



## Factors Associated with Anthrax Vaccination Coverage in Two Anthrax-prone Districts, Bangladesh, 2019

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Received: 10 Jun 2022; Revised: 8 Sep 2023; Accepted: 15 Sep 2023

<https://doi.org/10.59096/osir.v16i3.265576>

### Abstract

Anthrax is a significant public health threat in Bangladesh due to recent outbreaks in humans and animals. To reduce the incidence of anthrax, the Department of Livestock Services implemented the Preventing Anthrax and Rabies Project (PARB) to enhance anthrax surveillance and response in two anthrax-prone districts. We conducted a retrospective review of PARB data on livestock farmers' knowledge and practice towards anthrax, anthrax vaccination and anthrax vaccination coverage in six subdistricts of northern and one subdistrict in southwestern Bangladesh. We calculated prevalence ratios (PR) and 95% confidence intervals (CI) to identify risk factors for low vaccination coverage. We found that farmers from farms with low vaccine coverage (<80%) had poor knowledge on animal anthrax (PR 1.75, 95% CI 1.50–1.93) and human anthrax (PR 1.66, 95% CI 1.45–1.87), were less likely to treat (PR 1.79, 95% CI 1.58–1.99) and more likely to slaughter (PR 1.53, 95% CI 1.10–2.09) sick animals than farms with high vaccine coverage. These findings reveal poor knowledge and practices related to anthrax among farmers in low vaccine coverage subdistricts of Bangladesh. Developing and disseminating behavioral change components to farmers can improve their knowledge and practices about anthrax and increase vaccine coverage.

**Keywords:** anthrax, knowledge, practice, vaccination, Bangladesh

### Introduction

Globally, around 1.8 billion people live in anthrax-risk areas.<sup>1</sup> Human and animal anthrax are endemic in South Asian countries, including Bangladesh, and present a significant public health threat in these countries because most of the population is engaged in agronomic and animal rearing practices.<sup>2</sup> The Institute of Epidemiology, Disease Control and Research in Bangladesh investigated 15 human anthrax outbreaks from May 2016 to November 2018 and recorded 378 cases in 2020.<sup>3</sup>

Low vaccination coverage in animals due to scarcity of vaccine is an important factor in many animal anthrax outbreaks.<sup>4</sup> The Bangladesh Livestock Research Institute produced six million doses of anthrax vaccine in 2019–2020, but the demand was for 41 million doses to cover the cattle population.<sup>5</sup> Risk factors such as

behavioral (slaughtering sick animals) and environmental (seasonal flooding) contribute to the repeated outbreaks of anthrax.<sup>6,7</sup>

The Sirajganj and Meherpur Districts are two anthrax hot spots in Bangladesh because of frequent anthrax outbreaks and the high cattle population.<sup>7</sup> The Department of Livestock Services (DLS), Bangladesh conducts the 'Preventing Anthrax and Rabies in Bangladesh' (PARB) surveillance project with goals to reduce the incidence of animal anthrax and establish a protocol for anthrax outbreaks in anthrax-prone districts. Community animal health workers report the suspected occurrence of animal anthrax and rabies. They also collect and send samples to a DLS field disease investigation laboratory for confirmation. This paper describes the livestock farmers' knowledge and practice towards anthrax, anthrax vaccination and anthrax

vaccination coverage in two districts in Bangladesh and identifies risk factors for low vaccination coverage. This information was not previously available in these subdistricts and will be used to develop programs for better management of anthrax disease.

## Methods

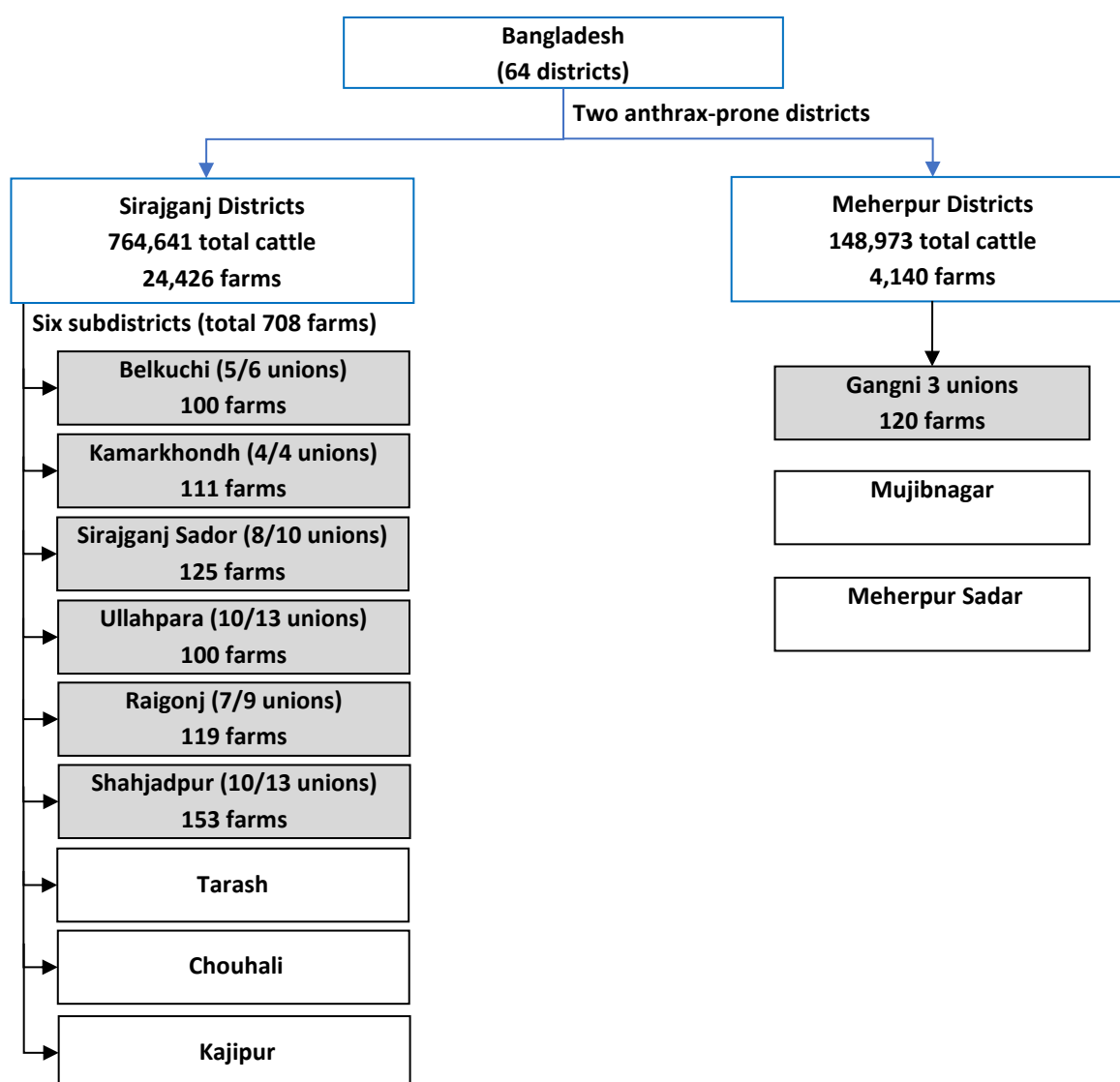
### Study Design and Population

We conducted a retrospective review of the DLS PARB data from June 2018 to June 2019 and interviewed the farmers from 14 to 28 Jul 2019.

### Sampling and Sample Size

Farms were selected from subdistricts with previous anthrax outbreaks and availability of a field assistant

to assist with the survey (Figure 1). To choose study areas, we reviewed scientific papers, government reports, and electronic and print media on anthrax outbreaks. Of the 64 districts in Bangladesh 6 reported an anthrax outbreak in the last seven years. Of these, two (Meherpur and Sirajganj Districts) had a high frequency of livestock rearing and a previous anthrax outbreak. Within these two districts, we selected subdistricts with previous anthrax outbreaks. Sirajganj District had nine subdistricts with a previous anthrax outbreak but only six had a field assistant available. Meherpur District had three subdistricts with a previous anthrax outbreak but only one had a field assistant available. The Unions in the subdistrict and the farms in the unions were selected by convenience sampling.



*Cattle population from Planning Ministry, Bangladesh Bureau of Statistics.<sup>8</sup>*

*Gray shaded boxes are the subdistricts that were surveyed.*

**Figure 1. Selection of farms to be sampled for anthrax vaccine coverage, Bangladesh 2019**

## Data Collection

PARB data collectors used semi-structured questionnaires to interview farmers through door-to-door surveys between 5 AM to 11 AM and 4 PM to 6 PM. If a farmer was not at home, the data collector interviewed another person who was knowledgeable about raising the cattle. The data collector went to each farm with a government or private vaccinator.

## Operational Definitions

- Eligible cattle—age more than one year and not pregnant
- Completed anthrax vaccination—one shot (1 mL) of anthrax vaccine each year.
- Adequate knowledge on anthrax—defined as recognizing the word ‘anthrax’, knowing the symptoms, and disease potentiality (severity and transmission of anthrax).
- “To handle a sick animal” means when an animal gets sick, the farmer will treat the sick animal by treating the symptoms or slaughtering the animal if it does not recover.

## Calculation of Anthrax Vaccine Coverage

We calculated vaccine coverage by dividing the number of cattle farmers who completed vaccination of their eligible cattle by the total number of farmers interviewed with the assumption that one farmer equaled one farm and an average number of cattle on a farm being four. We defined high vaccine coverage as 80% or above.<sup>4,9</sup>

## Data Cleaning and Analysis

Duplicate entries were identified and removed from the data set. We conducted descriptive and inferential statistical analysis in Epi Info 7 to identify factors of low vaccination coverage. We calculated the prevalence ratios and 95% confidence intervals (CI) to assess associations.

## Ethical Approval

All participants were informed of the purpose of the investigation and participation was voluntary. Verbal informed consent was collected from participants and guardians of minors before the interview. There were minimal risks of harm to study respondents. Participants were assured that their personal identity would be kept confidential and that the data would be used only for the purposes of the study. Participants were informed that they could withdraw from the study at any time with no penalty. The study was conducted with the permission of the Principal Investigator of the PARB project, which had

administrative approval from the Ministry of Fisheries and Livestock.

## Results

### Demographic Characteristics of Participants

We identified 907 farms and interviewed 828 farmers (91% response rate). As shown in Table 1, most participants (59%) were aged between 30 and 50 years. Approximately 48% had no formal education and 74% said that farming was their livelihood. Most farmers reared cattle (66%) as their main source of livelihood and to increase their income. Others also reared chickens (58%) and ducks (21%).

**Table 1. Sociodemographic characteristics of livestock farmers in Sirajganj and Meherpur Districts, Bangladesh, 2019 (n=828 farms)**

Variables	n (%)	Average
<b>Age group (years) (n=812)</b>		<b>39</b>
0–10	3 (0.4)	
11–20	44 (5.4)	
21–30	138 (17.0)	
31–40	257 (31.7)	
41–50	234 (28.8)	
51–60	72 (8.9)	
61–70	32 (3.9)	
71–80	32 (3.9)	
<b>Number of family members (n=826)</b>		<b>6</b>
2–4	202 (24.4)	
5–7	409 (49.5)	
8–10	181 (21.9)	
11–13	27 (3.3)	
≥14	7 (0.8)	
<b>Occupation (n=823)</b>		
Farmer	607 (74)	
Housewife	68 (8)	
Laborer	60 (7)	
Service holder	29 (4)	
None (student)	28 (3)	
Businessperson	20 (2)	
Others	11 (2)	
<b>Education status (n=821)</b>		
None	390 (48)	
Primary school certificate	291 (35)	
Secondary school certificate or above	140 (17)	
<b>Main type of animal reared (n=826)</b>		
Cow	3,237 (66)	3.9
Goat	1,486 (31)	1.8
Sheep	142 (3)	0.2
Buffalo	4 (0)	0.005
<b>Type of poultry reared (n=826)</b>		
Backyard poultry	10,018 (58)	12.1
Commercial poultry	1,770 (11)	2.1
Ducks	3,699 (21)	4.47
Pigeons	1,753 (10)	2.12

## Vaccine Coverage

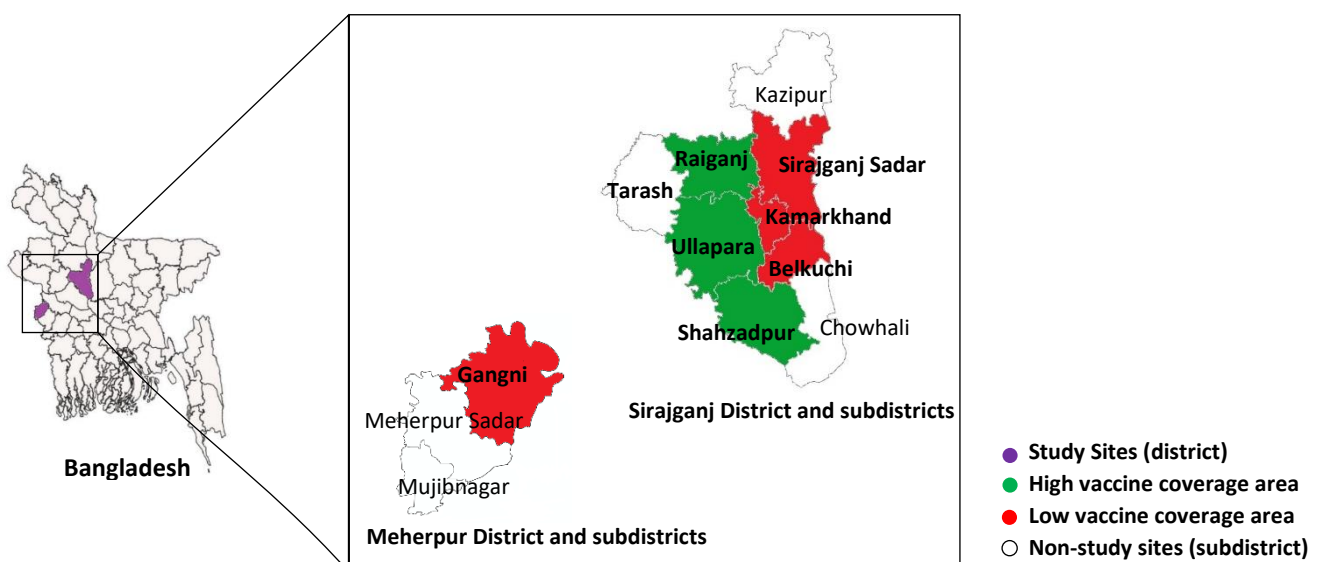
Table 2 presents the anthrax vaccination status of livestock farms. Vaccination coverage was highest in Sahjadpur Subdistrict (84%) of Sirajganj District and lowest in Gangni Subdistrict (52%) of Meherpur District. The overall vaccine coverage was 70%. Based on the 80% cut-off value, we categorized Sahjadpur (84%), Ullahpara (83%), and Raigonj (82%) Subdistricts as having sufficient vaccination coverage

and Belkuchi (70%), Kamarkhandh (55%), Sirajganj Sadar (59%), and Gangni (52%) as subdistricts with low vaccination coverage.<sup>5</sup> Vaccination coverage of study area has been showed in Figure 2.

There were 733 farmers (62%) vaccinated their animals against anthrax, foot and mouth disease, black quarter disease, or hemorrhagic septicemia; of whom 26% vaccinated their cattle only with anthrax vaccine and 68% in combination with another vaccine.

**Table 2. Anthrax vaccination status of livestock farms in Sirajganj and Meherpur Districts, Bangladesh, 2019**

Characteristics	Livestock farms completed anthrax vaccination		Total (n=733)	Prevalence of vaccination	Prevalence in percent
	Yes	No			
Subdistrict					
Gangni	34	32	66	0.515	52%
Kamarkhondh	61	50	111	0.549	55%
Sirajganj Sadar	74	51	125	0.592	59%
Belkuchi	65	28	93	0.698	70%
Raigonj	97	21	118	0.822	82%
Ullahpara	57	12	69	0.826	83%
Shahjadpur	127	24	151	0.842	84%
Total occupation of livestock owner (n=644)					
Farmer	348	98	446	0.780	78%
Businessperson or service holder	106	17	123	0.861	86%
Housewife or student	73	2	75	0.97	97%



**Figure 2. Map showing the livestock vaccination coverage and study sites in Sirajganj and Meherpur Districts, Bangladesh, 2019**

## Knowledge and Practice

Table 3 compares knowledge and practice between subdistricts with low and high vaccine coverage. Farmers from farms with low coverage had 1.75 times less knowledge about animal anthrax vaccination, and 1.66 times less knowledge on human anthrax vaccination.

In terms of practice, farms with low coverage were 1.8 times more likely to not treat a sick animal, 1.5 times more likely to slaughter, consume or sell the meat of a

sick animal, and 1.4 times less likely to handle a sick animal despite being aware of the health hazards of anthrax. There was no difference between farmers from farms with low and high vaccine coverage regarding training on anthrax disease and prevention, source of information, and disposal of carcasses.

During interviews with farmers, it was mentioned that coverage was low because of insufficient number of veterinarians in the subdistricts and limited access to vaccines.

**Table 3. Knowledge and practice of livestock farmers in Sirajganj and Meherpur Districts, Bangladesh, 2019 (n=828 farms)**

Characteristics	Low coverage subdistrict (n)	High coverage subdistrict (n)	Prevalence	Prevalence ratio	95% CI
<b>Knowledge related factors</b>					
Other sources	208	284	0.42	0.67	0.56–0.82
Government veterinary hospital only	57	35	0.62	Ref	
<b>Basic knowledge on animal anthrax (n=828)</b>					
Not adequate	207	62	0.77	1.75	1.50–1.93
Adequate	249	310	0.44	Ref	
<b>Basic knowledge on human anthrax (n=828)</b>					
Not adequate	258	107	0.70	1.66	1.45–1.87
Adequate	198	265	0.42	Ref	
<b>Practice when a sick animal identified (n=828)</b>					
Slaughter and eat or sell meat in market	14	7	0.66	1.53	1.10–2.09
Do not provide treatment	203	58	0.77	1.79	1.58–1.99
Get treatment	239	307	0.43	Ref	
<b>Handling of sick animals (n=603)</b>					
No	82	58	0.58	1.38	1.15–1.63
Yes	198	265	0.42	Ref	
<b>Training on animal anthrax disease and prevention (n=790)</b>					
No	438	322	0.57	0.95	0.71–1.29
Yes	18	12	0.6	Ref	
<b>Handling of dead animals (n=599)</b>					
Float in water	22	29	0.43	0.91	0.65–1.26
Bury	259	289	0.47	Ref	

Ref: reference group

## Discussion

Vaccine coverage for anthrax in seven subdistricts in Sirajganj and Meherpur Districts ranged from 52 to 84 percent, with three subdistricts being above the recommended level of 80%. Factors related to low coverage were farmers' knowledge on animal and human anthrax and their behavior and practice dealing with sick animals. Farmers stated that low vaccine coverage was due to insufficient number of veterinarians in the area and limited access to vaccines. In addition, insufficient production and distribution of vaccines contributed to the low coverage.<sup>5</sup>

Compared to areas with high vaccination coverage, farmers from subdistricts with low vaccination

coverage did not have adequate knowledge of human and animal anthrax and vaccination, treated sick animals less often, gave delayed treatment, and slaughtered sick animals more often. There was no difference between farms with low and high vaccine coverage concerning farmers training on anthrax disease and prevention, source of information, and disposal of carcasses.

Farmers with better knowledge on anthrax have better anthrax prevention practices.<sup>10</sup> In our study, subdistricts with low vaccination coverage were more likely to self-treat their sick animals and often handled sick animals without personal protection. When their animals become severely ill, they often slaughtered the

animal and then ate or sold the meat. When the animal died, most farmers buried the dead animal but some discarded the carcass in the river.<sup>10</sup> This behavior puts the farmers at greater risk for anthrax.

Farmers are more likely to spend money for veterinary services if there is a chance to save an animal.<sup>11</sup> In our study, most farmers wanted veterinary services but only 16% had a veterinarian treat their animals. This could have occurred because access is a problem in rural areas and, when a veterinarian is unavailable, farmers seek treatment from a pharmacist or traditional healer.

Knowledge of anthrax transmission and mortality motivated Bangladeshi farmers to vaccinate their animals.<sup>7</sup> Consequently, most farmers vaccinate their animals against many diseases and anthrax vaccination is the most common of all vaccinations. However, farmers in subdistricts with low anthrax vaccination coverage are not aware that animals need to be vaccinated once per year.

Most farmers know about the symptoms of animal and human anthrax and that anthrax is a lethal disease for animals and can cause serious illness in humans.<sup>10,12</sup> In our study, most farmers did not know how to prevent anthrax. They are unfamiliar with anthrax transmission because they may be new farmers and there is limited access to relevant training. While many sources provide information on anthrax, it might be difficult for them to understand. In addition, anthrax has local names and sometimes farmers mix up anthrax with other acute diseases.

### Limitations

In our survey, farmers may not have responded to all questions accurately and few of the respondent are not above 18 years of age. In our professional experience, farmers often give socially acceptable responses when they are affected financially or involved in subsequent slaughtering, selling and consumption of meat from a suspected carcass. Multivariable analyses could not be performed due to data unavailability and therefore confounding could exist. However, the associated factors found in this study are consistent with other studies and background knowledge, therefore the findings are acceptably reliable and useful.

### Public Health Action and Recommendations

We recommend increasing the farmer's awareness of anthrax through campaigns, media coverage, and training on anthrax prevention and control. Awareness programs may help to increase basic knowledge about anthrax transmission and prevention. For example, development of materials (with pictures) for school

children and local people, particularly those in farmers' families, would be helpful. Educational material needs to be developed at a primary school level of education with photos and illustrations to make the information easy to read and understand. Distribution of the materials during a mass vaccination program could increase knowledge among farmers. We also recommend increasing vaccine production by the Livestock Research Institute in Bangladesh to increase vaccine coverage.

Increasing the number of veterinary surgeons and supportive staff in those areas will be helpful to increase the quality of veterinary services. Expansion of the veterinary extension service may help sick animals receive better treatment. Burial or incineration of carcasses can reduce soil contamination with anthrax spores. There are government rules and regulations that promulgate fines for people slaughtering sick animals with improper disposal of the carcasses.<sup>13,14</sup> We encourage government officials to enforce these regulations to discourage this behavior.

### Acknowledgements

The authors acknowledge the contribution of the staff of the U.S. Centers for Disease Control and Prevention, Preventing Anthrax and Rabies Project, and the Division of Livestock Services.

### Suggested Citation

Malakar S, Henderson A, Billah MM, Khokon MSI, Sufian MA. Factors associated with anthrax vaccination coverage in two anthrax-prone districts, Bangladesh, 2019. OSIR. 2023 Sep;16(3):139–45. doi:10.59096/osir.v16i3.265576.

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