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Review and Meta-Analysis of PPR in Goat and Sheep of Bangladesh from 2000 to 2019

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ARTICLE INFO	ABSTRACT
	Peste des petits ruminant (PPR), considered as goat plague is the most fatal infectious viral disease for small ruminants. This disease is endemic in many parts of the world including Bangladesh causes extensive loss on livestock and economy. This study was conducted to estimate the prevalence of PPR and this is the first meta-analysis on PPR as per authors knowledge in Bangladesh. Articles published during the years 2000 to 2019 on the topic PPR within three electronic databases were used for prevalence estimation by random effect meta-analysis model. A total of 39 articles were finally included in the model for prevalence estimation of goat and sheep. 1589784 goat and 142036 sheep were included in the study for analysis. Analysis showed prevalence of PPR was 15.17% (95% CI: 15.11-15.22) and 9.17% (95% CI: 9.02-9.32), respectively for goat and sheep. As PPR is affecting small ruminants in variable percentage in different districts of Bangladesh, this study estimates the cumulative prevalence of Bangladesh. This study may act as a baseline for taking effective control strategy of PPR in Bangladesh through proper allocation of resources on a priority basis.

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Introduction

Peste des petits ruminant virus (PPRV) causing the disease peste des petits ruminant (PPR) belongs to the family paramyxoviruses (OIE, 2018). PPR affecting mainly digestive and respiratory systems showing symptoms such as fever, conjunctivitis, diarrhea, bronchopneumonia, ulceration and erosion in oral mucosa etc. (Balamurugan et al., 2012). This PPR virus has genetic similarity with rinderpest virus (RPV), measles virus (MV), canine distemper virus (CDV) (Mantip et al., 2019). PPRV can be spread by tear, oculo-nasal discharge, fine droplet from sneezing or coughing, feces, contaminated waterer or feeding troughs or bedding materials, direct contact with infected animals etc. (Parida et al., 2019). Average incubation period for PPR is about five (5) days and affected animals can transfuse the virus without showing any symptoms (Parida et al., 2016). This disease can be diagnosed by rapid detection kit, ELISA, PCR, Real time PCR etc. (Malik et al., 2019). After first introduction of PPR in 1942, PPR spread in most of the African nations, Arabian Peninsula, Indian subcontinent, China etc. (Wang et al., 2015). As an OIE (The World Organization for Animal Health) enlisted disease, the member states must inform OIE according to criteria (Hota et al., 2018). Bangladesh is a developing country consists of 64 districts with a huge population of at least 160 Million (Bangladesh Population, 2020- Worldometer). A significant number of

her populations are living in rural area and depending on livestock and agriculture. Goat and sheep is the fundamental livestock in Bangladesh with homogenously distributed all over the country (Rahman, 2018). This mentioned small ruminants in rural area plays significant role is poverty reduction and women empowerment. There are 262.67 million goat and 35.37 million sheep in Bangladesh according to the Department of Livestock Services (DLS), Bangladesh (DLS, 2018). Vaccine is readily available for PPR with a minimal cost supported by government itself but proper preventive measure is not successful for poor management practice and public awareness. As PPR is affecting the mentioned livestock species the most, this disease deserves a proper control strategy with a focus to local management practice. Considering the circumstances, this study was undertaken to estimate the prevalence of PPR precisely in Bangladesh based on the previous published research articles. Meta-analysis is advantageous over other techniques in terms of increased sample size hence study power and therefore provides precise estimates. Knowledge on the exact prevalence is crucial to allocate resources efficiently in disease control programs especially in lower income country like Bangladesh. Therefore, this study will boost to take proper control strategy against PPR in Bangladesh.

Materials and Method

Methods

The study was conducted according to the guidelines provided by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) for review and meta-analysis (Ahaduzzaman, 2019).

Literature Search

A systemic selection procedure was maintained to choose scientific articles related to prevalence of PPR in Bangladesh. Papers were searched in three selected online databases Google Scholar, PubMed and Scopus. All searches done from 15th of April 2020 to 17th April, 2020 according to descriptive term, population term and outcome term with search options adjusted with syntax provision of the individual database (Ahaduzzaman, 2019). Search nomenclatures were listed in the Table1.

Data Extraction

Data extracted in excel spreadsheet including author, year of publication, duration of the study, area of the study, population, positive, prevalence and host species. Overall, data from 1589784 goat and 142036 sheep were analyzed for this study (Table 2 and Table 3).

Selection of Study

Articles were considered suitable for meta-analysis based on the following criteria: English language, animal level prevalence, duration of study between 2000 to 2019, goat or sheep or both populations; cross-sectional, case-control, longitudinal and cohort studies. Articles were excluded if prevalence data were not given, case study and experimental trial also discarded.

Table 1. Electronic database search nomenclature to find published reports on the prevalence of PPR in goat and sheep

Search term	Keywords
Descriptive term	Prevalence OR incidence OR frequency OR occurrence OR detection OR investigation OR rate
Population term	Peste des petits ruminants OR PPR OR goat plague
Outcome term	Goat OR doe OR buck OR caprine OR ovine OR sheep OR ram OR ewe OR small ruminant

Table 2. Characteristics of 38 studies included in meta-analysis in Goat

SL	Author	Study area	Duration	Sample	Positive (%)
01	Banik et al., 2008	Mymensingh	2003	100	25 (25)
02	Sardar et al., 2006	Mymensingh, Dhaka	2004	10815	1405(12.99)
03	Kabir et al., 2010	Kurigram	2008	115	33 (28.69)
04	Rahman et al., 2012	Barisal	2008-11	448	23 (5.13)
05	Rahman et al., 2018	Netrokona, Dinajpur, Chittagong	2009-10	539	203 (37.66)
06	Karim et al., 2014	Magura	2010	209	10 (4.78)
07	Islam et al., 2013	Patuakhali	2010	183	92 (50.27)
08	Rahman et al., 2011	Pabna	2010	6408	140 (2.18)
09	Sarker et al., 2011	Rajshahi	2010-11	627	129 (20.57)
10	Mondal et al., 2014	All districts	2010-12	1545831	234898 (15.19)
11	Noman et al., 2011	Cox's Bazar	2011	1086	509 (46.86)
12	Alam et al., 2015	Gazipur	2011	488	32 (6.55)
13	Nath et al., 2014	Chittagong	2011-12	2013	228 (11.32)
14	Hasan et al., 2012	Tangail, Sirazgonj, Rajshahi	2012	282	193 (68.43)
15	Islam et al., 2014	Cox's Bazar	2012	182	87 (47.80)
16	Parvez et al., 2014	Chittagong	2012-13	5485	493 (8.98)
17	Siddiqui et al., 2014	Cox's Bazar	2012-13	192	72 (37.50)
18	Sarker et al., 2015	Mymensingh	2012-14	1450	223 (15.37)
19	Lucky et al., 2016	Sylhet	2013	222	19 (8.55)
20	Naznin et al., 2014	Chittagong	2013	202	98 (48.51)
21	Rabbi et al., 2014	Rangpur	2013	307	46 (14.98)
22	Islam et al., 2015	Chuadanga	2014	284	44 (15.49)
23	Rakshit et al., 2015	Patuakhali	2014	91	69 (75.82)
24	Rahman et al., 2017	Rangpur	2014	230	18 (7.82)
25	Ahmed et al., 2017	Sylhet	2014	1857	336 (18.09)
26	Bueaza et al., 2015	Thakurgaon	2014	132	52 (39.39)
27	Debnath et al., 2015	Jhalakati	2014	39	8 (20.51)
28	Amin et al., 2016	Barisal	2014-15	6799	580 (8.53)
29	Meher et al., 2017	Pabna	2014-15	465	253 (54.40)
30	Rahman et al., 2016	Rajshahi	2015	72	20 (27.77)
31	Rahman et al., 2016	Dinajpur	2015	114	47 (41.22)
32	Rahaman et al., 2017	Jhenaidah	2015	120	10 (8.33)
33	Poddar et al., 2018	Pirojpur	2015	319	43(13.47)
34	Islam et al., 2016	Rajshahi, Sirajgonj, Gazipur	2015	606	255 (42.07)
35	Khan et al., 2018	Gopalgonj	2016	45	10 (22.22)
36	Alam et al., 2018	Comilla	2016-17	252	31 (12.30)
37	Yousuf et al., 2017	Bogra, Sirazgonj, Mymensingh, Rangpur	2017	200	56 (28)
38	Mohanto et al., 2018	Rangpur	2018	975	412 (42.25)

Table 3. Characteristics of 5 studies included in meta-analysis in Sheep

SL	Author	Study area	Duration	Sample	Positive (%)
01	Banik et al., 2008	Mymensingh	2003	100	27 (27)
02	Chowdhury et al., 2011	Mymensingh, Netrokona	2010-11	100	16 (16)
03	Hasan et al., 2012	Tangail, Sirazgonj, Rajshahi	2012	123	98 (79.67)
04	Mondal et al., 2014	All districts	2010-12	141707	12885 (9.09)
05	Rahman et al., 2017	Rangpur	2014	6	4(66.66)

Table 4. Overall prevalence of PPR in Goat and Sheep of Bangladesh

Species	Total Sample	Positive	Pooled Estimation (%)	95% CI	Heterogeneity ($\chi2$)	I^2 (%)	P-value
Goat	1589784	241202	15.17	15.11-15.22	8154.48	99.5	0.000
Sheep	142036	13030	9.17	9.02-9.32	900.61	99.6	0.000

Data Analysis.

All data were inserted and coded in Microsoft office Excel 2016 spread sheet and prevalence estimated with 95% confidence interval (CI). The CI was calculated using the standard formula for a proportion

(p): $p \pm 1.96 \times [p \times (100 - p) \div n]$,

Where n is the studied population size (Islam et al., 2014). Meta-analysis performed by command "metan" in Stata-IC 13 and heterogeneity of the studies estimated by interpreting the I^2 statistic value and Cochran's Q (represented as $\chi2$ and P-values) (Ahaduzzaman, 2019). The I^2 values of 25, 50 and 75% were considered as low, moderate and high heterogeneity, respectively (Ahaduzzaman, 2019). Due to a higher degree of heterogeneity between studies the random effect model was selected for summary statistic. In forest plot results are presented as prevalence percentage with 95% CI besides study bias effects was determined using two funnel plots (Ahaduzzaman, 2019).

Results

Search Results and Eligible Studies

As initial search results showed 344 workable scientific papers which was downed to 92 after deletion of duplicate papers. There were 39 papers selected after screening of the papers showed in the Figure 1 and among them 34 were particularly on goat (Islam et al., 2013; Karim et al., 2014; Rahman et al., 2012; Kabir et al., 2010; Rahman et al., 2011; Rahman et al., 2018; Sardar et al., 2006; Sarker et al., 2011; Noman et al., 2011; Alam et al., 2015; Nath et al., 2014; Rabbi et al., 2014; Islam et al., 2014; Islam et al., 2016; Lucky et al., 2016; Naznin et al., 2016; Parvez, 2014; Rakshit et al., 2015; Siddiqui et al., 2016; Sarker et al., 2015; Ahmed et al., 2017; Alam et al., 2018; Amin, 2016; Bueaza, 2015; Debnath et al., 2015; Islam et al., 2016; Mohanto et al., 2018; Khan et al., 2018; Md. Mustafizur Rahaman, 2017; Meher et al., 2017; Rahman et al., 2016; Rahman et al., 2016; Sadar et al., 2018; Yousuf et al., 2017), 4 papers dealing on both sheep and goat (Hasan et al., 2012; Mondal et al., 2014; Rahman et al., 2018; Banik et al., 2008) a single article particularly on sheep (Chowdhury, 2011).

Prevalence Estimation

Total 1731820 small ruminants including 1589784 goat and 142036 sheep were meta-analyzed in this study. Pooled prevalence was found 15.17% (95% CI: 15.11-15.22) and 9.17% (95% CI: 9.02-9.32) for goat and sheep, respectively (Table 4). Forest plot showed the overall prevalence and the selected articles estimated prevalence (Figure 2 and Figure 3). Analysis showed clear indication of high heterogeneity ($I^2 > 80\%$) which later showed in funnel plot. Funnel plot proved publication bias for both goat and sheep as appearing non-symmetrical funnel and points falling outside the funnel (Figure 4).
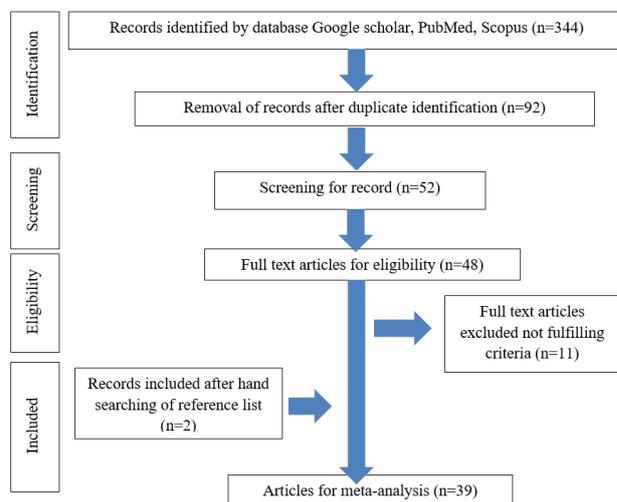

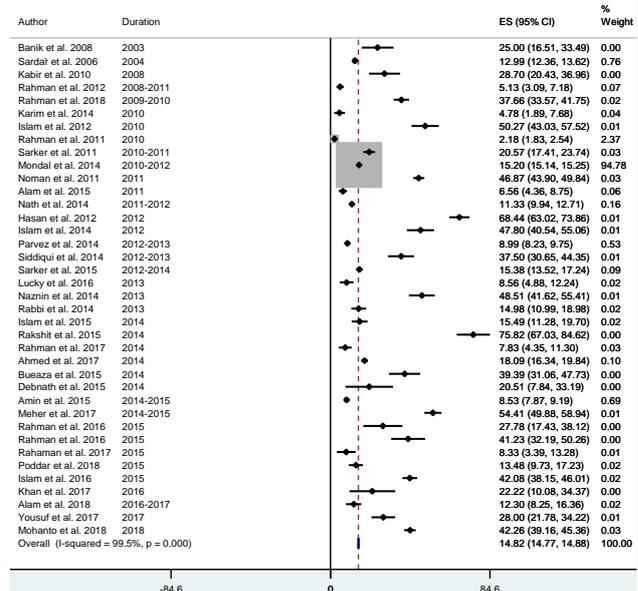Figure 1. Flow chart of the selection of eligible studies for selection in the meta-analysis

Figure 2. Forest plot of the prevalence estimates of PPR in goats amongst studies conducted in Bangladesh
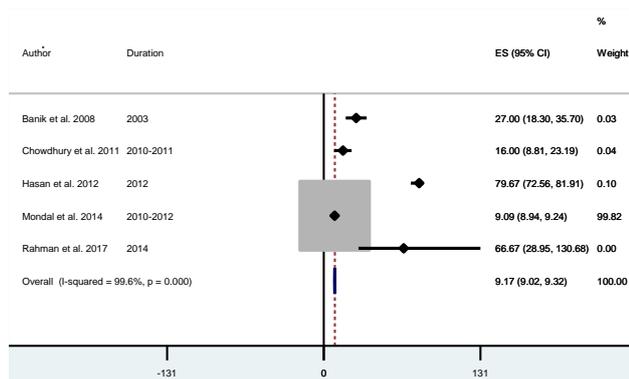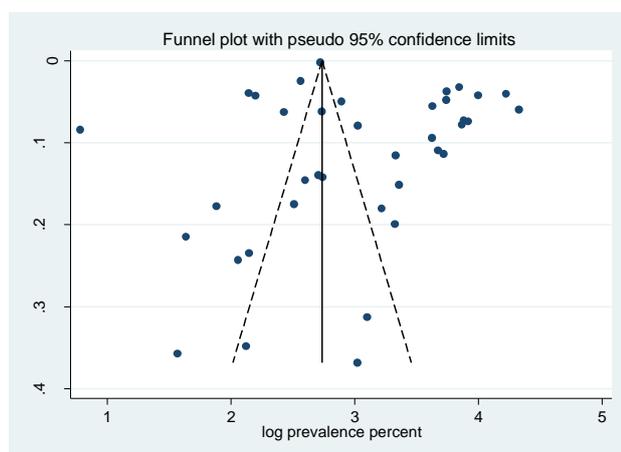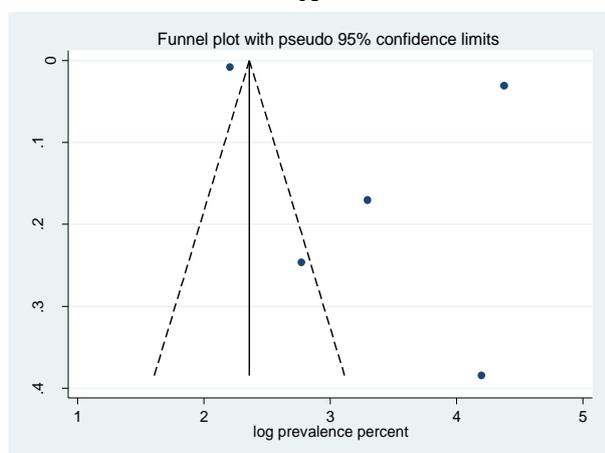
Figure 3. Forest plot of the prevalence estimates of PPR in sheep amongst studies conducted in Bangladesh

A

B

Figure 4. Funnel plot for examination of publication bias of the prevalence of PPR in goat (A) and sheep (B)

Discussion

PPR is considered as one of the major viral diseases in Bangladesh. Many researches have been done before to know the prevalence of PPR in many parts the country. There are no review and meta-analysis of PPR as per author's knowledge. This study estimates the prevalence of PPR in Bangladesh by analyzing 39 standard scientific paper. It covers a huge population including 1589784 and 142036 goats and sheep, respectively. The selected papers encircle homogenously all the districts of Bangladesh although a higher frequency of study locations were Mymensingh, Chittagong, Cox's Bazar and Barisal might be due to presence of agricultural universities in first two districts. Overall prevalence in this study was estimated as 15.17% (95% CI: 15.11-15.22) in goats and 9.17% (95% CI: 9.02-9.32) in sheep. In comparison to other PPR endemic country prevalence in Ghana was recorded as 6.84% and in Laos 1.7%, whereas in Djibouti prevalence was 6% in small ruminants (Burns et al., 2019; Moumin and Moussa, 2018; Folitse et al., 2017). In parts of Egypt the overall morbidity of PPR was found 54.2% which is higher than the estimated prevalence in Bangladesh (Elhaig et al., 2018). We retrieved few studies on sheep PPR in comparison to goat PPR in Bangladesh might be due to lower sheep population than goat. The estimated prevalence showed a clear indication that goats are more susceptible to PPR and the findings are consistent with the verdict of other authors (Abubakar et al., 2008; Al-Majali et al., 2008; Delil et al., 2012; Gari et al., 2015). Majali et al. (2008) found that the prevalence of PPR in sheep and goats were 29% and 49 %, respectively in Jordan (Al-Majali et al., 2008). Abubakar et al. (2007) concluded that sheep and goat sero-prevalence was 28.8 and 82.7%, respectively in Pakistan (Abubakar et al., 2008). Besides, Delil et al. (2012) reported that sheep was affected in lower percentage (7.3%) than the goat (42.6%) in Ethiopia (Delil et al., 2012). Moreover in India, Hota et al. (2017) showed that goats (48.2%) were more in risk than sheep (44.7%) (Hota et al., 2018) and in Kenya, Kihu et al. (2015) suggested that goats (40%) were affected in higher rate than sheep (32%) (Kihu et al., 2015). But the finding of the present study is not consistent with the findings of Osman et al. (2018) who reported higher prevalence in sheep (84%) than goat (66%) (Osman et al., 2018). This study observed a higher heterogeneity among the articles which may be due to population size, area of the examination, season of the examination, sampling procedure, vaccination status etc. This study showed us the PPR prevalence at a glance in Bangladesh. The results may act as a baseline for further molecular study and help to control the disease effectively.

Limitations

The selected papers were not homogenously distributed all over the country. Study populations highly fluctuates particularly a single paper weighted more than 80% of the total populations.

Conclusions

This study suggests that PPR is highly prevalent in Bangladesh and goat is more affected than sheep. Proper strategy must be undertaken for effective control of the disease.

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