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PREVALENCE AND RISK FACTORS OF PESTE DES PETITS RUMINANTS IN GOATS AT NAOGAON SADAR, BANGLADESH

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ABSTRACT

Small ruminants, such as sheep and goats, play a pivotal role in the economy of Bangladesh, contributing significantly to both rural livelihoods and national income. However, it is hampered by the varieties of diseases, among which Peste des Petits Ruminants (PPR) is extremely significant. In addition, Naogaon is located adjacent to an area with a high prevalence of PPR (Rajshahi), but it was previously neglected, and no data has been recorded. To ascertain the prevalence of PPR in Naogaon Sadar Upazila, a study was carried out. Data were obtained through direct interviews with goat owners at the Upazila Veterinary Hospital (UVH) and indirectly from the hospital's register book, covering November 2022 to October 2023. Of the 572 observed goats, the prevalence of PPR was the highest (32.17%) among other diseases. Results indicate a significantly higher prevalence in Jamunapari breeds (44.87%) compared to Black Bengal breeds (35.86%); females (57.86%) are more likely to be affected than males (22.28%). The prevalence of PPR was highest in the rainy season (36.11%), followed by autumn (32.35%), winter (31.45%), or summer (28.36%). There was a higher prevalence in young goats (38.56%) compared to kids or adult goats. Moreover, non-vaccinated goats (42.37%) were more affected than vaccinated goats (5.66%). Pearson's chi-square tests with a P value at the significance level ($P<0.05$) were used to analyze all of the data. Age, breed, vaccination status, and deworming were significantly ($p < 0.05$) associated with PPR. Uncovering the prevalence and corresponding risk factors of PPR in a previously neglected area, this study will help to establish improved disease control strategies for stakeholders to minimize this disease's associated economic losses.

Keywords: Prevalence, PPR, Goats, Naogaon Sadar

INTRODUCTION

Global demand for meat is increasing gradually and is projected to rise by 1.4% yearly, which requires an additional 3.4 million tons of meat to fulfill the world's growing meat consumption by 2031 (O'Neill, 2021). To meet this growing demand, increasing livestock production in the near future is an urgent need for all nations. In Bangladesh, the livestock sector contributes 1.85% to the national gross domestic product (GDP), where the GDP growth rate of livestock is 3.23% ("Livestock Economy at a Glance," 2022-2023). Bangladesh has a total of 30.7 million small ruminants, including 26.9 million goats and 3.82 million sheep ("Livestock Economy at a Glance," 2022-2023). Small ruminants, especially goats, are closely associated with humans as socioeconomic animals due to their products (meat, milk, and hair) and contribute to the sustainability of rural economies and several ecosystems (Samad, 2021). Goat meat is highly valued in Bangladesh for its taste and palatability. Additionally, the country has started exporting goat meat to international markets. However, the domestic production of goat meat and its export are hindered by the existence of infectious diseases (Rahman et al., 2011). Among these infectious diseases, Peste des Petits Ruminants (PPR) is a transboundary, World Organization for Animal Health (WOAH) notifiable, highly contagious, economically significant viral disease in small ruminants, particularly in goats. PPR is an economically important disease in sheep and goats (Munibullah et al., 2024). The causative agent of PPR

is the PPR virus (PPRV), an enveloped RNA virus that belongs to the genus Morbillivirus within the Paramyxoviridae family. It falls under the subfamily Paramyxovirinae and is classified within the order Mononegavirales (Ahaduzzaman, 2020). The PPRV is genetically classified into four distinct lineages (I, II, III, and IV) based on partial sequencing of the fusion (F) gene. While lineages I, II, and III are primarily found in Africa, lineage IV is predominantly distributed in Asia. (Ahaduzzaman, 2020). The PPRV strains found in Bangladesh showed a phylogenetically close genetic relation to lineage IV (Nooruzzaman et al., 2021). PPR was initially discovered in 1942 in the Ivory Coast, West Africa, and subsequently spread to other regions of the world, including sub-Saharan Africa, the Arabian Peninsula, the Middle East, and some regions of Asia (Banyard et al., 2010). In Bangladesh, the PPR virus was initially discovered in 1993 during an intense outbreak (Islam et al., 2001), which was verified by a global reference laboratory, and it was discovered that the virus has a close relationship with a cluster of Asian PPR virus isolates from West Bengal, India (Dhar et al., 2002). Following that outbreak, PPR then spread throughout the country; it is estimated that PPR affects most of the districts in Bangladesh (Rahman et al., 2021). PPR presents clinical signs similar to rinderpest (RP) in cattle. Affected animals exhibit a high fever (107°F–108°F), along with ocular and nasal discharges. The disease is characterized by catarrhal inflammation of the ocular and nasal mucosa, necrotic stomatitis, bronchopneumonia, and severe diarrhea, often leading to dehydration. In most cases, the infection results in death, although occasional recovery may occur (Ugochukwu et al., 2019). In addition, PPR causes high morbidity, varying from 10% to 100%, and mortality of 50-90%, depending on immunity, biosecurity, overall health, and nutritional status of animals (Kumar et al., 2014). Moreover, according to the OIE/FAO report on global PPR control and eradication, the disease causes an estimated annual economic loss of $1.2–1.7 billion worldwide, resulting from animal mortality, reduced production, and the expenses associated with disease control measures. (FAO, 2015). In Bangladesh, it is estimated that PPR causes more than $25 million in losses each year (FAO, 2024). Although PPR is a vaccine-preventable disease, it frequently occurs in different parts of Bangladesh due to inappropriate vaccination strategies, improper vaccination policies, and insufficient data availability. The epidemiological investigation exposed that the highest case of PPR was found in Rajshahi (36.1%), whereas the lowest was found in Barishal (2.1%) (Rahman et al., 2021). However, no study was performed at Naogoan Sadar though it has a large population of goats, and is adjacent to a high PPR prevalence area of the Rajshahi division. Therefore, the current status of PPR in this area is still unrevealed. This study was conducted to determine the current scenario, prevalence, and associated risk factors of PPR in the northern part of Bangladesh. It will help to establish proper immunization strategies along with essential biosecurity procedures for the prevention, control, and eradication of PPR from this region.

MATERIALS AND METHODS

Study area

The investigation was carried out at Naogaon Sadar's Upazila Livestock Office & Veterinary Hospital, where veterinary services and livestock management activities are carried out to support animal health and welfare (Figure 1). This location was taken into consideration due to its abundance of small ruminants, especially goats, along with favorable geographic circumstances for PPR.

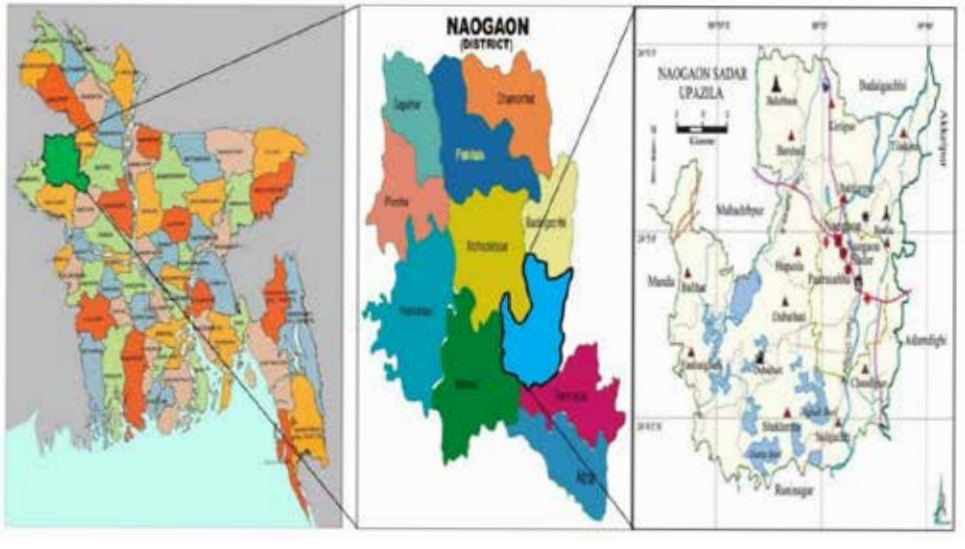

Figure 1: Map showing the study area (Naogaon Sadar, Naogaon, Bangladesh)

Study animals
The study focused on small ruminants, specifically goats that were carried to the hospital. These animals were categorized based on various factors, including age, sex, breed, vaccination status, and the type of farming system they were raised in. A total of 572 cases of goat (no findings of PPR in sheep in a particular area at a particular time) were examined in this study within a period of 12 months (from November 2022 to October 2023). During the study period, 184 cases of PPR were reported among the selected goats (n=572).

Field diagnosis and data collection
The data were collected directly at the Upazila Livestock Office & Veterinary Hospital, from the owner of the examined animal (goats) with their consent, and indirectly from the record book. Data were collected through a comprehensive assessment, which included owner-reported information on various factors such as breed, age, sex, weight, duration of rearing, housing conditions, and pregnancy status. Clinical history was thoroughly examined, encompassing details on the animal's purchase history, previous disease occurrences, deworming, vaccination, and any noted abnormal symptoms. Further, clinical evaluations (detailed physical examinations comprising inspection, body temperature measurement, auscultation, and respiratory assessments) were conducted, alongside the documentation of clinical signs observed in the suspected goats, in order to diagnose PPR.

Data analysis
The collected data were analyzed statistically through the Statistical Package for the Social Sciences (SPSS) version 26.0. Pearson's chi-square test was employed to assess associations between categorical variables. A significance level of $p < 0.05$ was established, with values below this threshold considered statistically significant.

RESULT

The overall prevalence of diseases at Naogaon Sadar, Naogaon
The overall prevalence of diseases in Naogaon Sadar, Naogaon, during the study period was assessed based on the examination of 572 goats. Among these, 184 goats were diagnosed with PPR, resulting in an overall PPR prevalence of 32.17% (n = 572). Additionally, the prevalence of other diseases observed included flu (11.7%), foot rot (9.8%), cysts (7.2%), and various other diseases (39%), as shown in Figure 2. PPR was identified as the most prevalent disease during the study period.

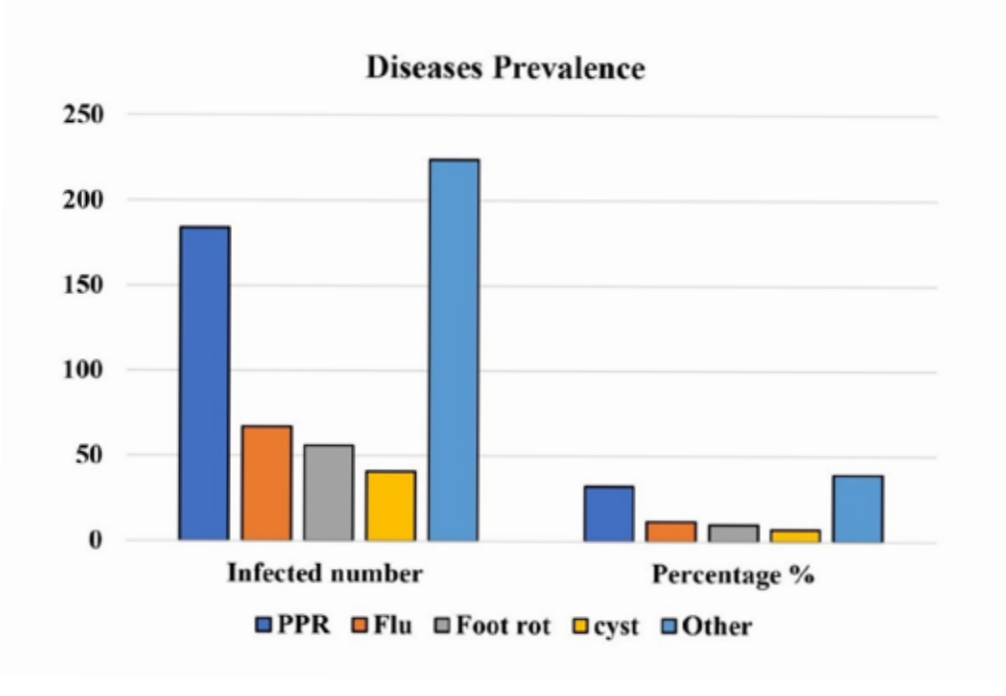

Figure 2: Overall prevalence of diseases at Naogaon Sadar, Naogaon, Bangladesh

PPR prevalence according to characteristics of the animal (age, sex, breed)
Age of animals had a great impact on PPR prevalence, where young goats (n = 319) exhibited the highest prevalence of PPR (123 cases). The prevalence of young animals (38.56%) was higher than that of kids and adults (Table 1). Though a higher number of males (413) was documented, the PPR-affected number of males and females was the same (92). However, females had a higher PPR prevalence (57.86%) than

males. When considering breed, the highest number of Black Bengal goats (304) was documented, with the highest clinically PPR-affected number (109). However, the Jamuna Pari goat breed had a higher PPR prevalence (44.87%) than the Black Bengal and crossbreed (Table 1). Importantly, the age, sex, and breed of the goat were significantly associated with PPR prevalence ($p<0.05$).

Table 1. **PPR prevalence based on animal-related factors (Age, Sex, Breed)**

Parameter	Variable	Examined Goat	Percentage (%)	Clinically PPR-infected Goat	Percentage (%)	Prevalence	P value
Age	Kid	107	18.71	29	15.76	27.10	
	Young	319	55.77	123	66.85	38.56	**0.000***
	Adult	146	25.52	32	17.39	21.92	
Sex	Male	413	72.20	92	50.00	22.28	< **0.000***
	Female	159	27.80	92	50.00	57.86	
Breed	Black Bengal	304	53.15	109	59.24	35.86	
	Jamuna pari	78	13.64	35	19.02	44.87	**0.000***
	Others crossbreed	190	33.22	40	21.74	21.05	

* P value <0.05 was considered statistically significant

Month-wise prevalence of PPR

A total of 572 goat populations were registered at Upzilla Veterinary Hospital (UVH) in Naogaon Sadar, Bangladesh, over one year (November 2022-October 2023). Among them, 184 goats had been clinically identified with PPR. Thus, the overall prevalence of PPR in goats was 32.17% (n = 572). In monthly observations, the highest prevalence was recorded in July (47.37%, i.e., 18/38), followed by August (46.00%), October (38.71%), February (36.36%), March (35.90%), September (35.19%), November (33.33%), May (32.43%), and January (30.43%), while lower prevalence was recorded in April (25.53%) and June (20.00%), and the lowest prevalence was recorded in December (17.33%) (Table 2).

Table 2. Month-wise prevalence of PPR in goats recorded at UVH, Naogaon Sadar during the period of November 2022 to October 2023.

Month	Total Goat	Clinically PPR-infected Goat	Prevalence (%)
Nov-22	36	12	33.33
Dec-22	75	13	17.33
Jan-23	46	14	30.43
Feb-23	33	12	36.36
Mar-23	39	14	35.90
Apr-23	47	12	25.53
May-23	37	12	32.43
Jun-23	55	11	20.00
Jul-23	38	18	47.37
Aug-23	50	23	46.00
Sep-23	54	19	35.19
Oct-23	62	24	38.71
Total	**572**	**184**	**32.17**

Prevalence of PPR based on vaccination and deworming status

Table 3 illustrates PPR prevalence according to goat vaccination status and deworming history. Among 159 vaccinated goats, only 9 were PPR-infected. Among 413 non-vaccinated goats, 175 were PPR-infected. The non-vaccinated goat had a higher PPR prevalence (42.37%) than vaccinated goats (5.56%). In regard to goat deworming history, among 207 dewormed goats, 55 were clinically PPR-infected. Among 365 non-dewormed goats, 129 were clinically PPR-infected. Non-dewormed goats had a higher PPR prevalence than dewormed goats. Importantly, both vaccination status and deworming history had significant ($p<0.05$) associations with PPR prevalence.

Table 3. PPR prevalence based on vaccination and deworming status

Parameter	Variable	Examined goat	Percentage (%)	Clinically PPR-infected Goat	Percentage (%)	Prevalence	P value
Vaccination Status	**Vaccinated**	159	27.80	9	4.89	5.66	**< 0.000***
	Non-vaccinated	413	72.20	175	95.11	42.37	
Deworming	**Dewormed**	207	36.19	55	29.89	26.57	**0.048***
	Non-dewormed	365	63.81	129	70.11	35.34	

* P value <0.05 was considered statistically significant

PPR prevalence based on management practices (feeding system, floor system) and season

Table 4 illustrates PPR prevalence according to feeding system, floor system, and season. Among 168 stall-feeding goats, 22 were identified as PPR-infected. Among 404 grazing goats, 162 were PPR-infected. Grazing goats had a higher PPR prevalence (40.10%) than stall-feeding goats (13.10%). The feeding system has a significant association with PPR prevalence ($p<0.05$). The goat rearing on soil floor systems (36.93%) and macha (37.93%) (elevated bamboo floor) had a higher PPR-infected number and prevalence than concrete floors (18.47%). floor system had significant ($p<0.05$) associations with PPR prevalence Among the four seasons, the rainy season (36.11%) had a higher PPR prevalence than summer (28.36%), autumn (32.35%), and winter (31.45%). However, the season of the year had no significant association with PPR prevalence ($p>0.05$).

Table 4. PPR prevalence based on management practices (feeding system, floor system) and season

Parameter	Variable	Examined goat	Percentage (%)	Clinically PPR-infected Goat	Percentage (%)	Prevalence	P value
Feeding system	**Stall feeding**	168	29.37	22	11.96	13.10	**0.014***
	Grazing	404	70.63	162	88.04	40.10	
Floor System	**Concrete**	157	27.45	29	15.76	18.47	**0.000***
	Soil	241	42.13	89	48.37	36.93	
	Macha	174	30.42	66	35.87	37.93	
Season	**summer**	134	23.43	38	20.65	28.36	**0.583**
	Rainy	144	25.17	52	28.26	36.11	
	Autumn	170	29.72	55	29.89	32.35	
	Winter	124	21.68	39	21.20	31.45	

* P value <0.05 was considered statistically significant

DISCUSSION

PPR is a highly contagious viral disease affecting small ruminants, such as sheep and goats, characterized by its rapid transmission, significant destructive impact, and substantial economic consequences (Liu et al., 2018). It is exceedingly endemic throughout Asia, including Bangladesh, and directly affects the country's economy as small ruminants contribute significantly to the GDP of the nation by giving farmers a source of income, meat, and wool (Rahman et al., 2021). PPR is highly prevalent in Rajshahi, which is adjacent to Naogaon district, but no data has been recorded yet. Therefore, this epidemiological investigation was designed to reveal the prevalence of PPR in previously neglected areas like Naogaon Sadar. In addition, this study will contribute to the PPR eradication program in Bangladesh by establishing proper preventive strategies.Overall, the prevalence of PPR in the present study was 32.17%, which is the most prevalent, followed by other diseases. This finding is consistent with previous studies, such as one conducted in India, where the reported prevalence of PPR was 32.4% (Singh et al., 2004). It also aligns closely with the study by Rahman et al. (2021), who reported an overall prevalence of 36.2% in the small ruminant population of Rajshahi. In contrast, a lower prevalence was reported by Parvez et al. (2014), who found a

prevalence of 8.99% in Chittagong. Additionally, the results show a higher prevalence compared to those reported by Islam et al. (2012), further emphasizing the variability in PPR prevalence across different regions. Al-Dubaib (2009) and Swai et al. (2009) reported 50.27% in Patuakhali, 55.1% in some areas of Saudi Arabia, and 49.5% seroprevalence in Tanzania, respectively. This variation might be due to different geographical locations, breeds, ages, sex, seasons, research periods, and diversified management practices.Compared to Black Bengal goats, Jamunapari goats had a greater frequency of PPR. This may be because of their tendency for repeated pregnancies and high milk production, which might further strain their immune systems and increase their susceptibility to the virus. The results of this study contradict those of Sarker and Islam (2011) and Parvez et al. (2014), who found that Black Bengal goats are more vulnerable to PPR compared to Jamunapari goats. Furthermore, the prevalence of PPR was higher in goats aged 6 months to 2 years than in kids (under 6 months) and adults (over 2 years), with the disease being most prevalent in goats under 1 year of age, especially 7-12 months of age (Rahman et al., 2016). Meher et al. (2017) also reported that the susceptibility of young animals aged 3 to 18 months was proved to be very high. The reduced susceptibility of kids to PPR may be due to the presence of maternal-derived antibodies in their system, which are transferred from exposed or vaccinated female sheep before the weaning period. These antibodies likely provide temporary immunity against the disease during the early stages of life (Rahman et al., 2023).Prevalence of PPR varies with gender depending on several factors, and the present study shows females were significantly more susceptible to PPR than males. Because of hormonal impacts, pregnancy, or nursing status, it was believed that female immune responses were typically lower than male ones (Chakrabarti, 2007). However, the specific clarification is unknown. A similar pattern was reported by Rahman et al. (2016), where around 46.42% of female goats are affected by PPR. However, on the contrary, a higher prevalence of PPR is reported in male goats than females by Sarker and Islam (2011) and Rahman et al. (2023).The prevalence was higher in unvaccinated and non-dewormed goats than in vaccinated and dewormed goats. This result aligns with previous findings, which reported a higher prevalence of PPR (38.77%) in unvaccinated goats (Rahman et al., 2023). Serological studies on PPRV antibodies in small ruminants of varying vaccination status have shown that protective antibodies against PPR are significantly higher in vaccinated goats compared to those that are unvaccinated or have an unknown vaccination status (Kumbe et al., 2024). These antibodies generate active immunity against PPR infection. The OIE/FAO has outlined a global target to eradicate PPR by 2030, with a structured plan that includes four critical stages: evaluation, control measures, eradication, and ongoing surveillance after eradication (FAO, 2015). Typically, vaccination or recovery after PPR triggers a lifetime immune response; nevertheless, a booster dose is advised every three years to maintain an adequate immunity level (Mariner et al., 2016). Therefore, scheduled vaccination is compulsory to protect animals from developing diseases at the field level.The prevalence was higher in grazing feeding than in stall feeding systems. This result might be found due to the rapid transmission of the diseases from different herds in the same grazing land. The highest prevalence was reported during the rainy season compared to other seasons, and there was no significant difference (>0.05). Other reports have also mentioned the increased prevalence of PPR during the rainy season (Rahman et al., 2021; Rony et al., 2017). Small ruminants are stressed during the rainy season, which may account for the increased prevalence of PPR during this time of year. Furthermore, because they are usually kept indoors throughout the rainy season, they stay in close proximity to one another, which makes the highly infectious PPR virus much easier to spread.

CONCLUSION

The results of the current study demonstrated the potential prevalence of PPR in goats based on breed, age, sex, hygiene practices, feeding system, immune status, and season, which may have detrimental effects on the health and productivity of the animals. Thus, in order to bring the disease's prevalence down to a potential minimum, farms' management practices must be improved. Recommended vaccines can be used to prevent PPR on farms. Farms must ensure proper sanitation, and female goats require extra attention since they are more susceptible to diseases. Moreover, the necessary epidemiological investigation is urgently needed to prevent and control PPR at the national and international levels.

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