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

F. M. Yasir Hasib1,a,* Sharmin Chowdhury1,b

1Department of Pathology and Parasitology, Faculty of Veterinary Medicine, Chattogram Veterinary and animal Sciences University, Khulshi, 4225 Chattogram, Bangladesh
2Corresponding author

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. Studies 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.

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.

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

| SL  | Author                  | Study area      | Duration | Sample | Positive (%) |
|-----|-------------------------|-----------------|----------|--------|--------------|
| 01  | Bank et al., 2008       | Mymensingh      | 2003     | 100    | 25 (25)      |
| 02  | Sardar et al., 2006     | Mymensingh, Dhaka | 2004    | 10815  | 140(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 (6.65)    |
| 13  | Nath et al., 2014       | Chittagong      | 2011-12  | 2013   | 226 (11.32)  |
| 14  | Hasan et al., 2012      | Tangail, Sirajgonj, 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  | Debmath 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    | Jienaidah       | 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, Sirajgonj, Mymensingh, Rangpur | 2017   | 200    | 56 (28)      |
| 38  | Mohanto et al., 2018    | Rangpur         | 2018     | 975    | 412 (42.25)  |

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 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 (χ²) | I² (%) | 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 spreadsheet and prevalence estimated with 95% confidence interval (CI). The CI was calculated using the standard formula for a proportion

\[(p) = \frac{1.96 \times [p \times (100 - p) + n]}{n}\]

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 I² statistic value and Cochran’s Q (represented as \(\chi^2\) and P-values) (Ahaduzzaman, 2019). The I² 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 downs 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; Deb Nath et al., 2015; Islam et al., 2016; Mohanto et al., 2018; Khan et al., 2018; Md. Mustafizur Rahman, 2017; Meher et al., 2017; Rahman et al., 2016; Rahman et al., 2016; Sadar et al., 2018; Youusuf 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 (I² > 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).
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; Folotise 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.

References

Abubakar M, Jamal SM, Hussain M, Ali Q. 2008. Incidence of peste des petits ruminants (PPR) virus in sheep and goat as detected by immuno-capture ELISA (Ic ELISA). Small Rumin. Res, 75: 256–259.
Ahaduzzaman M. 2019. The global and regional prevalence of oestrus in sheep and goats: A systematic review of articles and meta-analysis. Parasites and Vectors.

Ahmed S, Hassan MR, Hosssain MA, Uddin F, Rashid H, Talha MH, Rahman MM. 2017. Clinical Prevalence and Influencing Factors Analysis for the Occurrence of Peste Des Petits Ruminants (PPR) Disease of Goat at Sylhet Region, Bangladesh. Vet. Clin. Sci, 5: 1–5.

Al-Majali AM, Hussain NO, Amarin NM, Majok AA. 2008. Seroprevalence of, and risk factors for, peste des petits ruminants in sheep and goats in Northern Jordan. Prev. Vet. Med, 85: 1–8.

Amir N, Shil S, Hosssain M. 2011. Incidence and modulating effects of environmental factors on infectious diseases of Black Bengal goat in Cox’s Bazar district of Bangladesh Bangladesh in Cox Pazar Bölgesinde Siyah Bengal Keçilerinin Enfeksiyö z Hastalıkları Üzerine Çevre Faktörlerinin 22: 163–167.

Alam MA, Amin MR, Paul TK, Saha TK, Rahman K, Khalikuzzaman RM. 2015. Asian Journal of Medical and Biological Research Prevalence of clinical diseases and disorders of goats at Upazilla Livestock Development Center, Kapasia, Gazipur. Asian J. Med. Biol. Res, 1: 47–52.

Alam MB, Mahmud T, Khan SA, Islam A, Hai MA, Hassan MM. 2018. Occurrence of diseases and disease conditions in cattle and goats at the Upazila Veterinary Hospital, Debidwar, Comilla. J. Adv. Vet. Anim. Res, 5: 117–122.

Amin MR. 2016. Prevalence of common parasitic and infectious diseases of goat at Babugonj upazilla, Barisal, Bangladesh. Asian J. Med. Biol. Res, 1: 449–456.

Balamurugan V, Saravanan P, Sen A, Rajak KK, Venkatesan G, Krishnamoorthy P, Bhanuprakash V, Singh RK. 2012. Prevalence of peste des petits ruminants among sheep and goats in India. J. Vet. Sci, 13: 279–285.

Bangladesh Population. 2020. - Worldometer [WWW Document]. n.d. URL https://www.worldometers.info/world-population/bangladesh-population/ (accessed 4.26.20).

Banki SC, Podder MAS, MTI. 2008. Sero-surveillance and immunization in sheep and goats against peste des petits ruminants in Bangladesh. Bangladesh J. Vet. Med, 6: 185–190.

Bueza Z. 2015. Variability in prevalence and therapeutic effectiveness in PPR affected goats of Thakurgaon, Bangladesh. Burns RJ, Douangneun B, Thepangna W, Mukaka M, Wegner MD, Windsor PA, Blacksell SD. 2019. Peste des Petits Ruminants (<scp>PPR</scp>) virus serological surveillance in goats in Lao (<scp>PDR</scp>): Issues for disease eradication in a low-resource disease-free setting. Transbound. Emerg. Dis, 66: 939–947.

Chowdhury MT. 2011. Study on seroprevalence of peste des petits ruminants in sheep in Bangladesh. Bangladesh Agricultural University, Mymensingh.

Debnath T, Talukder M, Paul K, Science P. 2015. Occurrence of diseases and disorders in cattle and goat at jhalakati sadar upazilla of bangladesh 1195–1200.

Delil F, Asfaw Y, Gebregeziabher B. 2012. Prevalence of antibodies to peste des petits ruminants virus before and during outbreaks of the disease in Awash Fentale district, Afar, Ethiopia. Trop. Anim. Health Prod, 44: 1329–1330.

DLS. 2018. Livestock Economy at a Glance.

Elhaiq MM, Selim A, Mandour AS, Schulz C, Hoffmann B. 2018. Prevalence and molecular characterization of peste des petits ruminants virus from Ismailia and Suez, Northern Egypt, 2014–2016. Small Rumin. Res, 169: 94–98.

Folitse E, Amemor E, Nyarku R. 2017. Pattern of peste des petits ruminants (ppr) distribution in Ghana (2005–2013). Bulg. J. Vet. Med, 20: 51–57.

Garin G, Mekonnen G, Sibhat D, Abebe A, Sahle M, Abeie G. 2015. Participatory disease surveillance (PDS) of sheep and goat diseases in selected districts of Afar Regional State: Particular focus on Peste des Petits Ruminants (PPR) and sheep and goat pox disease (SGP). Ethiopia. Vet. J, 19: 83.

Hasan M. 2012. Seroprevalence of peste des petits ruminants (ppr) in goat and sheep in selected areas of Bangladesh. Bangladesh Agricultural University, Mymensingh.

Hota A, Biswal S, Sahoo N, Rout M, Chaudhury D, Pandey A, Muthuchelian D. 2018. Seroprevalence of PPR among Sheep and Goats of Different Agroclimatic Zones of Odisha. Int. J. Livest. Res, 8, 1

Islam K, Ahad A, Mahmood A, Rahman MM, Islam ZM, Kabir HB, Barua M, Chowdhury S, Nasir MK, Biswas PK. 2014. Prevalence and clinicopathological features of peste des petits ruminants. J. Infect. Mol. Biol, 2: 43–48.

Islam M, Khan M, Kader H, Begum M, Asgar M. 2013. Prevalence of PPR of Goat and Their Response to Antibiotic Treatment at Mirzaganj Upazila of Patuakhali District. J. Environ. Sci. Nat. Resour, 5: 181–184.

Islam MM, Hasan MA, Yousuf A, Islam M, Shahan MMAK, Islam MR. 2016. Seroprevalence of Peste des Petits Ruminant Virus specific antibody in goats in different regions of Bangladesh. J. Adv. Vet. Anim. Res, 3: 127–133.

IslamMZ, Musekiwa A, Islam K, Ahmed S, Chowdhury S, Ahad A, Biswas PK. 2014. Regional variation in the prevalence of:E. coli O157 in cattle: a meta-analysis and meta-regression. PLoS One 9, e93299.

Islam SS, Rao S, Akhter AT, Hosssain MM, Islam MR, Islam SM, Sariful, Singhha AK. 2016. Investigation of peste des petits ruminants outbreaks in goat farms of Chaudanga District of Bangladesh in 2014. Asian J. Med. Biol. Res, 1: 434–441.

Karim M, Parvin M, Hosssain M, Islam M, Hussan M. 2014. A Report on Clinical Prevalence of Diseases and Disorders in Cattle and Goats at The Upazila Veterinary Hospital, Mohammedpur, Magura. Bangladesh J. Vet. Med, 12: 47–53.

Khan NB, Pal DR, Mollah ML. 2018. Study on clinical diseases and disorders of cattle and goat at Gopalganj District in Bangladesh. Asian J. Med. Biol. Res, 3: 412–418.

Kihu SM, Gachoji MH, Ndungu EU, Gitao GC, Bebora LC, John NW, Wairire GG, Maingi N, Wahome RG, Ireri R. 2015. Sero-epidemiology of Peste des petits ruminants virus infection in Turkana County, Kenya. BMC Vet. Res, 11: 87–

Lucky NS, Hossain MK, Roy AC, Haque MM, Uddin AM, Islam MM, Howlader MMR. 2016. A longitudinal study on clinical diseases and disorders of cattle and goats in Sylhet, Bangladesh. J. Adv. Vet. Anim. Res, 3: 24–37.

Kabir MH, Reza MA , Razi KMA , Parvez MM, M.A.S.B. and S.U.M. 2010. A report on clinical prevalence of diseases and disorders in cattle and goat at the upazilla veterinary hospital, ulipur, kurigram. Int. J. BioRes, 2: 17–23.

Mantip SE, Shamaki, Farougou S. 2019. Peste des petits ruminants in africa: Meta-analysis of the virus isolation in molecular epidemiology studies. Onderstepoort J. Vet. Res, 86: 1–15.

Meher M, Afrin M, Hassan Z, Alam J. 2017. Epidemiological investigation of peste des petits ruminants virus infection in goat with therapeutic management at Bera upazila of Pabna in Bangladesh. Progress. Agric, 28: 114–119.

Rahman MK, Dash AK, Afrin K, Zaman S , P.B. and M.S. 2016. Study on diarrhea between ppr and fascioliasis in goat at Sylhet, Bangladesh. J. Adv. Vet. Anim. Res, 3: 124–133.

Mohanto JK, Hoque MF, S.U.M. 2018. Seroprevalence and risk factors for peste des petits ruminants in sheep and goats in Djibouti. Rev. sci. tech. Off. int. Epiz 37.
Malik MA, Hanif T, Khan JI, Zahur A, Latif A, Ullah A, Muhammad A, Anjum AA, N.H. 2019. Comparative Analysis of Two Serodiagnostic Assays for Detection of Antibodies Against Peste- des- Petits Ruminants (PPR) from Non- Vaccinated Sheep and Goats. Res. J. Vet. Pract. Comp, 7: 83–86.

Nath TC, Bhuiyan JU, Mamun MAI, Datta R, Kumar S. 2014. Full Length Research Paper Common Infectious Diseases of Goats in Chittagong District of Bangladesh, 1: 43–49.

Naznin M, Ahaduzzaman M, Chowdhury S, Biswas P. 2016. Prevalence and clinico-pathological parameters of PPR infected goats and their response to antibiotic treatment at Panchlaish, Chittagong, Bangladesh. Int. J. Nat. Sci, 4: 1–7.

OIE, 2018. Peste des petits ruminants (PPR).

Osman NA, Ibrahim HMA, Osman AA, Alnour RM, Gamal OA. 2018. Sero-prevalence of peste des petits ruminants virus antibodies in sheep and goats from the Sudan, 2016–2017. VirusDisease, 29: 531–536.

Parida S, Muniraju M, Altan E, Baazizi R, Raj GD, Mahapatra M. 2016. Emergence of PPR and its threat to Europe. Small Rumin. Res, 142: 16–21.

Parida S, Selvaraj M, Gubbins S, Pope R, Banyard A, Mahapatra M. 2019. Quantifying Levels of Peste Des Petits Ruminants (PPR) Virus in Excretions from Experimentally Infected Goats and Its Importance for Nascent PPR Eradication Programme. Viruses 11, 249.

Parvez MA. 2014. Prevalence and associated risk factors of Peste des Petits Ruminants (PPR) in goats in Chittagong district, Bangladesh. Res. J. Vet. Pract, 2: 14–17.

Rabbi MS, Mannan MA, Imtiaz SC and MAMP. 2014. A survey of livestock and poultry along with mortality trends of goat at kaunia upzilla, rangpur, Bangladesh. Bangl. J. Vet. Med, 12: 155–160.

Rahaman MM, FTZ and MA. 2017. Prevalence of clinical diseases and disorders in goats at Jhenaidah Sadar Upazila, Jhenaidah, Bangladesh. Asian-Australasian J. Biosci. Biotechnol, 2: 45–50.

Rahman MM, Alam MJ, Alam MS, Hasan MM, Moonmoon M. 2016. A study on prevalence of peste des petits ruminant (PPR) in goat at Bagmara upazilla at Rajshahi district in Bangladesh. Res. Agric. Livest, Fish, 3: 339–344.

Rahman MA, Islam MA, Rahman AK, Talukder MSP, M.T.I. 2012. science, clinical diseases of ruminants recorded at the patuakhali clinic, and technology university veterinary. Bangl. J. Vet. Med, 10: 63–73.

Rahman MM, Hassan MZ, Sultana S, Uddin MK, Hossain SS. 2018. Incidence of Peste des Petits Ruminants in Rangpur sadar of Bangladesh. Asian J. Med. Biol. Res, 3: 529–533.

Rahman MZ, Haider N, Gurley ES, Ahmed S, Osmani MG, Hossain MB, Islam A, Khan SA, Hossain ME, Epstein JH, Zeidner N, Rahman M. 2018. Epidemiology and genetic characterization of Peste des petits ruminants virus in Bangladesh. Vet. Med. Sci, 4: 161–171.

Rahman S. 2018. Agroecological, Land-Elevation and Socioeconomic Determinants of Raising Livestock in Bangladesh. Agriculture, 8: 12.

Rakshit N, Paul AK, Amin MR, Asaduzzaman M, Sen PC, T.M. 2015. Occurrence and therapeutic response of peste des petits ruminants (ppr) in goats at the selected southern part of bangladesh. Wayamba J. Anim. Sci, 1239–1243.

Sadar P, Poddar S, Dey T, Sultana J, Akter S. 2018. Prevalence of Peste des Petits Ruminants in Goat at Upizalla Veterinary Hospital, Pirojpur Sadar, Bangladesh. Turkish J. Vet. Res, 2: 5–8.

Sardar S, Samad M, Ehsan M. 2006. Incidence of goat diseases in the selected area of Dhaka and Mymensingh districts. J. Bangladesh Agric. Univ, 4: 299–304.

Sarker S, Islam MH. 2011. Prevalence and risk factor assessment of Peste des petits ruminants in goats in Rajshahi, Bangladesh. Vet. World, 4: 546–549.

Siddiqui M, Ahasan A, Islam N, Kandu P, Munshi M, Chowdhury E. 2016. Peste des Petits Ruminants (PPR) virus antibodies in goats and cattle of the Saint Martin’s Island in Bangladesh. Bangladesh Vet, 31: 55–73.

Wang J, Wang M, Wang S, Liu Z, Shen N, Si W, Sun G, Drewe JA, Cai X. 2015. Peste des petits ruminants virus in Heilongjiang Province, China, 2014. Emerg. Infect. Dis, 21: 677–680.

Sarker, AHM, Sharif MHH, Islam R, Ray R, Paul TK. 2015. A retrospective study of common diseases at veterinary teaching hospital, Bangladesh Agricultural University, mymensing. Bangl. J. Vet. Med, 13: 55–61.

Yousuf MA, Rahman MM, Alauddin M, Rahman SB, Islam SS, Islam MR, Ershaduzzaman M.2017. Sero-surveillance of peste des petits ruminant viral antibody in goats at different areas of Bangladesh. Asian J. Med. Biol. Res, 3: 347–351.