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An Appraisal of Toxocarosis in Calves in India through a Meta-analysis of Prevalence Studies

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ABSTRACT: Toxocarosis in buffalo calves is a very important diseases which is causing a significant impact on the dairy enterprises at it affects the most vulnerable stage of the life a dairy animal. The current meta-analysis was conducted to appraise the distribution of toxocarosis in cattle and buffalo calves of India. A systematic search for the prevalence data of cow and buffalo calves for the period 1986 to 2020 from open source databases was carried out which gave 30 eligible studies for this meta-analysis. The pooled prevalence of toxocarosis in cow and buffalo calves of India was found to be 10.5% (95 % CI=7.0 – 14.5%). Meta-analysis showed that there is statistically high heterogeneity for the prevalence estimates reported in recruited studies. The effect of moderators *viz.* sample size and publication year on meta-analysis was also analysed through a meta-regression. This meta-regression showed that there was significant negative relationship between both the variables and final estimates of prevalence. This study provided primary insights on the abundance of toxocarosis infection in calves and warrants for the critical care to be taken during early days of life as well as weaning of calves. Results of this study helps in planning for strategic deworming schedule of calves to avoid future losses.

Keywords: Cow, buffalo, calves, *Toxocara*, India, MetaXL, weaning.

INTRODUCTION

Indian rural population sustain mainly on agriculture and livestock rearing. Out of 170 million buffaloes of world, 165 million (97 per cent) are in Asia (Kundu *et al.*, 2004). In India, buffaloes and cattle are valued for milk and draft power with meat as an additive. Dairy industry is of paramount importance in India. The country is the world's largest milk producer, accounting for more than 13 per cent of world's total milk production. Helminth parasitism, especially, gastrointestinal parasitism, is one of the major health problems severely limiting the animal productivity in dairy animals. Among the pathogenic helminths species, *Toxocara vitulorum* is an economically important and highly pathogenic gastrointestinal parasite of cattle and buffaloes, particularly in new-born and younger age groups. The large sized nematode (*Toxocara vitulorum*) of the family Ascarididae commonly occur in the small intestine of cow and buffalo calves in many parts of the world including India (Kumar *et al.*, 2016).

Despite of significant production losses, which may run into millions of rupees (Sanyal, 1998) the problem is neglected due to its chronic and insidious nature (Parihar *et al.*, 2022). The different agroclimatic conditions, animal husbandry practices and pasture management mostly determine the incidence and severity of various parasitic infections in a region.

Although *Toxocara* infection has been studied over the past 100 years, the epidemiology of the disease remains hardly understood in many countries. In recent years, however, a number of investigations have been conducted by various authors (Bhangale, 2020) on the prevalence of GI parasites among dairy animals in different parts of the country. In order to raise awareness about a scarid infection in buffaloes, an exhaustive literature review on the prevalence of toxocarosis and the economic losses that it causes, is the first step in local and global efforts to control the infection. The objective of this systematic review and meta-analysis study was to provide an overview of the epidemiology of toxocarosis in calves by assessing its geographical distribution in Indian subcontinent identifying cow and buffaloes that are naturally susceptible to the infection, and estimating the pooled prevalence of *Toxocara vitulorum*.

The present review and meta-analysis of published studies was conducted to determine the epidemiological pattern and distribution of toxocarosis in cow and buffaloes calves and investigate its clinical impact in the different agroclimatic zones of the country would provide a basis for evolving strategic and tactical control of *Toxocara* infection that can contribute to

increasing animals' productivity within smallholder farming systems in tropical areas.

MATERIAL AND METHODS

The systematic review and meta-analysis were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher *et al.*, 2010). Inclusion and exclusion criteria were defined in terms of the relevance of the references to achieve the study objectives.

A. Literature search

We identified all published studies in English searching different electronic databases *viz.*, CAB Abstracts, Library of Institute of Tropical Medicine (EDS-ITM), PubMed, Science Direct, Research Gate, Google Scholar, Microsoft Academic and Krishikosh for studies published up to March, 2022. The terms employed were "*Toxocara vitulorum"*OR "Ascariosis/Ascriasis Neoascaris/Toxocarosis", "*Toxocara* infection" "Helminths", "GI Parasites" (Gastrointestinal Parasites), "Nematodes", "Roundworms", "Parasites", "cows", "Buffaloes", "India" and "Prevalence" alone or combined together using ''AND" and/or "OR "applied in the title, abstract and the keywords, where applicable. Information on author, study year, country, sample size, diagnostic method, number of samples positive and percent prevalence were extracted. No restrictions were applied with regards to language, location and date of publication. In additional manual search of relevant published research papers and peer reviewed articles were also included. All references located in the searches were entered in worksheet. Duplicate publications with the same information were removed and abstracts were obtained for the remaining references.

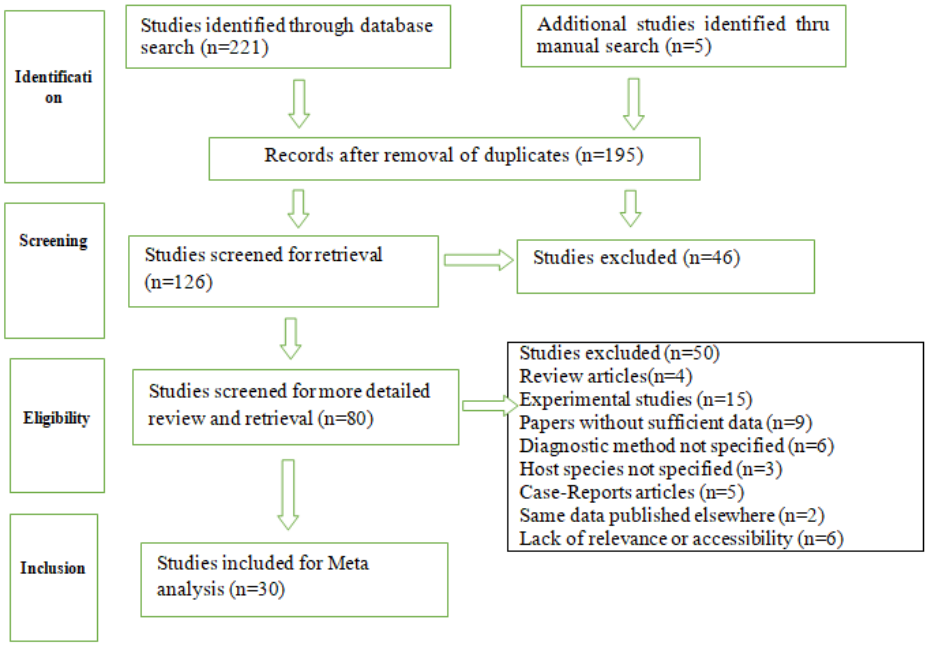


Fig. 1. PRISMA flow chart visualizing the procedure for identifying relevant publications for inclusion in meta-analysis of *Toxocara vitulorum* prevalence in India.

B. Study selection and data extraction

Reference information regarding author's name, title and year of publication were recorded in the data extraction file. Data were extracted from the included publications, on study area (districts, tehsil, region, State), duration of sample collection, number of samples screened, type of samples collected, the diagnostic method employed, number of positives and prevalence percentage. The prevalence percentage were calculated for publications that reported only the number of samples examined and the number of positives. Similarly, the number of positives were calculated for publications that reported only the total number of animals sampled and the prevalence. The data on prevalence were included from full research articles, reviews and abstract only for qualitative analysis. No case study was included. Relevant to inclusion criteria, the studies based on different parasitological techniques that estimated the prevalence of *Toxocara vitulorum* infection were included. Both the authors assessed the eligibility of all explored research papers (SYS and GNB). Data were extracted from the included publications and any disagreement was discussed and resolved. Finally, the relevant and required data from the included publications were extracted and incorporated in MS-Excel sheet.

Table 1: Characteristics of the studies included in the meta-analysis.

Study details	Study area/Location	Diagnostic methods employed	Sample size (n)	Samples Positive (p)
(Gupta, 1986)	Izatnagar, U.P.	Direct, Sedimentation/ Floatation	38	30
(Gupta and Chhabra 1990)	Haryana	Direct, Sedimentation/ Floatation	340	140
(Bharkad *et al.*, 1999)	Marathwada, Maharashtra	Floatation and Sedimentation	406	142
(Jitendran and Bhat 1999)	Himachal Pradesh	Qualitative and Quantitative	530	24
(Rao *et. al*, 2000)	Hyderabad, Telangana	Flotation and Sedimentation	309	93
(Bhuto *et al.*, 2002)	Hyderabad, Telangana	Telemann & McMasters Method	200	66
(Halmandge *et al.*, 2005)	Bidar, Karnataka	Direct, Sedimentation/ Floatation	1333	80
(Maharana *et al.*, 2005)	Junagarh, Gujarat	Centrifugal Sedimentation and Flotation	114	6
(Chavan *et al.*, 2008)	Nagpur, Maharashtra	Floatation and Sedimentation	615	170
(Singh *et al.*, 2008)	Faisabad, U.P.	Floatation and Sedimentation	719	44
(Saravanan *et al.*, 2009)	Namakkal. T.N.	Centrifugal Sedimentation	210	3
(Haque *et al.*, 2011)	Punjab	Floatation and Sedimentation	628	8
(Haque *et al.*, 2011)	Western plains of Punjab	Floatation and Sedimentation	233	14
(Kumar *et al.*, 2013)	Central Madhya Pradesh	Floatation and Sedimentation	960	10
(Chaudhary *et al.*, 2014)	Eastern haryana	Floatation and Sedimentation	4693	267
(Jyoti *et al.*, 2014)	Punjab	Floatation Method	1582	134
(Murthy and Rao 2014)	Telangana & Andhra Pradesh	Floatation And Sedimentation	150	25
(Sreedevi and Hafeez 2014)	Tirupati, A.P.	Direct, Sedmentation/ Floatation	694	10
(Maharana *et al.*, 2015)	Junagarh, Gujarat	Centrifugal Sedimentation and Flotation	114	6
(Patel *et al.*, 2015)	Gujarat	Floatation And Sedimentation	150	11
(Swarnakar *et al.*, 2015)	Udaipur, Rajasthan	Floatation Method	2025	2
(Nath *et. al*., 2016)	Madhya Pradesh	Floatation Method	3779	25
(Jamara *et al.*, 2017)	Nimar region, M.P.	Floatation Technique	687	36
(Malviya *et al.*, 2017)	Indore & Shahjanpur, M.P.	Floatation and Sedimentation	1500	240
(Shit *et al.*, 2017)	West Benagal	Direct, Sedimentation/ Floatation	1200	223
(Das *et al*., 2018 a)	Guwahati, Assam	Floatation Method	1120	293
(Das *et al.*, 2018 b)	Guwahati, Assam	Floatation and Sedimentation	1258	71
(Yadav *et al.*, 2019)	Malwa region, M.P.	Roberts and O'Sullivan Larva	1280	57
(Dappawar *et al.*, 2020)	Marathwada, Maharashtra	Flotation and Sedimentation	861	3
(Kumar *et al.*, 2020)	Samastipur, Bihar	Direct, Sedimentation/ Floatation	141	34

C. Meta-analysis

This meta-analysis study used a double arcsine transformation for prevalence estimates and followed the DerSimonian and Laird (2015) random effects model. The number of samples that tested positive divided by the sample size was used to estimate the prevalence of toxocarosis in buffalo calves. For each study, a 95% confidence interval (CI) of the prevalence value was determined. The I2 index and the Cochran's Q test were used to evaluate the heterogeneity of the studies. Estimates of the degree of heterogeneity using the I2 index were considered low (25%), moderate (50%) and high (75%) (Higgins *et al.*, 2003). Doi plot and LFK index were used for assessment of publication bias (Kanamori *et al.*, 2018). All these analyses were done on MetaXL addon in MS-Excel as described earlier (Barendregt *et al.*, 2013; Bhangale 2020). Meta-regression on sample size as a moderator has been conducted by using 'rma' package in R.

RESULTS AND DISCUSSION

According to the inclusion criteria for the systematic review and meta-analysis, 30 studies were found eligible amongst 226 papers reviewed from literature available online (Fig. 1). The results of the studies along with details of each study are given in Table 1. A maximum number of studies were from the northern and central (08 Nos. each) followed by southern region (6 Nos.); central eastern and western region (04 each) and which reported on the occurrence of *Toxocara* spp infection in buffalo calves from different parts of India. Saturated salt floatation method was the preferred technique in most of the studies for detection of *Toxocara* eggs from the fecal samples of bubaline calves. A total of 27869 fecal samples were processed for the detection of *Toxocara* eggs with apparent prevalence (2261) in the range of 0.1 to 78.9% over the period during 1986 - 2020. The high extent of heterogeneity (I^2 = 99.03 and Q = 2984.98, tau-square =0.115; p=0.00) observed in this analysis ascertained that the studies under this meta-analysis were from diverse populations (Fig. 2). Therefore, a random-effects model was employed. The weighted pooled prevalence of *Toxocara* spp infection inn buffalo calves from India was 10.5% (95% Confidence Interval= 7.0 – 14.5%). This analysis revealed substantial publication bias amongst the recruited studies as evident by a 2.28 LFK Index (Fig. 3). A meta-regression analysis significantly demonstrated that there is no effect of

sample size on the prevalence estimates under this meta-analysis.

Considering the high amount of heterogeneity amongst all the meta-analyses estimated in this review, meta-regression on three selected moderators were also performed to appraise the sources of heterogeneity. The effect of moderators *viz*., sample size and publication year on the prevalence was adjudged and results were plotted in Fig. 4 and 5.

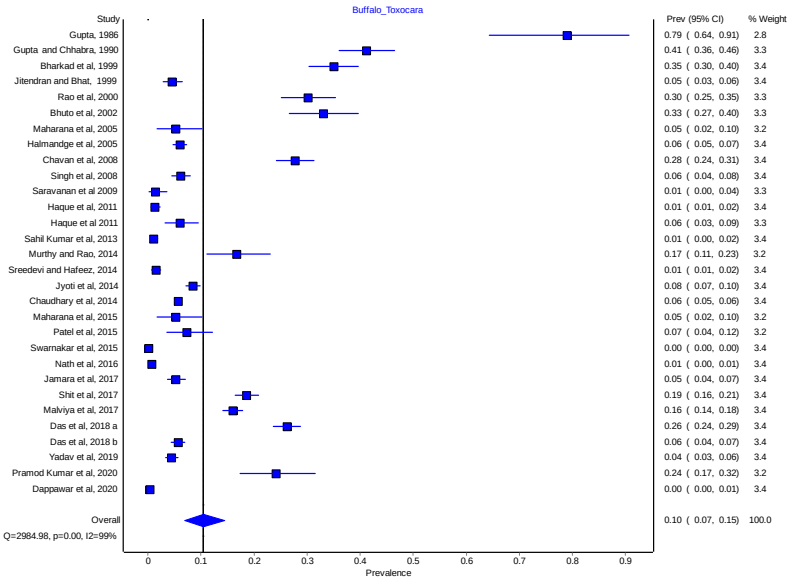


Fig. 2. Forest plot showing the prevalence of toxocarosis in buffalo calves in India reported by several studies.

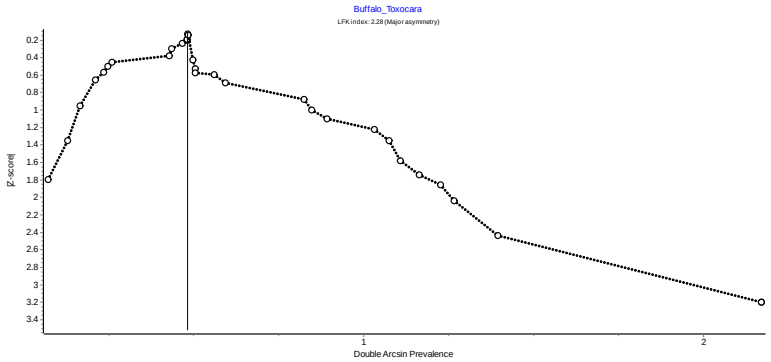
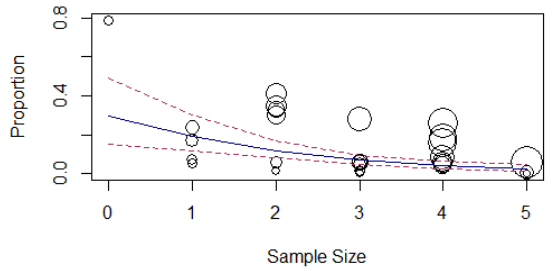


Fig. 3. Doi plot and LFK index for publication bias.

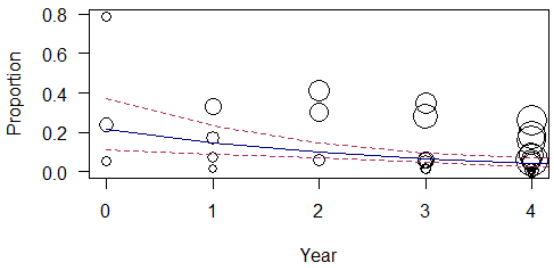
The slope of the estimated regression line for the sample size suggested that it had a significant negative moderating effect on the prevalence of toxocarosis in calves (results of the test of moderators: [QM (df=1): 17.52, p<0.0001]; slope coefficient (-0.572, Z=-3.339, p<0.0001]) (Fig. 4).



Sample sizes as 0: less than 100; 1: 101 to 200; 2: 201 to 500; 3: 501 to 1000; 4: 1001 to 2000; 5: more than 2000

Fig. 4. Meta-regression plot depicting effect of sample on the prevalence of toxocarosis in calves.

Similarly the estimated regression line with a declining inclination for publication year also suggested a significant negative moderating effect between region and prevalence of toxocarosis in calves [QM (df=1): 11.15, p<0.0001]; slope coefficient (-0.446, Z=-4.186, p<0.0001]) (Fig. 5).



Years as 0: before 2000; 1: 2000 to 2005; 2: 2006 to 2010; 3: 2011 to 2015; 4: 2016 to 2020

Fig. 5. Meta-regression plot depicting effect of publication year on the prevalence of toxocarosis in calves.

The problem of *T. vitulorum* infection in young bovine and bubaline calves is mainly confined in the developing countries, particularly where the buffalo predominantly exists (Young *et al*., 2014). *T. vitulorum* causes is a major infection in dairy animals especially in neonatal and young bovine and bubaline calves in

India. Toxocariasis is the major cause of young calf mortality, particularly in buffaloes and being the major contributor to the world's buffalo population. It acts as a constraint on paddy cultivation where drought power is required and where cow cannot be milked if the calf is not present. It poses a big challenge to research workers and scientists to overcome this problem. Most severe infections have been reported from humid tropics (Srivastava, 2000).

This is the first of its kind attempt which summarizes the findings of earlier studies and present a comprehensive review on calves' toxocarosis from India. Estimates of *T. vitulorum* prevalence in nearby nations likewise seem low. The prevalence found in our study is rather low (9.28%) when compared to those nations. According to Srikitjakarn *et al.* (1987) 58% of calves in Thailand had *T. vitulorum* during the first three months of life. More recently, Dorny *et al.* (2015) found that 12.4% of Cambodian calves between 1 and 3 months old had the disease. Clinical indications of toxocariasis, particularly in buffalo calves, were recorded by Roberts (1993) and poor hair coat, dermatitis, faeces that resembled white scour and smelled bad, lack of appetite with sporadic colic, and bloat were among them (Kebede *et al.,* 2018). More recent literature reports that calves with toxocariasis could have either pale colored or black diarrhea, or could be asymptomatic (Raza *et al.,* 2010; Islam *et al.,* 2005). To ascertain the role of *T. vitulorum* in the overall clinical impact of diseases in calves less than three months, more research is required.

The distribution of primary studies included in this meta-analysis are from diverse areas however, more such reports from across the country are required to build a reliable evidence of bubaline toxocarosis. the publication bias from this meta-analysis is however low; the factors responsible for the this bias needs to be taken care of by the practitioners while interpreting the results and applying for further decision making on toxocarosis distribution. The high extent of heterogeneity however confirms the diversity of populations included in the primary studies as evident from the characteristics of individual studies. Such heterogeneity in the meta-analysis is usually addressed by exploring the factors contributing to it. For this, sub-group analysis or meta-regression are the most followed methods. Current study also included a meta-regression where sample size as a moderator has no significant effect on the heterogeneity in the meta-analysis (Fig. 4 & 5). Looking towards the unwanted impacts of chemical based drugs it is always recommended to use alternative therapies such as herbal (Mamta *et al.,* 2022) or alterations in management practices to avoid the early exposure of those buffalo calves to embryonated eggs and larvae of *Toxocara* sp. It was also reported several times that due to lack of prescribed deworming schedule is one the most commonly perceived constraints by dairy farmers from the country (Shafiq *et al.,* 2017; Bansod *et al.,* 2022). Considering the extent of prevalence of this parasite, which may be attributed to lack of knowledge to farmers' community (Singh *et al.,* 2023), it is the need of time to formulate policies to address this issue not only through parasite centric interventions but also intensive extension work to fill the knowledge gaps in farmers and researchers (Ande *et al.,* 2021).

The findings of this study, which support the substantial prevalence rate of toxocarosis in buffaloes, call for epidemiologists and the nation's animal health apparatus to have active and passive surveillance, prepare preventive plans through additional research and monitoring, and develop control strategies.

CONCLUSIONS

The detailed meta-analysis of prevalence estimates of toxocarosis in cow and buffalo calves provided essential insights on its distribution in Indian livestock. The pooled prevalence rate of 10.5% is substantial and it affirms the necessity to undertake the more concerted efforts to reduce this infection by systematic epidemiological surveillance and monitoring so as to improve the productivity of dairy animals.

FUTURE SCOPE

The data analysed here provided essential insights on the need of more studies to be conducted for diagnosis of toxocarosis in dairy animals with more advanced tools to control the infection and improve productivity of available livestock resources.

Author contributions: SYS and GNB Conceived and designed the analysis; SYS Collected the data; SYS and GNB Contributed data or analysis tools; GNB Performed the analysis; GNB Wrote the paper, both the authors read and approved the final version of manuscript.

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Conflict of Interest. None.

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