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Meta-analysis of Prevalence of Clinical Mastitis in Crossbred Cows in India (1995-2014)

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ABSTRACT

Clinical mastitis is a most common disease in dairy herds causing huge economic losses directly to farmers and indirectly to Indian dairy sector. However, systematic review and meta-analysis of prevalence of clinical mastitis in cows in India has not been published so far. The aim of the present study was to provide the pooled estimate of the prevalence of clinical mastitis in crossbred cows in India by conducting the literature search for the period of 1995-2014. Meta-analysis using data records of 17873 crossbred cows and 7737 udder quarters from total of 17 published studies was done in R software. It was found that the pooled estimates of clinical mastitis in crossbred cows under cow-basis and quarter-basis was 16.08% (95% CI 11.69, 21.72) and 11.71% (95% CI 6.60, 19.94), respectively. High variation in prevalence estimates between studies indicated that several factors influence occurrence of clinical mastitis. It is suggested that systematic review and meta-analysis using large number of studies and incorporating several factors can be efficient tool to update the disease control strategy and will be best resource for researchers to improve future work.

Keywords: Cow, mastitis, clinical, prevalence, meta-analysis

Mastitis is characterized by physical, chemical and bacteriological changes in the milk and pathological changes in the glandular tissue of the udder (Radostits *et al.,* 2000). Mastitis is most common and costly disease in dairy farms which leads to huge economic losses directly to farmers. Those losses are due to reduction in production & productivity, medicine & labour costs, and less market value (Hogeveen *et al.,* 2011). Annual economic losses due to clinical mastitis in India have been estimated to be Rs. 3014.4 crores (Bansal and Gupta, 2009).

Clinical mastitis remains a complex disease and its control is a continue challenge despite of intensive research scheme. Many investigators reported that incidence of clinical mastitis is associated with many factors such as host-level factors (Rajala-Schultz *et al.,* 1999; Smith *et al.,* 2000; Grohn *et al.,* 2004; Olde Riekerink *et al.,* 2007; Van den Borne *et al.,* 2010) and herd-level factors (Barkema *et al.,* 1999; Barnouin *et al.,* 2005; Nyman *et al.,* 2007). Understanding the nature of associations of those factors has major importance in mastitis prevention and control program. The prevalence of mastitis in the farms in recent years may provide awareness about its trend and severity among farmers and researchers, therefore improvement can be made in managemental practices in order to reduce losses due to this devastating disease.

Considering the economic importance of clinical mastitis in Indian dairy sector, it is essential to gather information regarding the occurrence and distribution of mastitis and to check the consistency of prevalence estimates over the period. An extensive review of the calculations of the cost of mastitis and the benefits of mastitis management has been undertaken previously (Halasa *et al.,* 2007). Systematic review and meta-analysis of prevalence of subclinical mastitis in Indian dairy cows was done recently (Bangar *et al.,* 2015). However, pooled estimates

of prevalence of clinical mastitis (along with degree of variation) in cows in India have not been reported so far.

The present study was set to provide the pooled estimate of the prevalence of clinical mastitis among crossbred cows in India for the period 1995 to 2014 by conducting systematic review and meta-analysis.

MATERIAL AND METHODS

Literature from various databases were searched for prevalence of clinical mastitis in dairy cows in India and used for this study. Three electronic databases- Google Scholar (http://scholar.google.co.in), Science Direct (http://www.sciencedirect.com) and PubMed (http://www.ncbi.nlm.nih.gov/pubmed), were searched to identify relevant studies from 1995 to 2014. Additionally, offline journals, abstracts, theses, reports and conference proceedings were searched to reduce the biasness in the meta-analysis. Initial quality assessment of searched studies was done for selecting studies in meta-analysis by reviewing all studies under objective specific criteria. The criteria used were the information on prevalence of mastitis, affected and total number of cows in the study, farm studies, period and location of study. Total of 17 studies were included in this meta-analysis.

Meta-analysis

The detail information regarding author, year, location and period of the study, total number of cows, proportion of affected cows, quarters affected, were entered in the Microsoft excel spreadsheets for each study. Initially, the proportion data on mastitis prevalence were transformed by Logit method (Lipsey and Wilson, 2001). Meta-analysis of prevalence of clinical mastitis was performed under random effects model (Der Simonian and Laird 1986) as follows:

$$\bar{\beta}_w = \frac{\sum_{i=1}^{k} w_i^* \hat{\beta}_i}{\sum_{i=1}^{k} w_i^*} \quad \text{and} \quad SE\left(\bar{\beta}_w\right) = \frac{1}{\sqrt{\sum_{i=1}^{k} w_i^*}}$$

where, $w_i^* = \frac{1}{S_i^2 + \tau_i^2}$

where, $\bar{\beta}_w$ represents pooled estimate, $\hat{\beta}_i$ represents estimate of i^{th} study (i=1, 2….k), represents weights and SE represents standard error. S_i^2 and τ_i^2 represent within study variance and between study variance (Tau-squared), respectively. The heterogeneity of prevalence estimates between studies was determined by Cochran Q test (Cochran, 1954) and further quantified by I^2 Index (Higgins and Thompson, 2002; Higgins *et al.*, 2003). Q statistic is chi-square distributed heterogeneity statistic and I^2 Index provides percentage of total variation across studies that are due to heterogeneity rather than chance.

$$Q = \sum_{i=1}^{k}\left[w_i \left(\hat{\beta}_i - \bar{\beta}_w\right)^2 \right] \quad \text{and} \quad I^2 = \frac{Q - df}{Q}\%$$

The meta-analysis of prevalence (proportion data) was conducted in "Metaprop" Package of R 3.1.0 software (Comprehensive R Archive Network, http://cran.r-project.org/).

RESULTS AND DISCUSSION

We have done systematic review of prevalence of clinical mastitis in crossbred cows under the preset criteria for the period of 1995 to 2014. Proportion (%) of affected cows in each study, with 95% confidence interval, is presented in Table 1. Meta-analysis of prevalence of clinical mastitis in crossbred cows was done for overall (cow-basis and quarter-basis) and state-wise (cow-basis & quarter-basis) and is presented in Table 2. Results of simple proportions (%) are calculated simply as dividing total affected cows in all studies by total number of cows from all studies. Heterogeneity between studies is detected and quantified by Q statistic and I^2 index, respectively.

To our best knowledge, this is first meta-analysis of prevalence of clinical mastitis in crossbred cows in India. Recently, some meta-analyses (Cai *et al.*, 2014; Wang *et al.*, 2014; Islam *et al.*, 2014; Bangar *et al.*, 2015) using proportion data for estimating prevalence for various diseases in animal sciences have been reported.

In the present study, total of 17873 cows from 14 studies were included in the meta-analysis of cow-basis prevalence of clinical mastitis in crossbred cows. The pooled estimate of prevalence of clinical mastitis on cow-basis was found

Table 1: Details of 17 studies on prevalence of clinical mastitis in crossbred cows (1995-2014)

Sl. No.	Study	Location	Basis	Affected	Total	Proportion% (95%CI)
1	Chand and Behra, 1995	Haryana	Cow	955	2728	35.01 (33.22-36.83)
2	Thirunavukkarasu and Prabaharan, 1998	Tamil Nadu	Cow	261	2006	13.01 (11.57-14.56)
3	Singh, 2000	Uttar Pradesh	Quarter	116	446	26.01 (22.00-30.34)
4	De, 2004	Uttar Pradesh	Cow	38	193	19.69 (14.33-26.01)
			Quarter	105	739	14.21 (11.77-16.94)
5	Nirwan, 2006	Uttar Pradesh	Cow	78	385	20.26 (16.36-24.63)
			Quarter	222	1310	16.95 (14.95-19.09)
6	De and Mukherjee, 2009	Uttar Pradesh	Cow	29	191	15.18 (10.41-21.07)
7	Zahoor and Malik, 2009	J & K	Cow	98	637	15.38 (12.67-18.42)
8	Khalate, 2009	Maharashtra	Cow	66	187	35.29 (28.46-42.60)
			Quarter	84	748	11.23 (09.06-13.71)
9	Kumar *et al.*, 2010	Karnataka	Cow	63	679	09.28 (07.20-11.71)
10	Mahajan *et al.*, 2011	UttraKhand	Cow	953	4133	23.06 (21.78-24.37)
11	Bhatt *et al.*, 2011	Gujarat	Quarter	22	400	05.50 (03.48-08.21)
12	Shete, 2012	Uttar Pradesh	Cow	7	135	05.19 (02.11-10.39)
13	Tufani *et al.*, 2012	J & K	Cow	63	780	08.08 (06.26-10.22)
14	Sahu, 2012	Uttar Pradesh	Cow	74	1022	07.24 (05.73-09.00)
			Quarter	145	3934	03.69 (03.12-04.32)
15	Sinha and Thombare, 2013	Maharashtra	Cow	187	1893	09.88 (08.57-11.31)
16	Deka *et al*., 2013*	Mizoram	Quarter	28	160	17.50 (11.95-24.29)
17	Jingar *et al.* 2014	Haryana	Cow	1077	2904	37.09 (35.33-38.87)

*Not included in cow-basis analysis due to less sample size

Table 2: Meta-analysis of prevalence of clinical mastitis in crossbred cows in India

	Overall		State-wise				
	Cow	Quarter	Cow				Quarter
			J.K.	HR	MH	U.P.	U.P.
Studies included	14	7	2	2	2	5	4
Total cows	17873	7737	1417	5632	2080	1926	6429
Affected cows	3949	722	161	2032	253	226	588
Simple proportion (%)	22.09	9.33	11.36	36.08	12.16	11.73	9.15
Pooled estimate (%)	**16.08**	**11.71**	**11.26**	**36.06**	**19.56**	**12.44**	**12.73**
95 % CI : Lower	11.69-	6.60-	5.86-	34.05-	4.80-	7.28-	5.37-
95 % CI : Upper	21.72	19.94	20.55	38.12	53.96	20.43	27.27
Homogeneity test							
Q statistic	1129.76	355.31	18.03	2.64	87.73	61.45	335.77
p value	<0.001	<0.001	<0.001	0.10	<0.001	<0.001	<0.001
I^2 (%)	98.80	98.30	94.50	62.10	98.90	93.50	99.10
τ^2	0.48	0.70	0.25	<0.01	1.27	0.41	0.92

J.K.: Jammu and Kashmir; HR: Haryana; MH: Maharashtra; U.P.: Uttar Pradesh.

to be 16.08% (95% CI = 11.69, 21.72). The significant heterogeneity across studies was found to be 98.80%. Meta-analysis for quarter-wise prevalence of clinical mastitis using 7737 udder quarters of crossbred cows from 7 studies revealed that the pooled estimate of prevalence of clinical mastitis on quarter-basis was 11.71% (95% CI 6.60, 19.94) with significant heterogeneity (I^2=98.30%). The pooled estimate of cow-basis prevalence was found to be high for Haryana state (36.06%), which was found homogeneous (Q = 2.64; df = 1; I^2=62.10%; p = 0.10) across studies. For remaining states, the pooled estimates of prevalence were significantly ($p<0.001$) heterogeneous between studies, with at least 93.50% real variation between studies.

The meta-analysis of prevalence data was done using crossbred cows from each study that in effect controls some heterogeneity due to low estimates of prevalence in indigenous cows. The prevalence estimates of the present study were similar to previous reports (Miltenburg *et al.*, 1996; Elbers *et al.*, 1998; McDougall, 1999). The Meta-analysis of proportion data reveals that prevalence of clinical mastitis have high variation (>93.50%) between studies for either cow or quarter basis. The inconsistency in estimates may be due to different herd structure of studies, such as host-level factors, herd-level factors and different managemental practices (Sudhan *et al.*, 2005; Joshi and Gokhale, 2006).

In conclusion, the set systematic review and meta-analysis of prevalence of clinical mastitis in cows provided high estimate of pooled prevalence in India for 1995-2014. The high variation in estimates of prevalence was observed between studies and it indicates that incidence of mastitis may be influenced by several host-level and herd-level factors. It is also suggested that a systematic review and meta-analysis of large number of studies can be an efficient tool to update disease control strategy and will be best resource for researchers to improve future work.

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