humans varies from 0.75% to 1.0% in certain communities, particularly in rural areas, where there is more contact with the pig population. In India, neurocysticercosis is an important emerging disease of the central nervous system, second to tuberculosis. Neurocysticercosis is also emerging as one of the principal causes of epilepsy. The occurrence of *Cysticercus cellulosae* in the muscles of pigs is very well established in different parts of India, with an overall prevalence ranging from 3% to 26% (13, 18, 65, 66, 72, 76, 92). In India, little information on *Taenia saginata* is available due to a ban on the slaughter of cows and the fact that beef is not consumed on religious grounds.

Echinococcosis/hydatidosis

Echinococcosis or hydatidosis is an infection caused by a larval stage (the metacestode) of *Echinococcus* species. It can range in severity in humans from asymptomatic infection to serious disease, and can even be fatal in some cases. Human echinococcosis caused by *Echinococcus granulosus* continues to be a significant public health problem. In several regions of India, there are alarming indications of increasing human health risks associated with echinococcosis. Increasing trends in the seroprevalence of human hydatidosis have been observed in north India (38) and there are numerous reports and surveys that reveal the occurrence of human hydatidosis in most states (12, 36, 38, 39, 57, 91). The conditions in the country are ideal for the establishment and transmission of hydatidosis in both livestock and humans. Cultural, educational, socio-economic, agricultural and environmental factors contribute to the transmission of the disease. The presence of stray dogs and fallen carcasses plays an important role in the transmission of the disease in the country. *Echinococcus granulosus* has a wide geographical distribution in livestock (32, 93), and it is prevalent throughout the country. The overall prevalence of *E. granulosus* cysts in southern India was 7.0% (106/1,519), 7.1% (31/439), 9.4% (46/489) and 11.5% (10/87) in sheep, cattle, buffalo and pigs, respectively (29). Another study carried out from 1995 to 1997 in Puducherry showed higher infection rates: 9.6% (72) in sheep and 47.6% (680) in goats (17). In Uttar Pradesh, the prevalence of *E. granulosus* was found to be 2.9% (9/312), 1.4% (39/2,710) and 0.9% (27/2,980) in sheep, goats and pigs, respectively (19).

Trichinellosis

Although infection with *Trichinella* spp. is globally distributed, it has been documented only rarely in India. Human trichinellosis has been recorded only once, in 1996 (2). A few case reports have been documented from Bombay and Kolkatta, in cats and in domestic pigs in 1967 and 1968 (63, 73). In Maharashtra, out of 500 samples from adult pigs, larvae of *T. spiralis* were detected in three cases (52). Epidemiological studies are required urgently, because the infection is likely to be under-diagnosed, and it is necessary to explore the existence of the parasite among wildlife reservoirs.

Larva migrans

More than 200 million people are affected by hookworms in India. Cases of cutaneous larva migrans (37, 42, 55) and visceral larva migrans (30, 84) have been reported throughout the country. Seventy-two percent of dogs were found to harbour *Ancylostoma caninum*, 60% *A. braziliense*, and 37% harboured mixed infections with both hookworms (89). However, no *A. ceylanicum* was detected in the dog population associated with a tea-growing community that was endemic for the parasite in north-east India (89).

Amoebiasis and giardiasis

Human infection with *Entamoeba histolytica* has been reported in India. Study of the epidemiology of amoebiasis shows that many animals are potential reservoirs of infection (61). The parasite has been detected in the dog population associated with a tea-growing community that was endemic for the parasite in north-east India (89).

Sarcocystosis

Cases of human sarcocystosis have been reported from Lucknow. A preliminary survey of children belonging to families who slaughter domestic pigs without any meat inspection (6) revealed that *Sarcocystis suihominis* was prevalent in the selected population. The prevalence of *S. hominis* was 6.9% (58) and 3.79% (81) in cattle in Uttar Pradesh, the prevalence of *S. suihominis* was 49.5% (86), 36.66% (20) and 33% (4) in pigs from three different parts of the country. The prevalence of *S. suihominis* is much higher than that of *S. hominis* owing to the non-consumption of beef in India due to religious beliefs.
Other parasitic zoonoses

Many other zoonotic parasites have been reported (Table I) from different parts of the country.

Table I  
Zoonotic parasites recorded in India  
In addition to the major parasites discussed elsewhere in this article other parasites have been reported in India, examples of which are provided here.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Parasite</th>
<th>Species</th>
<th>States involved</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angiostrongylosis</td>
<td>Angiostrongylus cantonensis</td>
<td>Humans</td>
<td>Maharashtra</td>
<td>59</td>
</tr>
<tr>
<td>Diphyllobothriasis</td>
<td>Diphyllobothrium latum</td>
<td>Humans</td>
<td>Puducherry, Tamil Nadu</td>
<td>56, 78</td>
</tr>
<tr>
<td>Dirofilariosis</td>
<td>Dirofilaria repens, Dirofilaria tenuis</td>
<td>Humans via pet cats</td>
<td>Delhi</td>
<td>26</td>
</tr>
<tr>
<td>Dracunculosis</td>
<td>Dracunculus medinensis</td>
<td>Humans</td>
<td>Kerala, Southern India</td>
<td>14, 54, 69, 74</td>
</tr>
<tr>
<td>Echinostomiasis</td>
<td>Echinostoma ilocanum</td>
<td>Humans</td>
<td>Andhra Pradesh, Gujarat, Madhya Pradesh, Maharashtr, Rajasthan, Karnataka</td>
<td>88</td>
</tr>
<tr>
<td>Fasciolopsiosis</td>
<td>Fasciolopsis buski</td>
<td>Pigs</td>
<td>Assam</td>
<td>88</td>
</tr>
<tr>
<td>Gastrodiscoidiosis</td>
<td>Gastrodiscoides hominis</td>
<td>Pigs</td>
<td>Tamil Nadu</td>
<td>67</td>
</tr>
<tr>
<td>Gnathostomiasis</td>
<td>Gnathostoma spinigerum</td>
<td>Humans</td>
<td>Bengal</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cats</td>
<td>Madras</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dogs</td>
<td>Assam, Kerala</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pigs</td>
<td>Meghalaya</td>
<td></td>
</tr>
<tr>
<td>Human intestinal capillariasis</td>
<td>Capillaria spp.</td>
<td>Humans</td>
<td>Tamil Nadu</td>
<td>34</td>
</tr>
<tr>
<td>Malaria, zoonosis of simian origin</td>
<td>Plasmodium spp.</td>
<td>Humans</td>
<td>Greater Nicobars, Andaman &amp; Nicobar islands</td>
<td>33</td>
</tr>
<tr>
<td>Paragonimiosis</td>
<td>Paragonimus westermani</td>
<td>Humans</td>
<td>Madras, West Bengal, Assam, Manipur</td>
<td>60</td>
</tr>
<tr>
<td>Schistosomiasis</td>
<td>Schistosoma haematobium</td>
<td>Humans</td>
<td>Maharashtra</td>
<td>27</td>
</tr>
</tbody>
</table>

Conclusions

Climatic change associated with global warming, increased vector populations, world tourism, the demand for livestock food products, changing socio-economic conditions, poverty, the lack of safe drinking water, the large number of stray animals, certain cooking practices, defecating outdoors, poor personal hygiene, and the high population density are responsible for the rising prevalence of parasitic zoonoses in India. In this changing scenario, food safety is of the utmost importance. Leishmaniasis, echinococcosis/hydatidosis, neurocysticercosis, cryptosporidiosis, and toxoplasmosis in AIDS pose a great threat in India and the prevention and control of these parasitic zoonoses will be challenging. The use of molecular epidemiological investigations and spatial analytical tools can improve our understanding of the current status of parasitic zoonoses in India. Health education, vector control, control of animal movements, controlled slaughter, higher socio-economic development and improved risk assessments can help to control parasitic zoonoses in the country. There is a need for better coordination of medical veterinary sciences and improvement of collaborative approaches to formulate appropriate control strategies in India.
Tour d’horizon des zoonoses parasitaires en Inde

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Résumé
Les maladies zoonotiques d’origine parasitaire sont présentes dans toutes les régions de l’Inde avec des taux de prévalence variables. Les premiers rapports signalant la présence de parasites zoonotiques et de nouvelles maladies émergentes affectant les populations animales et humaines ont commencé à être publiés il y a quelques décennies. La prévalence des parasites zoonotiques est probablement sous-estimée, en raison de l’inadéquation de la surveillance exercée et du manque d’informations sur les animaux porteurs asymptomatiques. L’émergence de maladies humaines telles que l’hydatidose, la neurocysticercose, la cryptosporidiose et la toxoplasmose chez les personnes atteintes du syndrome d’immunodéficience acquise, ainsi que la réémergence de la leishmaniose cutanée représentent une grave menace sanitaire et un défi pour la prévention et le contrôle des zoonoses parasitaires en Inde.

Mots-clés
Épidémiole – Inde – Zoonose parasitaire.

Repaso de las zoonosis parasitarias en la India

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Resumen
En la India, la prevalencia de las enfermedades zoonóticas parasitarias varía según las regiones. En los últimos decenios han comenzado a aparecer informes que describen parásitos zoonóticos y nuevas enfermedades emergentes en poblaciones tanto humanas como animales. Es probable además que la prevalencia de parásitos zoonóticos esté subestimada debido a la falta de vigilancia adecuada y a la escasez de información sobre portadores animales asintomáticos. La aparición de dolencias como la hidatidosis, la neurocisticercosis, la criptosporidiosis o la toxoplasmosis en personas afectadas por el síndrome de inmunodeficiencia adquirida, junto con la reaparición de la leishmaniosis cutánea, hace pesar graves amenazas y plantea un gran problema para la prevención y el control de las zoonosis parasitarias en la India.

Palabras clave
Epidemiología – India – Zoonosis parasitarias.
References


