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Research article

A systematic review and meta-analysis on prevalence and epidemiological risk factors of zoonotic Fascioliasis infection among the ruminants in Bangladesh

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ABSTRACT

The parasitic Fascioliasis is a zoonotic and economically significant disease for livestock and humans, creating public health concerns around the world, including in Bangladesh. Populations of Bangladesh are more vulnerable to this parasitic infestation for their intimate interactions. To tackles the adverse effects on humans from food animals, it is exigency to know the exact prevalence and associated risk factors of zoonotic Fascioliasis among ruminants. Therefore, the aim of this systematic review and meta-analysis was to determine the authentic knowledge of potential risk factors and prevalence among livestock populations. Four globally recognized databases, including Web of Science, Scopus, PubMed, and Google Scholar, along with local databases, were used to search the related studies since 2000. A total of 38 studies were selected for the meta-analysis, and the pooled prevalence of Fascioliasis was found at 20% (95 % CI: 15–25). A subgroup analysis was also performed for: species, age, sex, study duration, and sample size. The prevalence rate was found highest in cattle and sheep at 21% (95 % CI: 15–27), female individuals at 26% (95 % CI: 16–35), aged animals at 26% (95 % CI: 15–36), and rainy season at 25% (95 % CI: 16–34). This is the first systematic review and meta-analysis in Bangladesh that offers a comprehensive picture of the prevalence of Fascioliasis in ruminants and possible risk factors. Thus, this study will assist the government, policymakers, and veterinarians in implementing effective control measures by providing more detailed information about outbreak patterns.

1. Introduction

Fascioliasis is a zoonotic trematode infection considered a major ongoing interest in the field of global public health. Approximately 50 million people worldwide and over 180 million are at risk of infection in developed and underdeveloped countries (Nyindo and Lukambagire, 2015). In Bangladesh, about 20% of the human population is directly, and 50% indirectly depends on the livestock sectors (Bhowmik et al., 2020), and these large populations are at high risk due to frequent exposure to livestock animals. In ruminant, Fascioliasis is mainly caused by two major zoonotic trematodes spp., Fasciola hepatica and F. gigantic (Zainalabidin et al., 2015); whereas, human Fascioliasis is currently classified as a plant/food-borne trematode infection, commonly acquired by consuming leafy vegetables where metacercaria was encysted on leaves (Mas-Coma et al., 2014). Fascioliasis caused by *Fasciola gigantica*, is endemic in domestic ruminants of Bangladesh, which causes considerable economic impact due to mortality, liver condemnation, declined weight gain (up to 20%), and reduced quality and quantity (3–15% loss) of milk production (Khan et al., 2017; Mohanta et al., 2014). Fasciola hepatica occurs widely in sheep and cattle rearing areas throughout the world, causing severe morbidity and mortality. To minimize the Fasciola oriented economic downturn, numerous anthelmintic drugs have been reported to use in ruminants. The Fascioliasis prevalence in Bangladesh has been reported to vary from 21 to 53% in cattle (Aktaruzzaman et al., 2013; Karim et al., 2015; Rahman et al., 2017) and 19–51% in buffaloes (Rahman et al., 2017; Sammadar et al., 2015). The geographical phenomenon of Bangladesh, including the hilly and low marshy areas, mostly favor the growth of the snails, which are the intermediate host for the high prevalence of Fascioliasis in livestock animals, including cattle, buffalo, goat, and sheep (Belina et al., 2015; Karim et al., 2015). Several

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risk factors have been associated with the causes of Fascioliasis in ruminants, including the biology of host and parasites, management of flocks and herds, and the availability of intermediate host snail *(Lymnea auricularia)*. The extent of Fascioliasis in ruminants is also related to the temperature, moisture, season, health status of animals, flooded areas, or irrigated grazing land (Chakraborty and Prodhan, 2015). Thus, the emerging Fascioliasis significantly impacts both veterinary and human health. However, to find out the prevalence of this disease, numerous diagnostic methods based on the clinical signs, hematological tests, coprological analysis, and egg counting techniques, including McMaster and stool's ova counting method, are commonly used in Bangladesh (Mehmood et al., 2017).

The one health paradigm is an area that seeks to address the adverse effect of zoonotic infections through a comprehensive and sustainable approach. To know the epidemiological prevalence for intervention to this parasite is crucial for an individual country. In addition, country wise big data for particular disease prevalence and risk factor parameters are necessary to draw attention to this disease. Therefore, we conducted a systematic review and meta-analysis using the PRISMA guidelines. To our best knowledge, this is the first meta-analysis regarding the Fascioliasis infections in Bangladesh, which compiled last 20 years' time series data for analyzing the pooled prevalence with risk factors that can be a baseline for policymakers before taking any mitigation strategy.

2. Methodical search stratagem

2.1. The study protocol and literature search strategy

A systematic literature search was conducted using electronic databases, including Google Scholar, PubMed, Scopus, and the local journals (Bangladesh veterinary journal, Bangladesh agricultural university journal) to retrieve the related studies for the last 20 years. Three following combinations of keywords were used: for population (cattle, buffalo, sheep, and goats); interventions (parasite: *Fasciola spp.* and associated risk factors); outcomes (Fascioliasis or prevalence). All these keywords were restricted within the geography of Bangladesh. (For instance, prevalence + Fasciola + populations risk factors cattle/buffalo/sheep/goats + Bangladesh). Besides, additional studies were gathered by manually searching the cross-references or bibliographies section of eligible studies. However, the search criterion was limited to English-language studies; finally, the eligible studies were extracted by two reviewers to eliminate the bias. The PRISMA protocols were followed for searching and scrutinizing procedures (http://www.prisma-statement.org) (Moher et al., 2015).

2.2. Quality assessment of the study

The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was used to assess the overall quality of evidence (Atkins et al., 2004; Tegen et al., 2020). The quality of each study was declared using the three major assessment tools (methodological quality, comparability and outcome, and statistical analysis of the study). Two points were given to each criterion. Publications with a total score of 5–6 points were considered high, 3–4 points to moderate, and less than 3 points to be considered low quality and excluded (Tegen et al., 2020) (Table 1).

2.3. Study selection and data extraction

For conducting the methodical review and meta-analysis, we used six criteria as a standard for choosing the studies: (1) state of the case confined to cattle, buffalo, sheep, and goat species (2) prevalence including epidemiological studies written and published in the English language within the Bangladesh territory; (3) diagnosis based on direct smear, flotation, sedimentation, histopathology, saturated solution, McMaster, stool's ova count, alcohol retraining and morphology detection methods through feces; (4) studies published between 2000 to 2020; (5) holding full sample size more than 31. After designing the study, the title and abstract of the papers were carefully scrutinized by two reviewers independently, and pertinent papers were retrieved. The retrieving documents were then rechecked thoroughly, and deleted the duplicate and low-quality assessed articles. For conducting the meta-analysis, we processed the necessary data in Microsoft Excel with the authors first name, published year, study duration; location, animals age and sex, diagnostic method, and the number of samples, case positives, and percentage of prevalence were accumulated for each separate study.

2.4. Assessment of bias, data preparation, and analysis

The random effect model estimation method of Jamovi 1.2.27 software was chosen for eliminating biases; we considered the statistical test for showing the heterogeneity variation between studies and among the studies by considering low ($I^2 = 25\%$), moderate ($I^2 = 50\%$), and high ($I^2 > 75\%$) heterogeneity. Likewise, Q-statistics and Z-test were also calculated, and overall prevalence was showed in a forest plot using Jamvoi 1.2.27 software with a 95% confidence interval (CI). Finally, we graphically showed the funnel plot for clearing publication bias issues (Figure 1). Due to high heterogenicity among the studies, we separately analyzed subgroup parameters (categorical covariates), including age (young and old), sex (male and female), sample size (≤500 and >500), season (winter, summer, and rain), and duration (2000–2010 and 2011–2020) of the studies. We conducted a chi-square test among the categorized variables in each subgroup parameter (Odeniran and Ademola, 2019). The paired t-test among the continuous variables (prevalence) was performed for each subgroup which showed a significant *p*-value. The random effect model was also considered for estimating the pooled prevalence using different diagnostic methods.

3. Results

3.1. Study selection

In this step, we visualized a flow diagram that contains the selection process of choosing articles in Figure 2. By searching the keywords in three databases, we found 4896 records, and then we customized results based on the published year range between 2000 and 2020 and found 3721 records. After advance searching, we retrieved 767 records those are contained mentioned keywords in the title. Then, reading the title, abstract and full text, we got 75 studies that answered our research question. Next, we finalized 38 studies for conducting the meta-analysis on the basis of exclusion and inclusion criterions, among them (17 studies, sample size [N] = 7852) followed direct smear/sedimentation/flotation/saturated solution method, (2 studies, N = 1724056) mentioned direct smear test, (7 studies, N = 32321) stated histopathology/post mortem examination, (4 studies, N = 1701) stated McMaster, (6 studies, N = 2124) followed stoll's ova counting technique, and (3 studies, N = 823) morphology detection/alcohol retaining. In case of species subgroup, N = 1173098 for cattle, N = 90902 for buffalo, N = 457716 for goat, N = 47167 for sheep. Finally, we visualized all the characteristics of each study in Table 1.

3.2. Meta-analysis result

Showing the result in Table 1 and Table 2, the estimated prevalence of overall Fascioliasis was 20% (95% CI: 15–25) from 2000-2020. Moreover, we found considerable heterogeneity ($I^2 = 99.9$, $P < 0{\cdot}001$), and Q-statistics was found 1033375.9. Inside the overall prevalence, we categorized subgroup analysis, Firstly, in the case of species, we found the maximum number of studies (20) from cattle, but the heights prevalence rate was 21% both for cattle (95% CI: 12–30) and sheep (95% CI: >0–42). In contrast, the lowest prevalence rate was found at 19% (95% CI: 13–24) for goats, and the prevalence for buffalo was 20% (95% CI: 14–27), termed as mid-phase prevalence between cattle, sheep, and goat.

Table 1. Characteristics of 38 included studies.

Study	Location	Duration	Species	Test	Positive Case	Quality Assessment Score
(Affroze et al., 2013)	Netrokona	2008–2009	Cattle	Modified Stoll's ova counting technique	109	5
(Ahmed et al., 2015)	Chittagong	2013	Cattle	Direct smear/Sedimentation/Flotation	5	3
(Ahmedullah et al., 2007)	Barishal	2005–2007	Buffalo	Histopathology	18	3
(Akhter et al., 2019)	Sylhet	2016–2017	Cattle	Sedimentation	119	3
(Alim et al., 2012)	Chittagong	Not Applicable (N/A)	Cattle	McMaster and Stoll's method	11	5
(Bhowmik et al., 2020)	Chittagong	2020	Goat	Direct smear/Sedimentation/Flotation	32	3
			Sheep	Direct smear/Sedimentation/Flotation	29	
(Biswas et al., 2014)	Bhola	2011–2012	Buffalo	Egg morphology and quantitative test	126	3
(Chakraborty and Prodhan, 2015)	Chittagong	2011	Cattle	Direct smear/Sedimentation	42	3
(Hassan et al., 2020)	Dhaka	2014–2015	Cattle	McMaster/direct smear	20	5
(Hazzaz et al., 2017)	Dhaka	2016–2017	Cattle	Sedimentation/Flotation/Stoll's ova counting technique	11	5
(Hossain et al., 2011)	Sylhet	2007–2008	Goat	Histopathology	66	3
(Hossain et al., 2016)	Sunamgonj	2014	Goat	Sedimentation/Flotation/McMaster	42	5
			Sheep	Sedimentation/Flotation/McMaster	30	5
(Islam and Ripa, 2015)	Pabna	2014–2015	Goat	Post mortem examination	1010	3
(Islam et al., 2014)	Chittagong	2012	Cattle	Histopathology	22	3
			Buffalo	Histopathology	13	
(Islam et al., 2016)	Sylhet	2012–2013	Goat	Histopathology	202	3
			Goat	Direct smear/Sedimentation	405	
(Kabir et al., 2009)	Comilla and Brahmanbaria	2008	Cattle	Histopathology	398	3
			Buffalo	Histopathology	62	
			Goat	Histopathology	203	
(Kabir et al., 2018)	Sylhet	N/A	Cattle	Flotation	3	3
(Kabir et al., 2019)	Sirajganj	2016	Cattle	Direct smear/Sedimentation/Flotation	25	3
(Karim et al., 2015)	Shahjadpur	2012–2013	Cattle	Sedimentation with drop of methylene blue method	504	3
(Karim et al., 2017)	Patuakhali	2015	Cattle	Direct smear method	46	3
(Mamun et al., 2011)	Kurigram	2006–2007	Buffalo	Modified stoll's dilution Technique	53	5
(Mazid et al., 2006)	Mymensingh	2004	Sheep	Alcohol retaining/Washing in xylol	120	3
(Nath et al., 2013)	Chittagong	2011–2012	Cattle	Flotation with Saturated Solution method	3	3
(Nath et al., 2016)	Sylhet, Sunamgonj, Khagrachhar, Bandarban	2014	Cattle	Direct smear/Formol-ether concentration method	9	4
(Paul et al., 2016)	Sylhet	N/A	Cattle	Sedimentation/Flotation/McMaster	8	5
(Poddar et al., 2017)	Sherpur	2016	Sheep	Stoll's ova dilution technique.	12	5
(Rabbi et al., 2011)	Jaypurhat, Tangail, Mymensingh	N/A	Goat	Stoll's ova counting technique	164	5
(Rahman et al., 2014)	Pirganj	2010	Goat	Direct smear/Sedimentation/Flotation	20	3
(Rahman et al., 2017)	Entire Bangladesh	2011–2013	Cattle	Direct smear method	786660	3
			Buffalo	Direct smear method	4578	
			Goat	Direct smear method	104424	
			Sheep	Direct smear method	1233	
(Rahman et al., 2020)	Chuadanga	2018	Cattle	Direct smear method/Flotation	234	3
(Roy et al., 2016)	Bagerhat	2014	Buffalo	Stoll's ova counting technique	52	5
(Saha et al., 2013)	Barishal	2012	Buffalo	Direct smear/Sedimentation	70	3
(Saiful Islam and Taimur, 2008)	N/A	2005–2006	Goat	Sedimentation/Flotation/Saturated Solution method	32	4
(Saiful Islam and Taimur, 2008)		2010	Sheep	Sedimentation/Flotation/Saturated Solution method	12	3
(Sangma et al., 2012)	Tangail	2002–2003	Sheep	Stoll's ova counting technique/ Morphology detection	16	5
(Sardar et al., 2006)	Mymensingh	2002–2003	Cattle	Direct smear/Sedimentation/Flotation	200	3
(Sarker et al., 2016)	Dinajpur	2007–2008	Goat	Direct smear/Sedimentation	47	3
(Talukder et al., 2010)	Sylhet	2007–2008	Goat	Histopathology	70	3
(Yasin et al., 2018)	Chittagong	N/A	Cattle	Sedimentation	4	3
			Buffalo	Sedimentation	5	
			Goat	Sedimentation	0	

*N/A = Not Applicable.

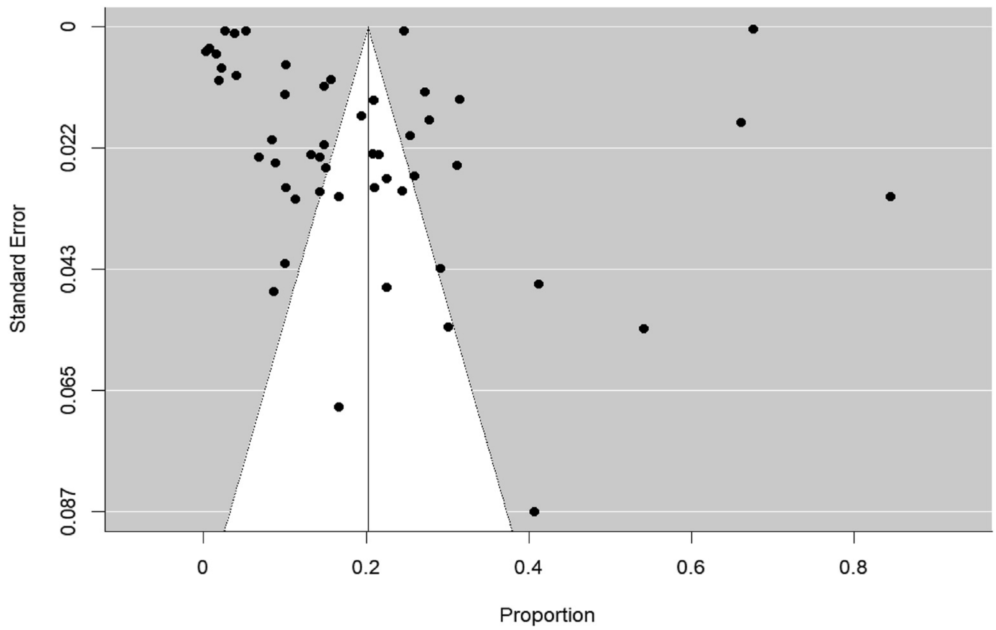

Figure 1. Funnel plot for perceiving the publication bias of the total existence of Fascioliasis among livestock population.

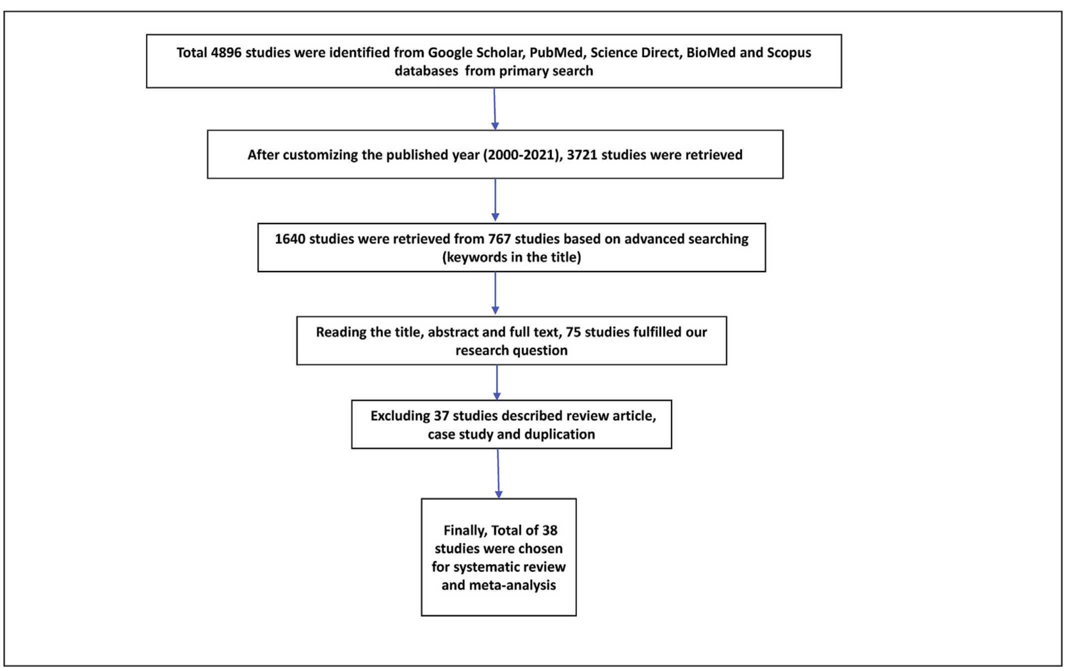

Figure 2. The assortment method of entitled studies for calculable scrutiny via flow diagram.

The summary of the statistics was ($I^2 = 99.8$, $Q = 72612.3$) for cattle, ($I^2 = 96.4$, $Q = 299.2$) for buffalo, ($I^2 = 99.9$, $Q = 25903.9$) for goat, ($I^2 = 99.6$, $Q = 792.430$ for sheep, and the *P*-value was <.001 for every case.

Analyzing the study period, the pooled prevalence was decreased only 2% in the last 10 years (2010–2020). In the periodic analysis 34 studies mention the duration period, and the overall prevalence were 24% (95% CI: 14–34) in the period of 2000–2010, and 22% (95% CI: 15–28) between 2010 to 2020. Moreover, the heterogenicity was significantly similar for the period of 2000–2010 ($I^2 = 98.9$, $P < .001$) and 2011–2020 ($I^2 = 99.9$, $P < .001$). Between the male and female, we got the higher prevalence rate in female individuals 26% (95% CI: 16–35, $Q = 4976.5$, and $I^2 = 99.6$); In contrast, the incidence rate was 20% (95% CI: 12–27, $Q = 1328.4$, and $I^2 = 99.4$) in male individuals.

Furthermore, we categorized young and old animals under the age group, where we found the young animal had less chance of being infected than older animals. The prevalence rate was 21% (95% CI: 13–29, $Q = 1634.7$, and $I^2 = 99.3$) in young animal. Likewise, 26% prevalence rate was identified within old animals (95% CI: 15–36, $Q = 271.7$, and $I^2 = 97.6$).

Next, we categorized the sample size into two groups, including 500 or below 500 samples and above 500 samples. Interestingly, we got a significantly higher prevalence rate within the study contained above 500 samples. For the sample size below or equal 500, we got the 19% (95% CI: 14–25, $Q = 1783.1$, and $I^2 = 99.2$) prevalence rate: meanwhile, 22% prevalence rate was found within the subgroup limited above 500 samples (95% CI: 12–32, $Q = 1012283$, and $I^2 = 100$).

Table 2. Potential risk factors of Fascioliasis infection among food animals.

Variable	Sub group	No. of studies	Sample size	Prevalence (95% CI)	Heterogeneity			Chi-square test (P value)	T-test
					P-value	Q-value	I^2 (%)		
Study period	2000–2010	11	5911	24 (14–34)	<.001	660.4	98.9	P = 0.022	P = 0.866
	2011–2020	23	1760630	22 (15–28)	<.001	1018559.0	99.9		
Species	Cattle	20	1173098	21 (12–30)	<.001	72612.3	99.8	P = 0.069	N/A
	Buffalo	9	90902	20 (14–27)	<.001	299.2	96.4		
	Goat	14	457716	19 (13–24)	<.001	25903.9	99.9		
	Sheep	7	47167	21 (>0–42)	<.001	792.43	99.6		
Sex	Male	20	20480	20 (12–27)	<.001	1328.4	99.4	P = 1.0	N/A
	Female		19347	26 (16–35)	<.001	4976.5	99.6		
Age	Young	25	6351	21 (13–29)	<.001	1634.7	99.3	P = 0.157	N/A
	Old		1469	26 (15–36)	<.001	271.7	97.6		
Sample size	500 or below	28	6751	19 (14–25)	<.001	1783.1	99.2	P = 0.011	P = 0.743
	Above 500	11	1762132	22 (12–32)	<.001	1012283	100		
Season	Winter	14	12208	23 (13–32)	<.001	1041.7	99.4	P = 0.898	N/A
	Summer		10330	22 (10–34)	<.001	804.7	99.5		
	Rain		11919	25 (16–34)	<.001	1015.1	89.2		

*N/A = Not Applicable.

Besides, we categorized the year into three-time phases, including rainy, summer, and winter seasons. We observed the maximum 25% (95% CI: 16–34) prevalence rate in the rainy period; likely, Q-statistic and I^2 were 1015.1 and 89.2. In contrast, we found 23% (95% CI: 13–32, Q = 12208, and I^2 = 99.4) prevalence rate in winter and 22% (95% CI: 10–34, Q = 804.7, and I^2 = 99.5) prevalence rate was noticed in summer.

Finally, we categorized the test procedure into six distinct groups, including direct smear/sedimentation/flotation/saturated solution method, direct smear, histopathology/post mortem examination, McMaster associated, stoll's ova counting technique, morphology detection/alcohol retaining. In the direct smear test, the prevalence rate was 31% (95% CI: 5–56); in contrast, 39% (95% CI: >0–85) prevalence rate was found in morphology detection/alcohol retaining test. Moreover, in the direct smear/sedimentation/flotation/saturated solution method, the prevalence rate was 18% (95% CI: 11–25), for the histopathology/post mortem examination, we found the prevalence rate 19% (95% CI: 1–25). Furthermore, the prevalence rate was 19% (95% CI: 12–26) and 9% (95% CI: 2–16) respectively for stoll's ova counting technique and McMaster associated with sedimentation/flotation/stoll's ova counting technique. The total prevalence rate was 21% (95% CI: 15–27) among the different testing methods (Table 3).

4. Discussion

Knowing the concise accumulative data of a disease with related risk factors is crucial for initiating mitigation strategy to the policymaker and meta-analysis is the best way to find out pooled data from segregate results. Thus, the current study appraises the overall prevalence of Fascioliasis with its potential risk factors in Bangladesh. Our findings noted that 20% (95% CI: 15–25%) of the livestock populations are affected by Fascioliasis (Figure 3), indicating a significant public health concern as an agro-based country. Recent study revealed that snail-borne trematode (SBT) infections were 76.7% for buffaloes, 68.9% for cattle, and 56.3% for goats, respectively, in farm animals on the offshore Saint Martin's Island of Bangladesh (Yasin et al., 2018). Besides, several studies reported that Bangladesh is the harbor land for *Fasciola spp.* in ruminants (Alim et al., 2004; Biswas et al., 2014; M. A. A. Mamun et al., 2011) and this could be due to the availability of abundant intermediate host snails in Bangladesh (more than 300 snail species) (Banglapedia, 2021).

Bangladesh is consisting of eight geographical divisions, and their prevalence is shown in Figure 4. The higher prevalence in Mymensingh and Barisal districts could be due to more research from those areas and old reputed agricultural universities. Moreover, Barisal is regarded as low-lying with several rivers that provides moistened, swampy areas for a significant prevalence of Fascioliasis infection (Sheikh et al., 2004). In the subgroup analysis, we analyzed our findings based on the studies' year and found 22% prevalence rate in between 2011 to 2020, which was lower (24%) than the year 2000–2010. Such variations are probably attributable to agro-ecological and environmental discrepancies between some sites, though the change in management systems could also be a reason (Abunna et al., 2010).

Our current study analyzed the species-wise prevalence and found that 21% among the cattle population, 20% in the buffalo population, 19% in the goat population, and 21% in the sheep population (Figure 5). However, the increased proportion of cattle Fascioliasis was identified at 91%, 70%, 68%, and 48.9% in Sudan, Uganda, Chad, and Zambia; in

Table 3. Prevalence of Fascioliasis according to different diagnostic test methods.

Test name	No. of studies	Pooled prevalence			(95% CI)	Heterogeneity			
		Sample size	Case	Prevalence (%)		P-value	Z-Value	Q-value	I^2 (%)
Direct smear/Sedimentation/Flotation/Saturated Solution method	17	7852	1800	18	11–25	<.001	5.28	2576.2	99.4
Direct smear	2	1724056	896941	31	5–56		2.35	923069.7	100
Histopathology/Post mortem examination	7	32321	2064	19	13–25		6.28	824.6	98.8
McMaster technique	4	1701	111	9	2–16		2.62	74.0	97.6
Stoll's ova counting technique	6	2124	401	19	12–26		5.65	56.37	92.1
Morphology detection/Alcohol retaining	3	823	262	39	>0 - 85		1.71	441.9	99.6
Overall	38	1768883	901579	21	15–27		7.23	192924.9	99.9

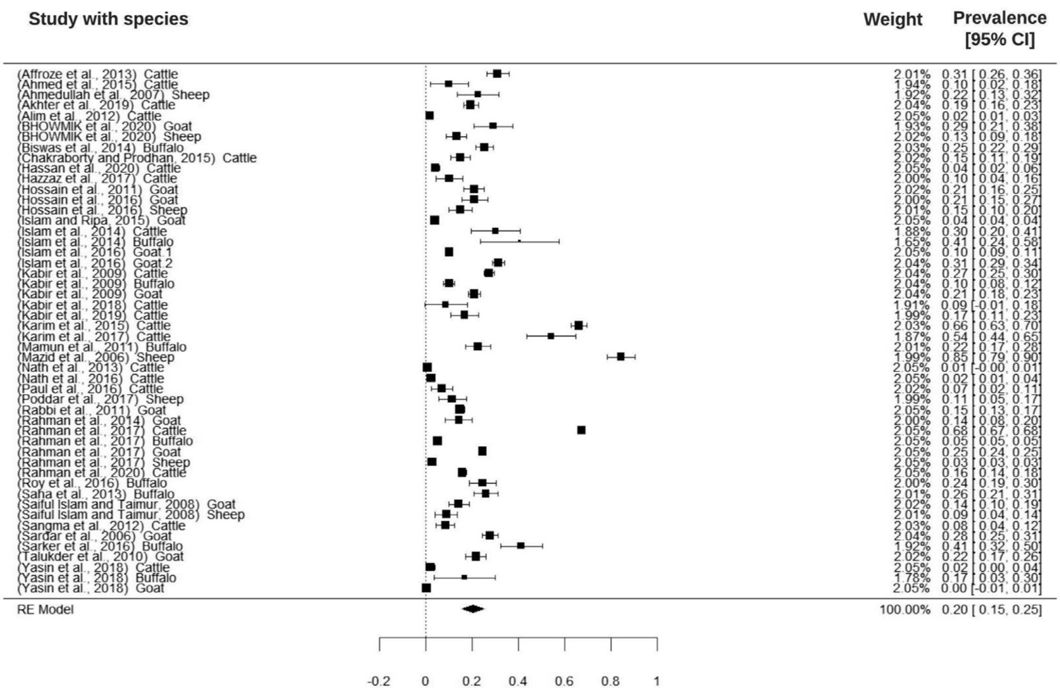

Figure 3. The Forest plot displays the prevalence of Fascioliasis among the ruminants.

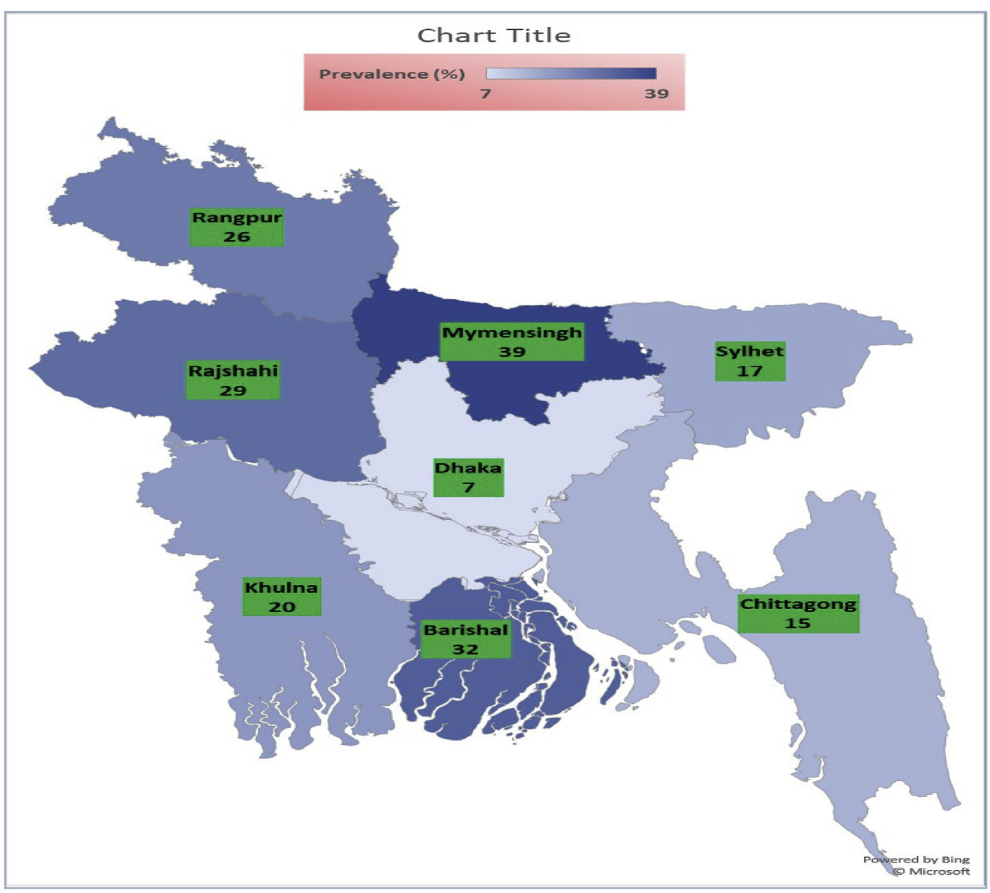

Figure 4. Divisional map of Bangladesh presenting the prevalence of Fascioliasis.

contrast, the prevalence was noted at 38.92%, 28.6%, 26%, 20.90%, 20.74%, 15.4%, and 14.3% in Tanzania, Ethiopia, Kenya, Egypt, Nigeria, Zimbabwe, and Tunisia. Similarly, in Kenya, 26% was found for buffalo, and in Egypt, the mediocre predominance was 20.8% (Mehmood et al., 2017). Moreover, (0.71–69.2) % and (0–47) % among the cattle and goat populations were regarded as Asian production animals with the highest

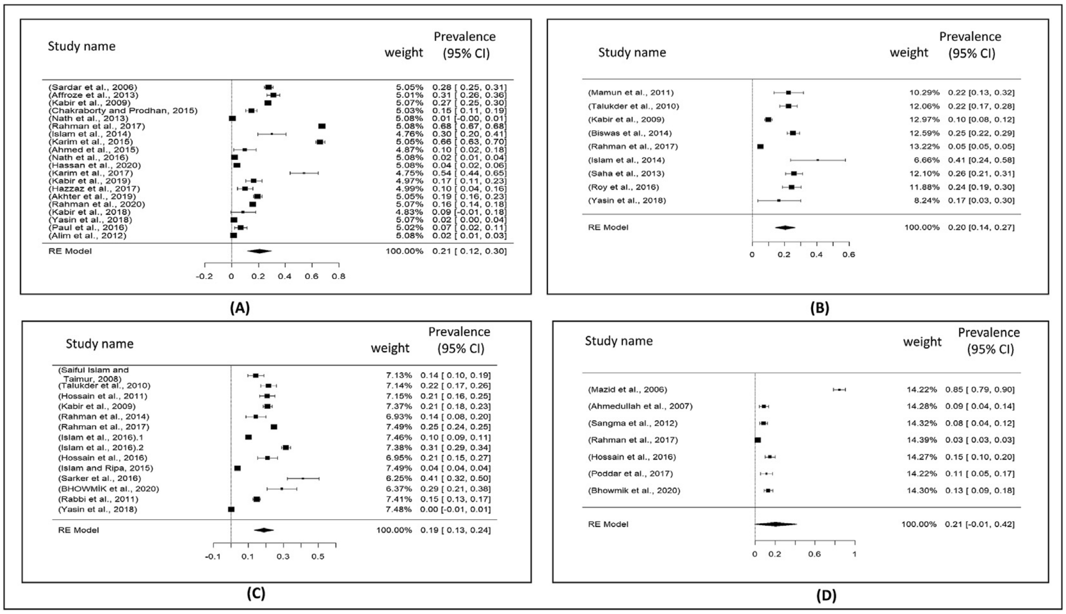

Figure 5. The Forest plot demonstrates the prevalence of Fascioliasis; (A) Cattle; (B) Buffalo; (C) Goat; (D) Sheep.

infection rates. Likewise, for Europe and Oceania region, cattle are considered the most common host, accounting for (0.12–86)% and (26.5–81)% infection rate, correspondingly (Khademvatan et al., 2019). Furthermore, the prevalence rate of Fascioliasis in European and African countries' goat was greatly varied with (0.28–68.4%) and sheep with (0.19–40.2%) (Mehmood et al., 2017). On the other hand, the prevalence rate was reported (2.78–8.98%) for sheep, (2.35–15%) goat, (10.79%) cattle, and (13.9%) buffalo in India, whereas 14.67–39.2% prevalence in sheep, 25.46% in cattle, and 4.08–28.75% in goat was reported in Pakistan, the neighboring country of Bangladesh (Garg et al., 2009; Kumari et al., 2010; Mehmood et al., 2017). The variability in occurrence between communities may be due to appropriate application of anthelmintic medicines, farmer knowledge, adequate control steps, including warmth changes, moisture, and relative humidity, all of which aid snail propagation (Abdulhakim and Addis, 2012).

In sex-wise subgroups, we found a higher prevalence rate in female individuals (26%) than male (20%). Females may have greater infection rates due to parturition stress and malnutrition, which makes them more susceptible to illnesses. Furthermore, when it comes to feeding considerations, females have a better probability to get the infection as they are being permitted to graze freely in grasslands.

Moreover, feeding the lactating cows with grasses grown around the rivers and low-lying areas throughout the dry season could potentially cause a high rate of parasitic infestation (Tilahun et al., 2014; Zewde

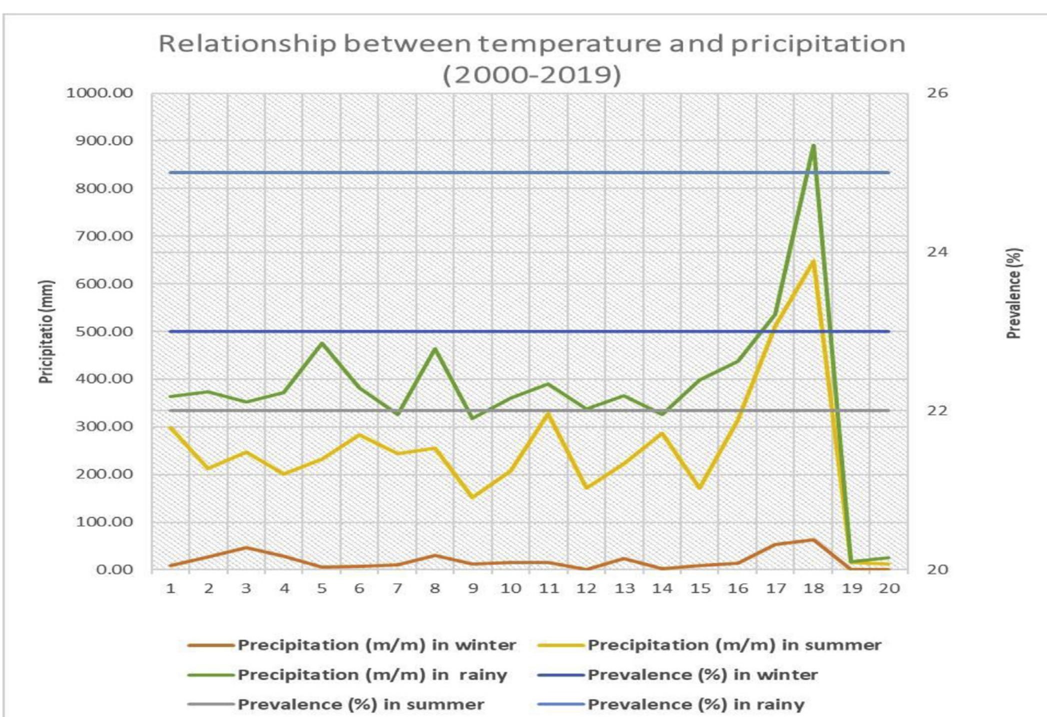

Figure 6. Prevalence of Fascioliasis in contrast with rainfall according to specific season.

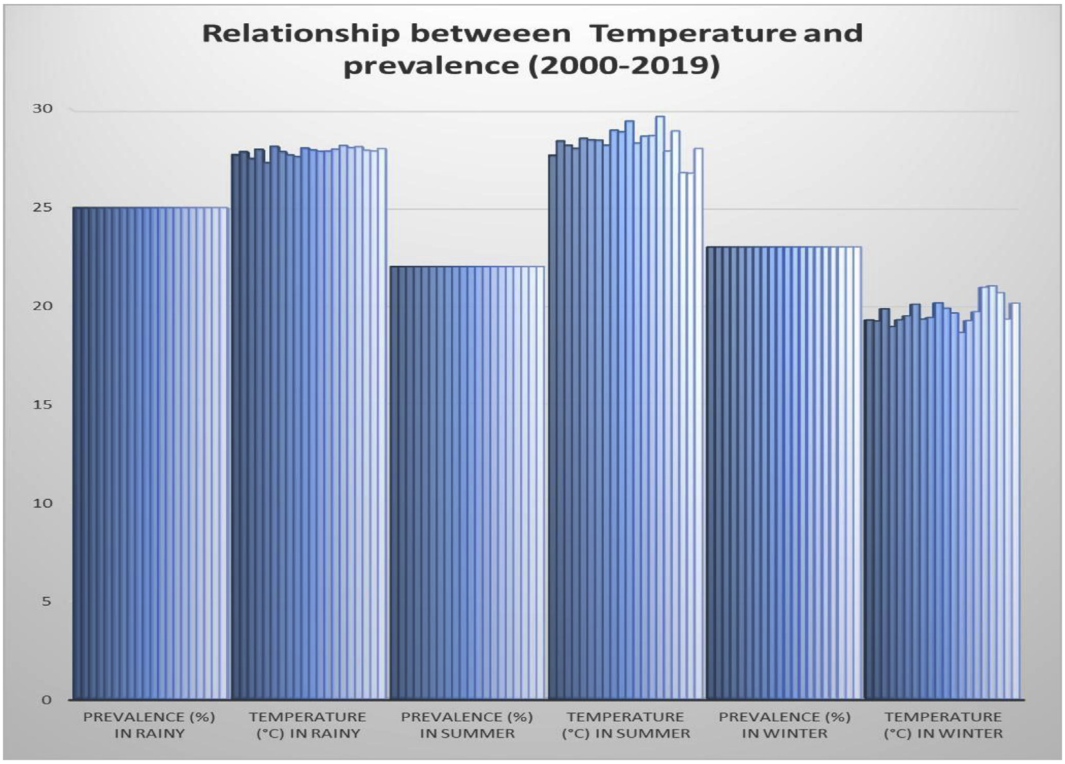

Figure 7. Prevalence of Fascioliasis in contrast with temperature of specific season.

et al., 2019). Nevertheless, various researchers suggested that gender seems to have no bearing on allowances of infection, including that both males and females are particularly prone to and vulnerable to the disease (Abdi et al., 2015; Keyyu et al., 2005).

In age groups, the present study declared that young individuals have a lower chance of infecting with Fascioliasis than old individuals. We found a 26% prevalence rate among aged animals and 21% amongst young animals. Several studies have shown that maturity has a substantial impact on the prevalence of Fascioliasis, with older animals becoming more susceptible to infection (Aragaw et al., 2012; Zewde et al., 2019). According to a recent study, younger animals are restricted indoors to provide good management, while older animals are allowed to the pasture for extended periods of grazing, which may contribute to the higher infection rate in adult animals (Zewde et al., 2019).

Analyzing the seasonal prevalence, we found a significant 25% prevalence rate in the rainy and 23% in winter season rather than the summer season (22%). Previous study reported that, the flukes mellow, including scattered eggs throughout the wet and rainy period, occurring

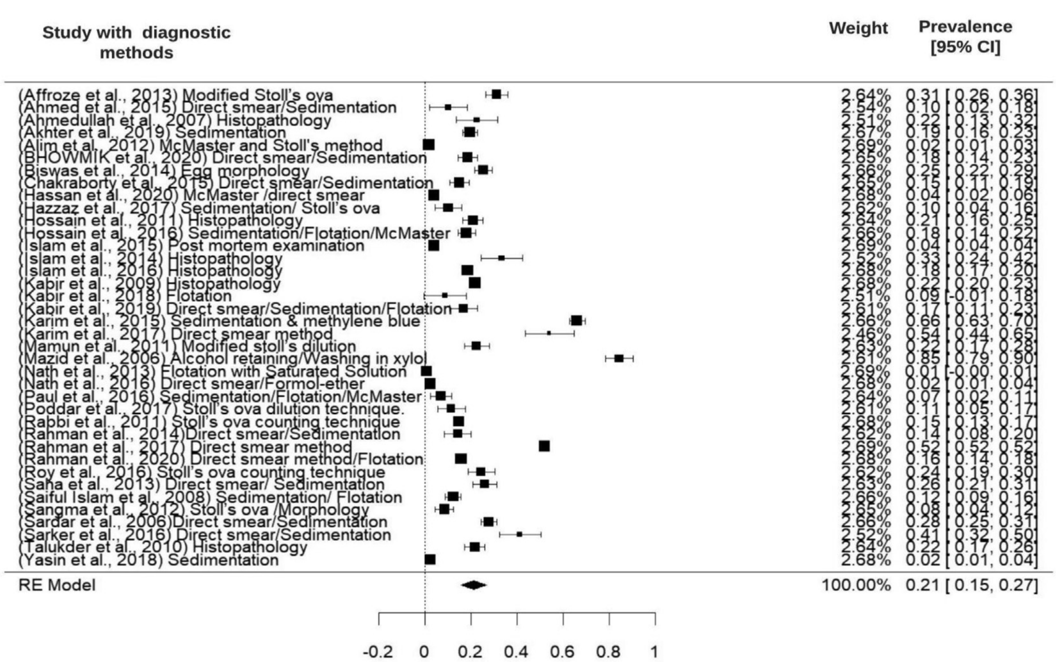

Figure 8. The Forest plot demonstrates the overall prevalence of Fascioliasis based on different diagnostic methods.

toward an apparent predominance of germs in animals during that season. The extreme temperatures hinder the pathogenic phases of the parasite and the snail as an intermediate host during the summer and lower precipitation throughout the year (Sheikh et al., 2004). To provide more objective evidence, we collected the annual rainfall and temperature data from the power.larc.nasa.gov website, shown in Figures 6 and 7. We showed the relationship between rainfall and temperature with the prevalence of Fascioliasis infection.

Finally, we categorized the different test procedures for analyzing the prevalence rate. The prevalence rate was reported at 21% based on various testing procedures. We found that the prevalence rate (39%) was higher when the morphology detection/alcohol retaining test was considered during the analysis. Likely, the direct smear test method revealed 31% the prevalence rate of Fascioliasis. However, those studies that followed the sedimentation test reported an 18% prevalence rate. The previous study reported that the high incidence might be linked to the clinical examination chosen, the representative sample, and the location of the individuals (Munguía-Xóchihua et al., 2007). However, several studies reported that assessing the prevalence rate by sedimentation test is an appropriate examination for performing the diagnosis among the large population (Ibarra et al., 1998; Munguía-Xóchihua et al., 2007). For egg counting methods, including McMaster, stoll's ova counting technique, the prevalence rate was reported from 9 to19 %. In contrast, we observed an 18% prevalence rate while performed histopathology/post mortem examination as *Fasciola spp*. Eggs take 8–15 weeks to appear in feces after infection; a previous study reported that counting worms at liver following post mortem examination or histopathology could only be considered a standard gold test for accessing Fasciola infection (Sánchez-Andrade et al., 2002). Finally, a forest plot of different diagnostic methods is visualized in Figure 8.

The proper method of a literature search from the internationally recognized database, an overall sample size, subgroup analysis about epidemiological risk factors, the impact of climate variables, and a recognized methodology were all included in this study. However, our analysis has a few limitations, such as the small sample size, the lack of necessary data in some studies, and the risk of missing some studies to include. Given the limitations, our findings may vary slightly from the actual prevalence rate. Thus, we recommended that rigorous molecular research should perform for finding an accurate prevalence of Fascioliasis in ruminants.

5. Conclusion

To summarize, we found a 20% prevalence rate of *Fasciola spp.* among the ruminant animals, with cattle and sheep being the most susceptible. Besides, infection is more vulnerable throughout the rainy period. As a result, the government should consider the data collected from this study while developing a control program. Furthermore, the veterinarian can use the results of the study to make the owner concerned. In Bangladesh, further research on the molecular epidemiology of *Fasciola spp*. is required.

Declarations

Author contribution statement

Md. Mukthar Mia; Mahamudul Hasan: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

Mohammed Rashed Chowdhury: Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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