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RESEARCH ARTICLE

Prevalence of *Taenia solium* taenaisis in Kanchipuram district of Tamil Nadu (India): A cross-sectional study

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ABSTRACT

Background: *Taenia solium* infections in humans include the infection by the adult tapeworm, these infections are of public health concern and are among the most important afflictions of humans who live in areas of poverty in the developing world and least developed countries. *T. solium*, a zoonotic disease, transmitted between pigs and humans and among humans, is common in developing countries. **Aims and Objectives:** The aim of the study was to estimate the detection rate of *T. solium* taeniasis among patients and random community screening with an indication of intestinal parasitic infection by routine stool examination. **Materials and Methods:** Stool samples were collected from the community and patients. Those who were willing, samples were screened for the cysts/ova/egg by direct microscopic examination by saline, iodine, concentration technique, and modified acid fast staining, were performed to differentiate species of *T. solium* and *Taenia saginata*. **Results:** Overall samples were 2030, out of which 870 stool samples were from community field screening 585 (28.81%) were positive. 1160 from tertiary care center, 668 (32.90%) were positive gave a total prevalence of intestinal parasitic infection of 61.72%. The prevalence of *T. solium taeniasis* was 194 (9.55%) out of which 92 (4.53%) were from community and 102 (5.02%) were from tertiary care center. **Conclusion:** The high prevalence of intestinal parasitic infestation might be due to the poor sanitary, contaminated water, and lack of education that is prevalent in the studied region as in other pockets in rural India. Our study showed the usefulness of the Ziehl-Neelsen modified acid-fast stain for identification of *Taenia* species.

KEY WORDS: *Taenia solium*; Parasitic Infection; Taeniasis; Prevalence and Acid Fast Staining

INTRODUCTION

Tapeworms were prevalent in ancient Egypt and were probably mentioned in the papyrus, ebers, and dating around 1550 BC, described by the Greeks including Hippocrates 460–375 BC.[1] Intestinal parasitic infections are most common in worldwide, these infections vary considerably from place to place and are closely related to poor socioeconomic status, poor environmental hygiene, and over-crowding, contaminated food and water transmitted by the feco-oral route.[2] In India like other developing countries, intestinal parasitic infections are a major health problem.

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The clinical manifestations can vary from altered bowel habits in the form of diarrhea, abdominal pain, right lower quadrant pain, neurological manifestation, rectal prolapse,

and anemia.[3] In spite of health education and hygienic habits being improved, the parasites continue to infect the people in rural area more often than people in urban area. While the scientific study of the taeniid tapeworm can traced back to the late 17th century. There are about 40 species of adult tapeworms and about 15 larval forms which can infect man, dogs, and other accidental hosts.[4]

Taenia solium is a Cestode species that causes taeniasis and cysticercosis in humans. *T. solium* has a complex life cycle of two-host. In 1856, Leucart was the first person described the life cycle of the parasite. Human beings harbor the adult tapeworm and acts as an only definitive host leads to taenaisis infection in intestine. However, both human and pigs act as intermediate hosts harbor the cysticerci larval form which finally leads to cysticercosis.

Taeniasis said to be the intestinal infection with the adult stage of the *T. solium*, taeniasis infection seen in humans, due to improper cooking of pork which is infected with cysticerci. From ages ago, cysticercosis has been known but its relation with the adult tapeworm was not clear yet.[5]

The worm attaches firmly to the mucosa of the intestine with the help of its suckers and hooks. Amild inflammation was caused by the adult worm cause at the site of infection, without further damage to the intestine. Taeniasis is usually characterized with the identification of mild symptoms such as, abdominal pain, distension, diarrhea and nausea, headache, pruritis ani, vomiting, and anorexia are seen due to tapeworm infestation. Sometimes, the patients are normal without showing any symptoms.[6]

Parasitic zoonoses of international importance include cysticercosis/taeniasis represents a significant hazard in most developing countries. Although these infections are not among the leading causes of parasite induced mortality worldwide, they cause considerable damage in human health and agricultural production.[7] The majority of tapeworm infections was asymptomatic or had vague indefinite abdominal discomfort. The prevalence rate of intestinal parasitic infestation ranges from 14.6% to maximum of 91% in different studies conducted in various parts of the country.[5]

Approximately 2.5 million people worldwide carry the *T. solium* tapeworm.[6] In contrast to the high prevalence of cysticercosis in endemic areas, *T. solium* taeniosis in seldom 4%, some counties reported 7%,[8] 6.3%.[9] The prevalence of Taeniasis ranges from 0% to 6.7% in Peru. Rates of taeniasis, as determined by stool examination, have also been reported to range between 0.1% and 6% in communities of India, Vietnam, China, and Indonesia.

The purpose of undertaking this study was to find the burden of undiagnosed cases of *T. solium* taeniasis infections in both community as well as hospital based screening in Kanchipuram District of Tamil Nadu state in India which was never explored before. Taeniasis is a major global problem and is also very common in Indian sub-continent among the various states in the Southern parts of India. The previous epidemiological studies have been shown very negligible prevalence.[10] However, in the hospital set up, many patients have symptoms suggestive of intestinal parasitic infestation. There is a chance of undiagnosis *T. solium* taeniasis infestation in few patients which lead to development of NCC and subsequent neurological complications.

Keeping all these aspects in mind, the study was undertaken on the prevalence of intestinal *T. solium* Taeniasis, among patients attending the outpatient clinics of Shri Sathya Sai Hospital and field screen population of Thirukazukundrem and Chengalpet Taluk (Nellikuppam, Ammapettai, and Kottamedu villages), Kanchipuram District, Tamil Nadu, for 2 years.

MATERIALS AND METHODS

Study Design and Duration of the Study

This cross-sectional study was carried out for 2 years in community and a tertiary care hospital in Kanchipuram District of Tamil Nadu (India) for which the study protocol was approved by the Institutional Ethical Committee (IEC) of Shri Sathya Sai Medical College and Research Institute, Sri Balaji Vidyapeeth.

Study Population

Inclusion criteria

People with history of abdominal pain, loss of appetite, weight loss, diarrhea, passing worms, and proglottids were included in the study.

Exclusion criteria

People with other causes of abdominal pain such as gastritis, peptic ulcer, and pancreatic diseases were excluded in the study.

The project was explained to the community population and also to the patients who attended outpatient clinic of tertiary care hospital. Informed consent was obtained from the willing patients and samples were collected in sterile container with proper instructions. Samples were screened within 12 h for the cysts/ova/egg by direct microscopic examination.

Sample collection

A total of 2030 stool samples were collected in a sterile container and transported to microbiology laboratory immediately. Some samples were refrigerated, if there is any delay in the processing of the sample. The samples were duly

labeled and properly filled requisition form with relevant details pertaining to the patient's age, sex, and clinical features was submitted to the microbiology laboratory.

Examination of Stool

Macroscopic examination

The specimen was examined by naked eye for color, consistency, and adult worms such as round worms, thread worms, segments, or proglottides of tape worm and larvae were recorded accordingly.

Microscopic examination (wet mounts)

Microscopic examination of the stool specimen was performed by following techniques such as saline, iodine, and concentration technique such as sedimentation and modified acid fast stain (AFS) for to differentiate *T. solium* and *Taenia saginata* species.

Saline wet mount

It was screened to demonstrate motile trophozoites, ova/cyst, and larva.

Iodine wet mount

Iodine mount was screened for cyst. The samples which were found to be negative for ova/cyst in saline and Iodine wet mounts were subjected for concentration technique such as formal ether technique.[3]

Concentration method

Sedimentation technique: Requirements: Microscope, Centrifuge, and discarding jar.

Formal-ether concentration

The deposit after shaking was poured on to glass slide, a cover slip was placed over it and the specimen was examined, after concentration techniques if it was found negative, it was reported as negative.

Modified acid fast staining

Was performed to differentiate species of *T. solium* and *T. saginata.* Take a clean glass slide, with a help an applicator stick make a thin smear over the glass slide, air dry, and fix the smear with methanol for 10 min, place the slide on staining rack and flood with carbol fuchsin, allow it to stand for 5 min, rinse the smear with tap water, decolorize with 3% acid alcohol for 2 min, rinse again with water and flood the smear with methylene blue for 1 min, rinse with tap water, drain, and air dry, and examine the smear directly under oil immersion objective (×100).

Statistical Analysis

The data were entered into the computer using SPSS 22 version and analyzed using Chi-square test to compare relative frequencies between gender-wise, age-wise, and hospital and in community.

RESULTS

The study was done over a period of 2 years. The number of samples collected and screened was 2030, out of which 870 stool samples were from field screening population of Thirukazukundrem and Chengalpet Taluk (Nellikuppam, Ammapettai, and Kottamedu villages), Kanchipuram District, and Tamil Nadu. Moreover, rest 1160 stool samples were from our tertiary care center.

The microscopic examination of stool samples had the following inference: Out of 870 community population, 585 (28.81%) were positive and 285 (14.03%) were negative, 1160 from tertiary care center, 668 (32.90%) were positive and 492 (24.23%) were negative for intestinal parasitic infection, gave a prevalence rate of 61.72%, that is, 2030 out of which 1253 (61.72%) positive and 777 (38.27) were negative for Ova/cyst [Table 1].

Among the total 2030 samples, 1278 (62.96%) were males and 752 (37.04%) were females. Out of 1278 of males screened, 755 (37.19%) were positive, females were 498 (24.53%) positive for intestinal parasitic infection**.**

There were 846 (41.67%) children, among them, 595 (29.31%) were positive and 1184 (58.32) were adults, 658 (32.41%) were positive. The youngest patient was 5 years old and oldest was 66 years old [Table 2].

Microscopical examination of 2030 stool samples, showed prevalence of *T. solium* Taeniasis, was 194 (9.55%), out of which 92 (4.53%) were from community and 102 (5.02%) were from tertiary care center.

Table 1: Prevalence of intestinal parasitic infection among patients attending hospital and in community (*n*=2030)

Intestinal parasitic infection	Community (%)	Hospital (%)	Total (%)	χ^2 (*P*-value)
Positive	585 (28.81)	668 (32.90)	1253 (61.72)	19.62 (0.0000)
Negative	285 (14.03)	492 (24.23)	777 (38.27)	
Total	870 (42.85)	1160 (57.14)	2030 (100)	

Prevalence of positive intestinal parasitic infection was higher in hospital (32.90%) than community (28.81%) and there was a statistical difference in the presence of intestinal parasitic infestation between hospital and community χ^2=19.62, *P*=0.0000

To differentiate *T. solium* and *T. saginata* eggs in the stool samples, modified acid fast staining was performed, as *T. solium* is non-acid fast and *T.saginta* is acid fast [Figure 1].

Other intestinal parasitic infections were also seen 493 (24.28%) in community, 566 (27.88%) in tertiary care, overall prevalence was 1059 (52.16%) [Table 3].

Total intestinal parasites encountered were - *Ascaris lumbricoides* – 394, *Ancylostoma duodenale* – 199, *Entamoeba histolytica* – 158, and *T. solium* – 194.

Mixed parasitic infection includes – 93 (*A. lumbricoides* + *E. histolytica* – 28, *A. duodenale* + *A. lumbricoides* – 15, *T. solium* + *A. lumbricoides* – *19, A. duodenale* + *E. histolytica* – 8, *T. solium* + *A. duodenale* – *11, Giardia lamblia* + *Enterobius vermicularis* – 8, *E. histolytica* + *A. lumbricoides* + *Trichuris trichiura* – 1, and *Entamoeba coli* + *T. trichiura* – 3).

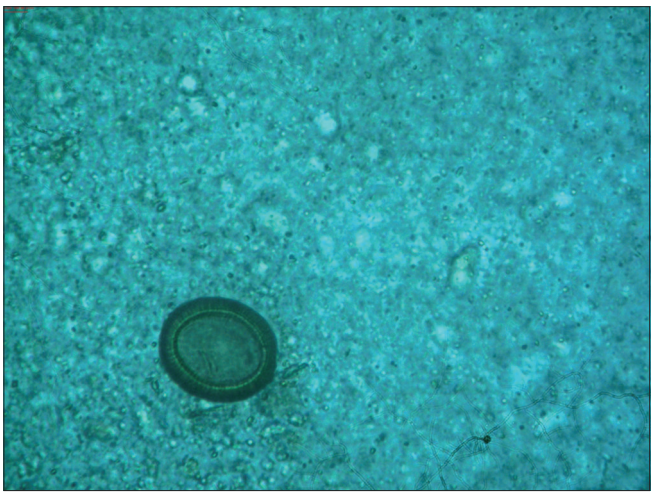

Figure 1: Modified acid fast staining for *Taenia*

E. coli – 50, *T. saginata* – *42, G. lamblia* – *40, T. trichiura* – *32, Hymenolepis nana* – *29, E. vermicularis* – 12, *cyclospora* – *4,* Chilomastix – *2,* and *Strongyloides larva* – *4,* making total positive of 1253 (61.72%), males were 755 (37.19%), females 498 (24.53%) [Table 4].

The most common parasites in both males and female are *A. lumbricoides*, *A. duodenale,* and *T. solium* followed by other parasites. Comparing to male and female prevalence, male had higher positivity of intestinal parasitic infection.

DISCUSSION

The present study showed higher prevalence of parasitic infestation of 1253 (61.72%) when compared to study done in urban population which is 33%.[2] The prevalence of positive intestinal parasitic infection was higher in hospital than community statistically significant even though the clinical information such as symptoms of abdominal pain, history of passing worms, and diarrhea were documented and recorded from both community and hospital cases. Hospital cases were 1160 in number and community constituted of 870 cases. Both the group of cases had abdominal pain, diarrhea, and history of passing worms as major symptoms, to the tapeworms symptoms of abdominal

Table 2: Age-wise prevalence of intestinal parasitic infection among patients in hospital and community (*n*=2030)

Intestinal parasitic infection	Children (age group ranging from (5–15)	Adults (age group ranging from (>15–66)	Total (%)	χ^2 (*P*-value)
Positive	595 (29.31)	658 (32.41)	1253 (61.72)	45.48 (0.0000)
Negative	251 (12.36)	526 (25.91)	777 (38.27)	
Total	846 (41.67)	1184 (58.32)	2030 (100)	

Prevalence of positive intestinal parasitic infection was higher in adults (32.41%) than children (29.31%) and there was a statistical difference in the presence of intestinal parasitic infestation between adults and children χ^2=45.48, *P*=0.0000

Table 3: Distribution of *T. solium* taeniasis and other parasitic infections among patients attending hospital and in community (*n*=2030)

	Positive *T. solium* taeniasis			
Intestinal parasitic infestation	**Community (%)**	**Hospital (%)**	**Total (%)**	**χ^2 (*P*-value)**
Positive *T. solium* Taeniasis (%)	92 (4.53)	102 (5.02)	194 (9.55)	7.54 (0.0060)
Negative for all intestinal parasites (%)	285 (14.03)	492 (24.23)	777 (38.27)	
Intestinal parasitic infestation	**Community (%)**	**Hospital (%)**	**Total (%)**	**χ^2 (*P*-value)**
Positive for other intestinal parasites (%)	493 (24.28)	566 (27.88)	1059 (52.16)	17.89 (0.0000)
Negative for all intestinal parasites (%)	285 (14.03)	492 (24.23)	777 (38.27)	

Prevalence of positive *T. solium* taeniasis, was higher in hospital (5.02%) than community (4.53%) and there was a statistical difference in the presence of intestinal parasitic infestation between hospital and community χ^2=7.54, *P*=0.0060. Other parasitic infection: Prevalence of positive for other intestinal parasites was higher in hospital (27.88%) than community (24.28%) and there was a statistical difference in the presence of other intestinal parasites between hospital and community χ^2=17.89, *P*=0.0000

Table 4: Gender-wise prevalence of individual intestinal parasitic infection among patients attending hospital and in community (*n*=2030)

Parasitic infestation	No. of males (%)	No. of females (%)	Total (%)
Ascaris lumbricoides	220 (10.83)	174 (8.57)	394 (19.40)
Ancylostoma duodenale	106 (5.22)	93 (4.58)	199 (9.80)
Taenia solium	120 (5.91)	74 (3.64)	194 (9.55)
Entamoeba histolytica	118 (5.81)	40 (1.97)	158 (7.78)
Mixed infection	61 (3)	32 (1.57)	93 (4.58)
Entamoeba coli	28 (1.37)	22 (1.08)	50 (2.46)
Taenia saginata	34 (1.67)	8 (0.39)	42 (2.06)
Giardia lamblia	27 (1.33)	13 (0.64)	40 (1.97)
Trichuris trichiura	15 (0.73)	17 (0.83)	32 (1.57)
Hymenolepis nana	12 (0.59)	17 (0.83)	29 (1.42)
Enterobius vermicularis	7 (0.34)	5 (0.24)	12 (0.59)
Cyclospora	3 (0.14)	1 (0.04)	4 (0.19)
Strongyloides larva	2 (0.09)	2 (0.09)	4 (0.19)
Chilomastix	2 (0.09)	0 (0)	2 (0.09)
Total	755 (37.19)	498 (24.53)	1253 (61.72)

Variants in distribution patterns of intestinal parasitic infection positive stool samples between sex, age, and hospital and in community were determined, the prevalence of infections was reported in proportions. Chi-square test (χ^2) was used to compare relative frequencies between gender-wise, age-wise, and hospital and in community. Data analysis was conducted using SPSS 22 version. Alpha level of 0.05 for all statistical tests

pain, nausea, diarrhea, and distension, were correlated with our study.[11,12]

In relation to gender wise distribution the prevalence of parasitism among the patients attending hospital and community, the higher prevalence seen in males (37.19%) than females (24.53%), there was statistical significance, when compared with other studies high prevalence was observed in males.[13]

The prevalence of parasitic infection with respect to age in children was (29.31%) and in adults was (32.41%), there was a statistical significance $P < 0.0000$. when compared with Patel *et al*. The prevalence of parasitic infections in adults was higher than children.[14,15]

According to the Silva *et al*., 2003, soil-transmitted helminthic (STH) infections were the most common prevalent infections of humans.[16] The high infection rates of STH occur in sub-Saharan Africa, East Asia, India, and South America.[17,18] Very few prevalence studies were conducted in Chennai. In our study province, we reported an overall helminthes prevalence of 49.21% comprising *A. lumbricoides* (19.40%), *A. duodenale* (9.80%), *T. solium* (9.55%), mixed parasitic infection includes (7.78%), *T. saginata (2.06%), T. trichiura (1.57%), H. nana (1.42%), E. vermicularis* (0.59%), and *S. larva (0.19%).* There was a significant difference in the prevalence of intestinal parasitic infections between hospital (32.90%) and community (28.81%) ($P = 0.0000$).

Our study stresses the importance of the routine stool examination as an important screening technique for the detection of parasitic ova and egg in the patient stool sample, which has become obsolete in many of the labs including those of teaching medical college departments.

Even if it is negative by the wet mount preparation a further confirmation screening tests can be done with concentration techniques such as flotation and sedimentation techniques as per standard protocol, even though known to have both low sensitivity and specificity due to the intermittent nature of egg excretion and non-uniform distribution of eggs in the feces leading to underestimate of the prevalence of taeniasis.[19] Even though destrobilation has led to a massive discharge of eggs, the eggs may be absent from the feces for up to several weeks thereafter.[20]

Furthermore, *T. solium* and *T. saginta* eggs under microscopy lead to problem with diagnostic specificity and differentiation of both eggs. This is particularly important given the risks associated with *T. solium* infection.[21] Therefore, in this study, we stress the importance of concentration technique of formol-ether to recover the minimal load of eggs, differentiation of *T. solium* and *T. saginata* was done by combination of fresh and fixed specimens of stool to perform modified acid fast staining, *T. solium* was non-acid fast and *T. saginata* acid fast.

The study utilized the potential utility of the Ziehl-Neelsen modified acid-fast stain for identification of *Taenia* species. It showed best results of positivity of *T. solium* 194 (9.55%) and *T. saginata* 42 (2.06%). The prevalence of positive *T. solium* taenisis was higher in hospital (5.02%) than community (4.53%) and statistical significance was noted between hospital and community-based populations.

We found that the egg embryophore outer covering of *T. saginata* stained entirely magenta and blue, whereas *T. solium* eggs were poorly stained also noted that a greater proportion of *T. saginata* eggs than *T. solium* eggs stained entirely magenta.[22]

Even though the accuracy of the test results was so low that this test is unlikely to be used by most clinical laboratories for differentiation of *Taenia* species when compared with serological examination such as coproantigen, ELISA has a specificity and sensitivity of 100% and 98%, respectively,[21] and during the last two decades, highly specific molecular methods to detect *T. solium* DNA in stool such as PCR have been developed[23-26] but none of them have been validated under field condition yet. All the techniques have their own limitations of advantages and disadvantages.

Kanget *et al*., from Vellore, Southern India, on 78 persons from a rural area, whose stools were sampled on alternate days for 30 days; none of the samples yielded *Taenia* eggs. The prevalence of *T. solium* Taeniasis in our study was high 194 (9.55%), in contrast to the high prevalence of cysticercosis in endemic areas; *T. solium* seldom 4%, in some countries, prevalence was 7% have been reported.[8] Mwape found taeniosis prevalence of 6.3%[9] [Table 4]. Our study showed that the prevalence of 9.55% which was high; these prompted us to undertake the study. The other parasite like Cyclospora was well demonstrable by the differential stain by AFS.

However, infection and reinfection in children are difficult to control and as long as poverty persists in developing countries, STHs will continue to be of public health concern worldwide. The health education should aim at reducing contamination of the soil by promoting the use of proper toilets and improved hygienic habits.[20] The vaccination of pigs is the alternative way to break the transmission cycle of *T. solium* cysticercosis.

The victorious vaccine which can interrupt the cycle this helps in reducing the infection rate in both humans and pigs. This impact plays a role in reducing the new cases of NCC in the community.[12]

Limitations of the present study was coproantigen detection ELISA and molecular techniques were not employed because lack of resources and also there was no prior prevalence information on *T. solium* taeniasis in the study region. Familial clustering analysis could not be made for which there was beyond the scope of the present study.

CONCLUSION

This study attempted to quantify the burden of *T. solium* taeniasis by both community as well as hospital based screening in Kanchipuram District of Tamil Nadu state in India which was never explored before. This present study showed *T. solium* taeniasis and many other STHs are prevalent in the study region. Identification of cases with *T. solium* concurrent infections with other STHs (namely, *Ascaris*, *Ancylostoma*) is also remarkable. Periodic use of deworming agents, education on hygienic habits, and safe drinking water supply can reduce the incidence. Furthermore, rapid specific detection of carriers and vaccination of intermediate hosts are recommended.

The simple wet mount is still a basic and reliable technique in resource poor settings for confirming parasitic infestation in patients if done with care. Our study showed the usefulness of the Ziehl-Neelsen modified acid-fast stain for identification of *Taenia* species.

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