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Systemic Meta-analysis of Mastitis Prevalence in Dairy Cattle and Goat of Bangladesh

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A R T I C L E I N F O	A B S T R A C T
	Bovine and caprine mastitis is a dreadful bacterial disease that drastically lowers milk production, and presently it is spreading as an endemic pathogen throughout the world, including Bangladesh. Moreover, mastitis is the main impediment to Bangladesh's tremendously rising milk-related industry and general livestock economy. Therefore, the aim of this study is to demonstrate the overall prevalence of clinical and sub-clinical mastitis in both dairy cows and goats. It is the foremost meta-analysis study regarding mastitis prevalence in Bangladesh and the study gathered the articles from the electronic database on the topic bovine and caprine mastitis published between January 2005 and November 2020. Finally, 33 articles were selected for estimating the overall prevalence rate of mastitis in ruminant (cow and goat) via random effect model estimation. Analyzing the result, the study found 43.0% (95% Cl: 37.0 - 50.0%) and 31.0% (95% Cl: 15.0 - 47.0%) prevalence rate in dairy cattle and goat. Statistically, the occurrence rate in Bangladesh is significantly higher than other countries. Although many studies showed the seroprevalence across different districts, this study demonstrates the aggregate incidence rates across Bangladesh as a whole. This paper may also serve as a reference point for the implementation of any control strategy of mastitis in Bangladesh.

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Introduction

Mastitis becomes one of the most infectious complications in milking animal, including cow and goat worldwide. It is perceived to be an economically terrible disease that impedes the milk sector's growing demand (Bangar et al., 2014). Besides, mastitis is a mortifying dairy animal's disease characterized by significantly reduces milk production, declines in the quality and quantity of milk, and production costs (Hogeveen et al., 2011). There are two primary sorts of mastitis (clinical and sub-clinical) characterized by the inflammation of the udder and teats (Ruegg, 2017; Taponen et al., 2017).

Swelling of the udder and persistence of the flakes in milk is a familiar typical indication of clinical mastitis (K.P. Suresh et al., 2017). In contrast, the diagnosis of subclinical mastitis is difficult due to the lack of obvious clinical signs that exist longer effectively in herds and are correlated with higher loss (Abrahmsén et al., 2014; Ndahetuye et al., 2019; Zeryehun and Abera, 2017).

Previously, the prevalence of mastitis was recorded in many studies in Bangladesh and reported a fluctuate rational result. Some studies showed a higher prevalence, and the rest studies indicated a lower prevalence percentage. Perhaps, this variation occurs due to the research duration and region, lactation period, animal breed, sample size, sampling method, and farm management practice (K.P. Suresh et al., 2017). As Bangladesh is a developing country with a huge population and the majority of the people live in the rural area depend on livestock besides agricultural farming. Mainly, Cattle and goats are the main domestic animal in Bangladesh (Hasib and Chowdhury, 2020; S. Rahman, 2018). Meanwhile, mastitis in the bovine and caprine population is becoming an impediment for the dairy sector as well as farmer livelihood. To overcome this disease, the strategic managemental initiative could play an important role in lessening further outbreaks. Therefore, gathering information about the prevalence of the previous study is

essential for guiding the policymaker. Thus, this study provides a vivid impression of the overall pooled prevalence estimate of mastitis for both dairy cattle and goats via systemic review and meta-analysis method.

Materials and Methods

Methods
The research was performed in compliance with the directives supported for review and meta-analysis by PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Ahaduzzaman, 2019; Hasib and Chowdhury, 2020).

Literature Search
Conducting a study, the term related to mastitis in Bangladesh was searched in Google Scholar, PubMed, Science Direct, and local Bangladeshi journals. Mastitis, prevalence, and Bangladesh were the core terms used in the process of electronic search. Besides, the terms, including bovine, caprine, clinical, and sub-clinical were also included in the search procedure. Only, the articles of the English language were aggregated for leading this study. Searching the papers was done from the 5th of December to the 7th of December, 2020.

Data Extraction
The data, including author, study year, study place, study duration, total sample, positive cases, type of mastitis, and the species of animal were extracted in an excel spreadsheet. Finally, data obtained from 7011 dairy cows and 3866 dairy goats were selected for analyzing this study.

Selection of Study
The studies were selected based on five objectives for including in the meta-analysis, including (1) published in the English language, (2) cross-sectional, (3) included the number of total and affected animals, (4) sampling based on the individual animal, (5) published between January 2005 to November 2020, and, (6) diagnosed by (California mastitis test) CMT or other equivalent test and clinical examination. Those studies were omitted, which proved to fail to fulfill the described objectives.

Statistical Analysis
Total sample size and frequency of positive case (calculated average positive sample in case of the individual result of more than two tests) for each study were inserted in Microsoft office Excel 2019, and variance of the studies was calculated (Neyeloff et al., 2012). Following this, Jamovi 1.2.27 software was used for further calculation including, a 95% CI, heterogenicity test, and chi-square test for knowing the significance of the variance among estimates (P<0.001).

After getting some of the basic requirements, the overall meta-analysis was visualized in the forest plot (random model) along with the funnel plot. In the forest plot, a horizontal line denotes the result of a study. In contrast, the 95% confidence interval (Cl) and the point estimate of each study are represented by the length of the line and the black box (Getaneh and Gebremedhin, 2017). Moreover, the weight of each study is proportional to the zone of the black box. Both Figure 2 and Figure 4 represent

the forest plot, where the study and author name present in the left-side column. Similarly, the first column of the right-side remarks weight, the second one represents proportion combined with the range of 95% Cl.

Results

Search Results (eligible studies)
Searching at the initial stage, 88 articles were found from PubMed, Science Direct, Google scholar. After accessing the irrelevant and duplicate articles, the number of the articles were 60. Then, screening, reading abstract, and accessing the objectives mentioned above, only 33 articles (26 on dairy cows and 7 on dairy goats) were chosen visualized in Figure 1. The eligible studies are presented under the study column of Table 1 and Table 2.
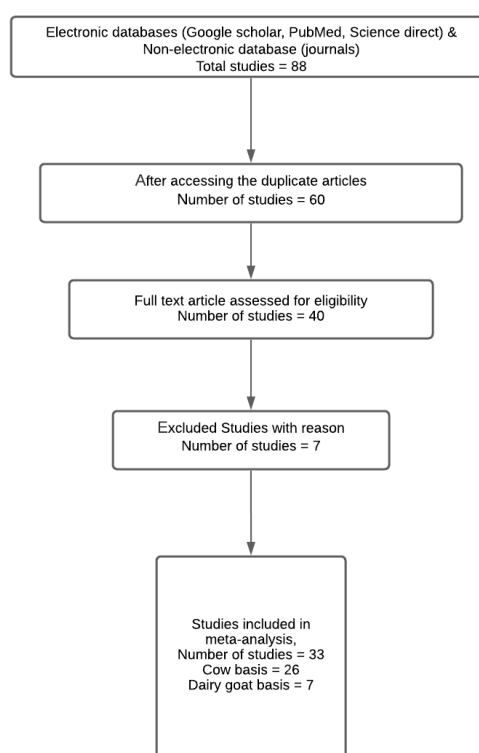

Figure 1. Flow diagram of the method of studies selection for the meta-analysis

Prevalence Estimation
Table 1, Table 2, and Table 3 represents the total meta-analysis result of mastitis, including clinical and subclinical-mastitis in selected species (dairy cow and lactating goat). Obtaining data from a total of 10877 animals including, 7011 dairy cows and 3866 dairy goats were used for meta-analysis. In the result section, the random effect model showed the overall prevalence of both types of mastitis was 43.0%, where the 95% CI was 37.0 - 50.0% in the dairy cow. Similarly, the overall prevalence of mastitis was 31.0% (95% CI: 15.0 - 47.0% in dairy goat. Moreover, significant heterogeneity (Q = 1688.425 for cow and Q = 254.932 for dairy goat) was perceived between the studies, where inverse variance index value (I^2) was 97.8% for cow and 99.6% for dairy goat presented in Table 3.

Table 1. Description of each selected study for calculating meta-analysis in dairy cattle.

Study	Location (District in Bangladesh)	Duration (Year)	Total Sample	Positive case (%)	TM
(Kahirl et al., 2008)	Sylhet	2006	456	246 (53.95)	SCM
(M. M. Rahman et al., 2010)	Sylhet	2008-2009	158	81 (51.27)	SCM
(Uddin et al., 2010)	Chittagong	2008	306	215 (70.26)	SCM
(M. A. Islam et al., 2010)	Sirajganj	2009	330	120 (36.36)	SCM
(Rabbani and Samad, 2010)	Mymensingh	2008	116	51 (43.97)	SCM
(M. M. Islam et al., 2012)	Chittagong	2011	602	124 (20.60)	CM
(M. Islam et al., 2012)	Mymensingh & Tangail	2009-2010	200	58 (29.00)	SCM
(Haque et al., 2014)	Satkhira	2012-2013	150	52 (34.67)	CM & SCM
(Kayesh et al., 2014)	Barishal	2013-2014	200	57 (28.50)	SCM
(Siddiquee et al., 2014)	Mymensingh	2011-2012	158	87 (55.06)	SCM
(Quaderi et al., 2014)	Mymensingh & Dhaka	2005-2007	560	380 (67.86)	SCM
(Tripura et al., 2014)	Mymensingh & Lakshmipur	2011-2012	139	72 (51.80)	SCM
(Barua et al., 2014)	Chittagong	2012	444	144 (32.43)	SCM
(Hoque et al., 2014)	Chittagong, Dhaka, Sirajganj, Mymensingh & Gazipur	2014	228	148 (64.91)	SCM
(Saha. et al., 2014)	Chittagong	2013-2014	153	100 (65.36)	SCM
(Bari et al., 2016)	Chittagong	2013	634	53 (8.36)	CM
(Hossain et al., 2016)	Jesssor	2013	432	65 (15.05)	CM
(Khokon et al., 2017)	Chittagong	2011-2013	100	69 (69.00)	CM & SCM
(Biswas and Sarker, 2017)	Barishal	2014	64	33 (51.56)	SCM
(Kabir et al., 2017)	Sirajganj	2015-2016	300	153 (51.00)	SCM
(Nahian et al., 2018)	Satkhira	2018	250	66 (26.40)	SCM
(Meher et al., 2018)	Barishal	2016-2017	152	54 (35.53)	SCM
(Arman et al., 2018)	Dhaka & Chittagong	2017	287	118 (41.11)	SCM
(S. Islam et al., 2019)	Chittagong	2015	114	39 (34.21)	SCM
(Bhuiyan et al., 2020)	Brahmanbaria	2018	400	115 (28.75)	SCM
(Sayeed et al., 2020)	Jhenaidah	2019	78	53 (67.95)	SCM

TM: Type of Mastitis, SCM: Sub-clinical Mastitis, CM: Clinical Mastitis

Table 2. Description of each selected study for calculating meta-analysis in dairy goat.

Study	Location (District in Bangladesh)	Duration (Year)	Total Sample	Positive case (%)	TM
(Amin et al., 2011)	Mymensingh	2009	2042	90 (4.41)	SCM
(A. Islam et al., 2012)	N/A	2009	231	90 (38.96)	SCM
(Sarker and Samad, 2013)	Mymensingh & Joypurhat	2010	1025	54 (5.27)	CM
(Razi et al., 2013)	Mymensingh	2010-2011	50	11 (22.00)	SCM
(Begum et al., 2016)	Rajshahi and Rangpur	2008-2010	292	164 (56.16)	SCM
(Ferdous et al., 2018)	Dinajpur	2017	120	52 (43.33)	SCM
(Akter et al., 2020)	Chittagong	2019	106	54 (50.94)	SCM

TM: Type of Mastitis, SCM: Sub-clinical Mastitis, CM: Clinical Mastitis

Table 3. Overall prevalence rate with heterogeneity of mastitis in dairy cattle and goat.

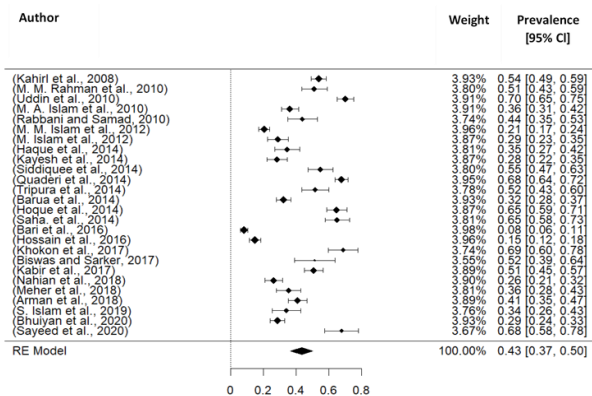| Species	Total Sample	Pooled estimate (%)	95% CI	Heterogeneity (χ2)	I^2 (%)	P-value	Tau^2
Cow	7011	43.0	37 - 50	1688.425	97.8	<.001	0.031
Goat	3866	31.0	15 - 47	254.932	99.6	<.001	0.044

Figure 2. Forest plot showing the estimate prevalence rate of mastitis in dairy cattle of Bangladesh

Figure 3. The disseminating points of the funnel plot show the overall estimate prevalence, along with publication bias in the dairy cattle of Bangladesh

The overall prevalence, along with separate occurrence was presented in Figure 2 and Figure 4. Besides, funnel plot individually for the cow, and dairy goat represents publication bias by presenting the non-symmetrical shape of a funnel with dropping the points exterior to the funnel (Figure 3 and Figure 5).

Author	Weight	Prevalence [95% CI]
(Amin et al., 2011)	14.72%	0.04 [0.04, 0.05]
(A. Islam et al., 2012)	14.39%	0.39 [0.33, 0.45]
(Sarker and Samad, 2013)	14.71%	0.05 [0.04, 0.07]
(Razi et al., 2013)	13.67%	0.22 [0.11, 0.33]
(Begum et al., 2016)	14.45%	0.56 [0.50, 0.62]
(Ferdous et al., 2018)	14.08%	0.43 [0.34, 0.52]
(Akter et al., 2020)	13.99%	0.51 [0.41, 0.60]
RE Model	100.00%	0.31 [0.15, 0.47]

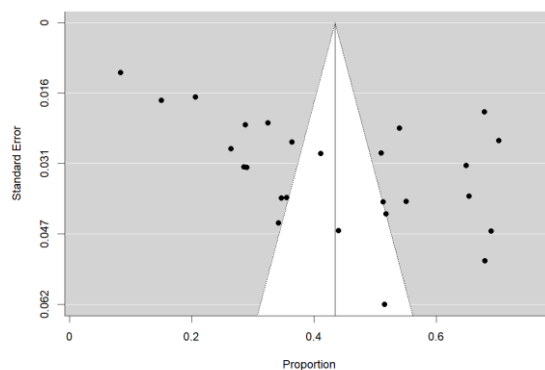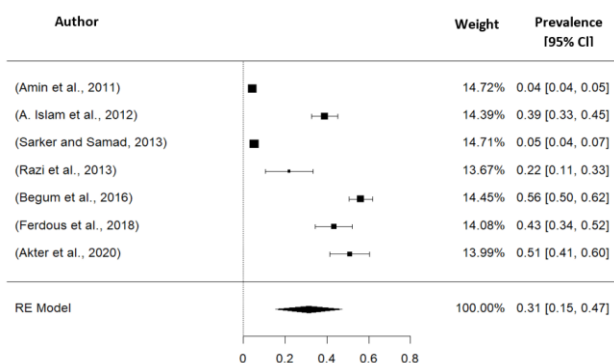Figure 4. Forest plot showing the estimate prevalence rate of mastitis in dairy goat of Bangladesh
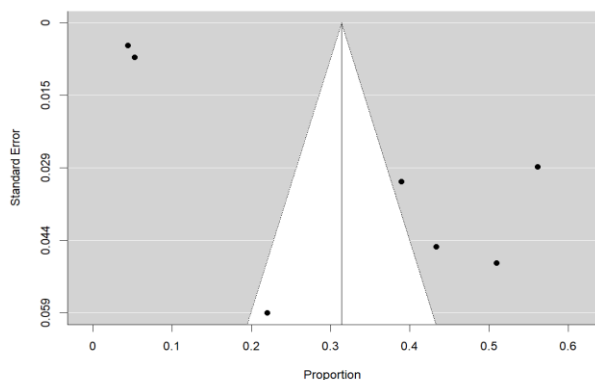

Figure 5. The disseminating points of the funnel plot show the overall estimate prevalence, along with publication bias in the dairy goat of Bangladesh

Discussion

Mastitis is one of the most common bacterial diseases in cattle, while it is also seen in Bangladesh's dairy goat population. Thus, the prevalence rate of mastitis has been shown in previous researches, but this is the first study to analyse the outline of the overall random model pooled prevalence rate in cattle and dairy goats using the meta-analysis process. Analysing the result, the significant inverse variation indexes of overall prevalence rate in cow and dairy goat between the respective studies imply a strong heterogenicity index. The findings showed that Chittagong and Mymensingh had the highest number of study locations due to the existence of reputable agricultural institutes in those regions. Variations in cow level factors, agroclimatic circumstances, and farm management tradition could be linked to distinct outcome (Getaneh and Gebremedhin, 2017; Joshi and Gokhale, 2006).

The meta-analysis summarized that the estimated prevalence rate was 43.0% (95% CI: 37.0 -50.0%) in dairy cow, which is lower than another study reported in Ethiopia

found 47.0% (95% CI = 42.0 - 52.0%) prevalence rate (Getaneh and Gebremedhin, 2017). Similarly, in regions of Kenya, the overall prevalence rate of mastitis was calculated to 80%, which is far higher than the present meta-analysis summarizes (Mbindyo et al., 2020). In contrast, rendering to a recent study, the overall occurrence rate of mastitis among cows in one segment of India was 5.1% indicates significantly lower occurrence than the current study findings (Dutta and Gowder, 2018). On the other hand, few research on the prevalence of mastitis in dairy goats were obtained due to their decreased susceptibility; among them, one study showed a 40.4% prevalence rate in Nigeria, which was lower than the present study's outcome (31.0%) (Danmallam and Pimenov, 2019). Dissimilarly, another research held in Kenya listed 72.7% prevalence rate of mastitis among dairy goats (Okoko et al., 2020). Finally, in Ethiopia, Alemu and Abraha, 2017 found that the prevalence rate of mastitis in cows and goats was 48.0% and 30.8%, respectively, concluding the cattle population has a greater susceptible rate than the goat population.

To sum up, this study demonstrated the combined prevalence of clinical and subclinical mastitis in Bangladeshi dairy animals (cow and goat) using a random model effect. Thus, the general conclusion of the prevalence rate is notably conspicuous in the cattle population. Moreover, this prevalence rate has the potential to have a significant impact on Bangladesh's rapidly expanding milk production and processing infrastructure. This study also recommends that farmers should enrich the knowledge about the essential management system.

Limitations

This research presents only pooled extermination without taking into account the troubling causes, including risk factors, climatic conditions, and disease connotations. In addition, all the paper chosen was not taken homogeneously from around the country.

Acknowledgements:

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