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Relationship of risk factors with incidence of mastitis in cows

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Abstract
The dairy industry is facing a great set back due to high prevalence and incidence of mastitis in milch animals. The aim of this study was to investigate management and animal level risk factors that favour occurrences of mastitis. The present study was conducted at the Large Animal Clinic of Madras Veterinary College (MVC) Hospital, Chennai. Out of two hundred and eighty milch animals examined during the study period, sixty cows were affected by mastitis. Relationship of risk factors with incidence of mastitis were determined using chi-square test for independence. Results revealed that crossbred Holstein-Friesian had the highest incidence rate of mastitis. Incidence of udder infection in cattle appeared to increase with the increase in average daily milk yield. Less hygiene of the farm favoured higher incidence of mastitis in cows. Injury to the udder would make the animal more prone to mastitis when compared to animals with healthy udder.

Keywords: mastitis in cows, risk factor, incidence, infection, milk yield

1. Introduction
Mastitis is the most important and expensive disease of dairy industry [1]. This disease is characterized by inflammation of mammary gland in response to injury for the purpose of destroying or neutralizing the infectious agents and to prepare the way for healing and return to normal function. Elevated leukocytes or somatic cells produced by inflammatory response cause a reduction in milk production and alter milk composition. These changes in turn adversely affect quality and quantity of dairy products [2].
Contagious mastitis can be divided into three types, clinical mastitis, subclinical mastitis and chronic mastitis [3]. Clinical mastitis results in alterations of milk composition and appearance, decreased milk production, and the presence of the cardinal signs of inflammation. Subclinical infections are those in which no visible changes occur in the appearance of the milk or the udder, but milk production decreases, bacteria are present in the secretion and composition is altered [2]. An inflammatory process that exists for months and may continue from one lactation to another in chronic mastitis. It exists as subclinical but may exhibit periodical flare-ups sub acute or acute form, which last for a short period of time [4].
The dairy industry is facing a great set back due to high prevalence and incidence of mastitis in milch animals. Mastitis is often the end result of the interaction of several factors such as man, cow, environment, microorganisms and management. The efficiency of mastitis control can be improved by using information about cow-specific risk factors. This information allows farmers to identify the cows that have a higher risk of mastitis and to subsequently provide a higher level of care for these cows.
The aim of this study is to investigate management and animal level risk factors that favour occurrences of mastitis. The identification of risk factors is important for the design of mastitis control programs in dairy herds.

2. Materials and Methods
The present study was conducted at the Large Animal Clinic of Madras Veterinary College (MVC) Hospital, Chennai. The primary data were collected from milch cows presented in outpatient ward of the MVC hospital. In addition, farm visit of the respective farmers were made to obtain the additional information on bovine management practices followed by the selected farmers.
Out of two hundred and eighty milch animals examined during the study period, sixty cows were affected by mastitis.

Pre-tested questionnaire was prepared and detailed information about mastitis infected animals were collected from the farmers. Total farm details including details of barn, management aspects, previous history of disease aspects if any and hygienic aspects were collected through personal interview method. Diagrammatic representation of sampled observation were given in Figure 1.

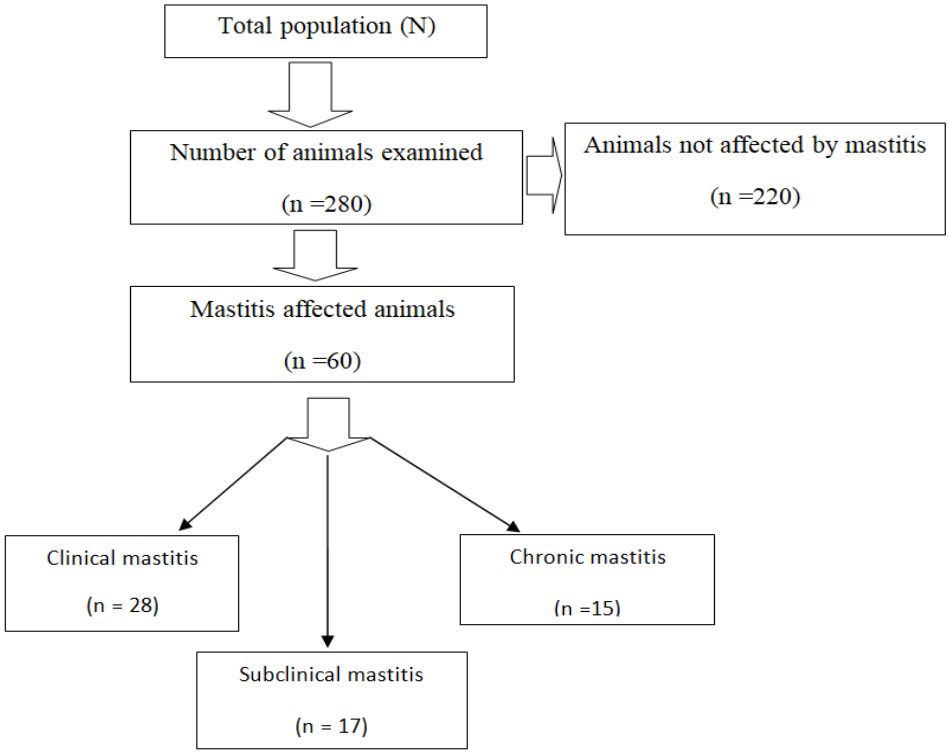

Fig 1: Diagrammatic representation of sampled observation

In the present study, collected data were subjected to preliminary, exploratory and descriptive analysis. Relationships of risk factors with incidence of mastitis were determined using chi-square test for independence. Chi-square test for independence were performed by using IBM® SPSS® 20.0.for windows®. [5] calculated the prevalence of mastitis (clinical and sub-clinical) using percentage values and possible association of disease with risk factors were analyzed using Chi-square test and predictive value (P-value). [6] assessed the existence of association between the risk factors (age, parity, breed, lactation stage and milking hygiene) and mastitis using the Pearson Chi-square (χ^2) test. Risk factors for mastitis that were evaluated by [7] included teat-end condition, cow dirtiness, breed, parity, age and stage of lactation. Relationships of these factors with mastitis status were determined using Chi-square analysis and relative importance as causes of mastitis were assessed using logistic regression.

3. Results and Discussion

3.1 Nature of mastitis in sample cases.

Table 1 showed that acute clinical cases of mastitis were predominant (46.67 percent) when compared to subclinical and chronic mastitis. Out of sixty mastitis infection studied, 28 cases were clinical mastitis, 17 cases were sub-clinical and the remaining 15 mastitis cases reported were chronic cases.

3.2 Breed wise incidence of mastitis

To analyse the breed wise incidence of mastitis in cows, relevant details were collected and are presented in Table 2. Overall figures indicated that the crossbred Holstein-Friesian (HF) had the highest incidence rate of 23.23 percent. This is in conformity with the earlier studies done by [8]. They concluded that exotic breed like Holstein-Friesian (HF) were more prone to mastitis. For nondescript cows incidence was less compared to Jersey and HF crossbreds. Chi-square analysis indicated that the incidence of mastitis had no significant association with different cattle breeds presented in the large animal clinic of Madras veterinary college (P>0.05). On the other hand, [9] found that mastitis had got a significant association with different cattle breeds.

3.3 Age-wise incidence of mastitis

Table 3 revealed that aged cows were more prone to mastitis (24.86 percent) than young milch animals aged less than five years (15.89 percent). These results are in association with [7, 8]. Chi-square analysis revealed that there was no significant association between age and incidence of mastitis (P>0.05).

3.4 Milk yield and incidence of mastitis

The relationship between milk yield and incidence of mastitis is presented in Table 4. As could be seen from the table, the incidence of udder infection in cattle appeared to increase with the increase in average daily milk yield. Similar results were observed by [9, 10, 11]. Chi-square analysis revealed a significant association (P<0.05) of incidence of mastitis with milk yield in cows.

Table 1: Nature of mastitis in sample cases

Nature of mastitis	Number of cases	Percentage
Clinical	28	46.67
Sub Clinical	17	28.33
Chronic	15	25
Total	60	100

3.5 Stage of lactation and incidence of mastitis

Association between different stage of lactation and incidence of mastitis is displayed in Table 5. A browse of the table indicates that incidence decreased with the advancement in the stage of lactation in cows. Chi-square analysis revealed a significant association (P<0.05) of incidence of mastitis with stage of lactation. Animals in early stage of lactation were severely affected with mastitis than at end and mid lactation stage [6]. The similar observation were done by [8, 9, 12]. This result also corroborates with the fact that maximum milk yield during early lactation can make the animal more prone to mastitis.

Table 2: Breed wise incidence of mastitis

Breed	Number affected	Percentage affected
HF cross	23 (99)	23.23
Jersey Cross	27 (121)	22.31
Non descript	10 (60)	16.66
Total	60 (280)	21.43

(Figures in parentheses indicate total number of animals exposed)
[a]Incidence in cows is independent of breed of the animal (χ^2 = 0.702^{NS}; P >0.05)

Table 3: Relationship between age and incidence of mastitis

Age of the animal	Number of animals affected	Percentage affected
Less than or equal to 5	17 (107)	15.89
Greater than 5	43 (173)	24.86
Total	60 (280)	21.43

(Figures in parentheses indicate total number of animals exposed)
[a]Incidence in cows is independent of age of the animal (χ^2 =3.158^{NS}; P >0.05)

3.6 Relationship between number of lactations and incidence of mastitis.

As seen from the Table 6, increase in the number of lactations has caused a general increase in mastitis incidence in milch cows. Chi-square analysis showed that the incidence of mastitis in cows was highly associated with a number of lactations (P<0.01). The results obtained is in agreement with [6, 9]. The relative risk of clinical mastitis was lower for primiparous cows, and increased with further parity [13]. Again animals with more number of lactations will be aged and earlier result of more mastitis in aged animals is evident from this finding.

Table 4: Relationship between milk yield and incidence of mastitis

Average daily milk yield in litres in the preceeding week before infection	Number of animals affected	Percentage affected
≤6	10 (65)	15.38
6.1 to 8	10 (62)	16.12
8.1 to 10	17 (89)	19.10
10.1 to 12	15 (47)	31.91
Above 12	8 (17)	47.06
Total	60 (280)	21.43

(Figures in parentheses indicate total number of animals exposed)
[a]Incidence in cows is dependent on average daily milk yield (χ^2 =8.532*; P<0.01)

Table 5: Relationship between stage of lactation and incidence of mastitis

Order of lactation	Number of animals affected	Percentage affected
First	27 (86)	31.40
Second	24 (125)	19.20
Third	9 (69)	13.04
Total	60 (280)	21.43

(Figures in parentheses indicate total number of animals exposed)
[a]Incidence in cows is dependent on stage of lactation (χ^2 =8.324*; P <0.05)

3.7 Category of quarters affected

In Table 7, the involvement of different quarters of the mammary gland in mastitis infection is shown. Of the total number of 240 quarters from 60 affected animals, the affected quarters were 111 (46.25 percent). The incidence of mastitis was more in hind quarters than fore quarters. [13] observed that the rear udder quarters had a higher risk of clinical mastitis incidence compared to the front udder quarters.

3.8 Number of clinical quarters at a time

Details of a number of clinically affected quarters at a time with mastitis in cows were shown in Table 8. Among the sixty infected cows, single quarter affected was seen in 30 cases (50 percent), two quarters in 20 cases (33.34 percent), three quarters in 8 cases (13.34 percent) and all the four quarters affected only in two cases (3.33 percent). Table 8 showed that the incidence of mastitis was more in single quarter involvement than more than one quarter involvements. The results obtained is in agreement with a study done by [9].

3.9 Relationship between milking methods and incidence of mastitis

Relationship between different milking methods and incidence of mastitis was assessed in Table 9. Out of 60 affected cases, 50 animals were milked using knuckling method. Stripping and knuckling method caused more damage to the teat tissues leading to more prone to mastitis. Results showed that higher incidence of mastitis was in knuckling (25.1 percent) than stripping (17.65 percent), machine milking (11.11 percent) and full hand method (10.34 percent).The similar observation was done by [9]. Chi-square analysis showed that the incidence of mastitis in cows had no association with the method of milking (P>0.05).

Table 6: Relationship between number of lactations and incidence of mastitis

Number of Lactations	Number of animals affected	Percentage affected
1	8 (69)	11.60
2	17 (80)	21.25
3	19 (85)	22.35
4	8 (31)	25.81
5 and above	8 (15)	53.34
Total	60[a] (280)	21.43

(Figures in parentheses indicate total number of animals exposed)
[a]Incidence in cows is dependent on lactation number (χ^2 =13.443**; P <0.01)

Table 7: Category of quarters affected

Involvement of quarters	No. affected	Percentage
Right fore	21	18.92
Right hind	30	27.03
Left fore	24	21.62
Left hind	36	32.43
Total number of infection studied =60		
Total number of quarters affected =111(46.25 percent)		

Table 8: Number of clinical quarters affected at a time

Number of quarters affected	Number of animals	Percent to total affected
1	30	50.00
2	20	33.34
3	8	13.34
4	2	3.33
Total	60	100

Table 9: Relationship between milking methods and incidence of mastitis

Particulars	Practice followed	Number affected	Percent affected
Milking method	Full Hand milking	6 (58)	10.34
	Stripping	3 (17)	17.65
	Knuckling	50 (196)	25.51
	Machine milking	1 (9)	11.11
	Total	60[a] (280)	21.43

(Figures in parentheses indicate total number of animals exposed)
[a]Incidence in cows is independent of milking methods (χ^2 =4.726^{NS}; P >0.05)

3.10 Relationship between management practices and incidence of mastitis

In the present study, some of the management practices believed to precipitate mastitis in milch animals along with previous disease aspects which were examined for their association with incidence of mastitis and the results are presented.

3.10.1 Relationship between barn details and incidence of mastitis

Certain barn details regarding type of farming system, floor space provided per milch animal, herd size, provision of bedding materials were collected and the relationship between barn details and incidence of mastitis were assessed. The details were presented in Table 10. Chi-square analysis showed that incidence in cows were dependent on farming system and floor space provided (P <0.05) and was independent on herd size and provision of bedding materials (P >0.05).Overstocking of cattle and poor manure management would exacerbate the detrimental effects of the environment on mastitis control [14].

3.10.2 Relationship between milking hygiene and incidence of mastitis

Table 11 made it clear that less hygiene of the farm favoured higher incidence (38.14 percent) of mastitis in cows than that of hygienic farms (9.26 percent). [5] suggested that hygienic milking practice, culling of chronically infected cows and hygienic practice in the environment should be followed to prevent mastitis. Inadequate sanitation of dairy environment and lack of proper attention to health of mammary gland were important factors (P<0.05) contributing to the prevalence of mastitis [6].

In the farms where mastitis affected animals were milked last, incidence of mastitis (13.04 percent) was less when compared to the other farms (27.27 percent) where mastitis affected animals were milked in between. Cows in herds that did not milk mastitic cows last were significantly more likely to have mastitis than those that did that [15]. In the case of udder and leg hygiene score, the animals maintained in a very dirty manner were more prone to mastitis.

Hand prewashing by the milker with soap would reduce the incidence of mastitis (15.79 percent) when compared to the other milkers who were not using the soaps prior to milking (28.12 percent). [1] suggested that during milking, the milker's hand should be properly washed, dried and cleaned so that chances of spread of disease could be minimized. Chi-square analysis revealed that hygiene of the farm (P<0.01), whether the milkers were milking mastitic cow last or not (P<0.01), udder and leg hygiene (P<0.01), hand pre-washing before milking (P>0.05) had got significant relationship with incidence of mastitis. Incidence in cows were found independent of pre or post dipping, udder washing before milking, udder drying after washing (P>0.05).

Table 10: Relationship between barn details and incidence of mastitis

Particulars	Practice followed	Number affected	Percent affected
Farming system	Grazing	42[a] (156)	26.92
	No Grazing	18[a] (124)	14.52
Floor space provided	Adequate	11[b] (83)	13.25
	Not adequate	49[b] (197)	24.87
Herd size	Less than or equal to five	17[c] (90)	18.89
	Greater than five	190[c] (43)	22.63
Bedding materials	Yes	14[c] (85)	16.47
	No	46[c] (195)	23.58

(Figures in parentheses indicate total number of animals exposed)
[a]Incidence in cows is dependent on farming system (χ^2 =6.316*; P <0.05).
[b]Incidence in cows is dependent on floor space provided (χ^2 =4.683*; P <0.05).
[c]Incidence in cows is independent on herd size and bedding materials (χ^2 =0.508^{NS}; χ^2 =1.782^{NS}; P >0.05).

3.10.3 Relation of previous history of disease aspects and current incidence of mastitis.

Table 12 described that milch animals with the history of retention of placenta (ROP) in their current calving had more chance of infection (29.03 percent) when compared to animals with normal parturition. Injury to the udder would made animal more prone to mastitis (32 percent) when compared to animals with healthy udder (20 percent). The pendulous udder exposes the teat and udder to injury and pathogens easily adhere to the teat and gain access to the gland tissue [15].

Table 11: Relationship between milking hygiene and incidence of mastitis

Particulars	Practice followed	Number affected	Percent affected
Hygiene of the farm	Good	15[a] (162)	9.26
	Poor	45[a] (118)	38.14
Milking mastitic cow last	Yes	15[b] (115)	13.04
	No	45[b] (165)	27.27
Udder and leg hygiene score	Slightly dirty	16[c] (110)	14.55
	Moderately dirty	20[c] (100)	20.00
	Very dirty	24c (70)	34.29
Hand prewashing	With soap	24[d] (152)	15.79
	Without soap	36[d] (128)	28.12
Pre/Post teat dipping	Yes	15[e] (75)	20.00
	No	45[e] (205)	21.95
Udder washing before milking	Whole Udder	25[e] (118)	21.12
	Teats only	35[e] (162)	21.60
Udder drying after washing	Yes	22[e] (110)	20
	No	38[e] (170)	22.36

(Figures in parentheses indicate total number of animals exposed)

[a]Incidence in cows is dependent on hygiene of the farm (χ^2 =33.812**; P <0.01)

[b]Incidence in cows is dependent on milking mastitic cow last (χ^2 =8.149**; P<0.01)

[c]Incidence in cows is dependent on udder and leg hygiene score (χ^2 =10.089**; P <0.01)

[d]Incidence in cows is dependent on hand prewashing (χ^2 =6.280*; P <0.05)

[e]Incidence in cows is independent of pre/ post dipping, udder washing before milking, udder drying after washing (χ^2 =0.124^{NS}; χ^2 =0.007^{NS}; χ^2 =0.220^{NS}; P >0.05)

Chi-square analysis revealed that incidence in cows was dependent on history of retained placenta in current calving (P <0.05) and dependent on injury to the udder (P <0.05). Incidence in cows was found to be independent on history of mastitis in previous calvings (P >0.05).Previous history of mastitis were found statistically significant with regard to occurrence of bovine mastitis in Sudan by [12], which is in disagreement with the current study.

Table 12: Relation of previous history of disease aspects and current incidence of mastitis

Particulars	Practice followed	Number affected	Percent affected
History of Retained placenta in current calving	Yes	27[a] (93)	29.03
	No	33[a] (187)	17.65
Injury to the udder	Yes	16[b] (50)	32.00
	No	44[b] (230)	20.00
History of metritis in current calving	Yes	15[c] (80)	18.75
	No	45[c] (200)	22.5
History of mastitis in previous calvings	Yes	33[c] (145)	22.76
	No	27[c] (135)	20

(Figures in parentheses indicate total number of animals exposed)

[a]Incidence in cows is dependent on history of retained placenta in current calving (χ^2 =4.782*; P <0.01).

[b]Incidence in cows is dependent on injury to the udder (χ^2 =4.040*; P <0.01).

[c]Incidence in cows is independent on history of metritis in current calving, history of mastitis in previous calvings (χ^2 =0.477^{NS}; χ^2 =0.316^{NS}; P >0.05).

4. Conclusion

The crossbred Holstein-Friesian (HF) had the highest incidence rate of mastitis. Incidence of udder infection in cattle appeared to increase with the increase in average daily milk yield. Increase in the number of lactations has caused a general increase in mastitis incidence in milch cows. The rear udder quarters had a higher risk of clinical mastitis incidence compared to the front udder quarters. Stripping and knuckling methods of milking caused more damage to the teat tissues leading to more prone to mastitis. Less hygiene of the farm favoured higher incidence of mastitis in cows. Injury to the udder would made animal more prone to mastitis when compared to animals with healthy udder. Incidence of mastitis, having been associated with a variety of factors inherent in animals and factors resulting from improper farming practices, appeared to decrease when the management practices are proper and scientific.

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