



Prevalence and Associated Risk Factors of Cow Mastitis among Small Scale Farmers and Dairy Farms in Western Tigray, Northwest Ethiopia

Leul Berhe^{1*}, Zinabu Nigus Belay¹ and Gebresilase Gebrekidan¹

¹*Livestock Research Core Process, Humera Agricultural Research Center, Tigray Agricultural Research Institute, Humera, Ethiopia.*

Authors' contributions

This work was carried out in collaboration among all authors. Author LB design of the study, data collection, data entry, analysis and report writing. Author ZN participated in the design of the study. Author GG data collection. All authors read and approved the final manuscript.

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ABSTRACT

A cross sectional study was carried out from November 2017 to June 2018 to assess awareness status and management practice common among dairy cows owners and to determine the prevalence of bovine mastitis and its associated risk factors in four districts and nine kebelles of Western Zone of Tigray Regional State, North West Ethiopia. In this study, out of the 355 dairy cows and 1314 functional quarters examined, 99(27.89%) cows and 142(10.81%) quarters were found positive for sub-clinical mastitis on California Mastitis Test (CMT). In addition, from the 355 dairy cows and 1420 quarters examined, 88(24.79%) and 108(7.61%) cows and teats respectively, were found to be blind. From the total risk factors considered, statistically significant association ($P < 0.05$) was found in different breed, udder type and parity. Semi structured questionnaires surveys were distributed to 87(95.60%) males and 4(4.40%) females. According to the survey result, 76(83.52%) of the dairy cow owners housed their cows in open area with muddy or soily floor type. From the total 91 interviewed 32(35.16%) regularly dispose dung and cleaning of house. During the survey, udder management before and after milking was assessed. According to the

*Corresponding author: E-mail: shishayeberhe@gmail.com;

response of 89(97.80%) milkers washed their hands prior to milking and 2(2.20%) did not. From the total 91 interviewed individuals, 13(14.29%) milkers disinfect their hands before proceeding to milk the next cow while 78(85.71%) did not. During the survey, sequence of milking cows was assessed. Based on the response of respondents, 85(93.41%) of the milker did not follow sequence of milking and the rest 6(6.59%) milkers emphasized the need to follow the order of milking. The result of the present study indicated a relatively high prevalence of subclinical mastitis and with higher incidence of one or more nonfunctional teat which impose higher economic loss to the dairy owners. Lack of strategic control measures and improper attention to the health of the mammary glands contribute the higher infestation rate. Better management practices in milking and adequate housing with proper sanitation should be provided.

Keywords: California mastitis test (CMT); dairy cows; mastitis; prevalence; risk factors; Western Tigray.

1. INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa [1]. The total cattle population for the country is estimated to be 60.39 million, out of which Tigray region accounts for 4.82 million cattle [1]. The livestock sector has made great contribution to the national economy and still promising to rally round the economic development of the country [2]. Dairy production is one of the sectors of livestock production in many parts of Ethiopia and makes a major contribution to national and household economies as well as provides milk for nutrition [3]. Milk contributes significantly to meeting the human requirements for animal protein and is especially important in the diet of children and patients [4]. Despite Ethiopia having large dairy cows population, the national and regional milk supply is lower compared to its potential due to the poor genetic potential of dairy cows, lack of market chain, shortage of animal nutrition and different diseases of animals in which mastitis is a disease among the fore mentioned constraints of dairy production [5], [3].

Mastitis is the most prevalent infectious disease of adult dairy cows and the infection is possibly developed when the cow is lactating or dries off [6]. Mastitis can be classified as either subclinical or clinical, depending on how the severity of the infection, which in turn depends on how the host is able to resist the infection [7,8]. Mastitis is one of the most devastating diseases in the dairy industry [9,10]. Mastitis cause a great deal of reduction in productivity, influence the quality and quantity of milk yield, cause culling of animals at an unacceptable age, distort animal welfare and also cause death of animals [11]. Most estimates have shown that subclinical mastitis cause 30% and 15% reduction in production per affected

quarter and cow respectively throughout the lactation, making the disease one of the most costly and serious problems affecting the dairy industry worldwide [12,13,14].

Mastitis control relies upon the application of effective control measures to the herd rather than identification or special treatment of individual animals [6]. Most new infections occur during the early part of the dry period and in the first two months of lactation, especially with the environmental pathogens. In heifers, the prevalence of infection is often high in the last trimester of pregnancy and several days before parturition, followed by a marked decline after parturition [15].

Mastitis is a major disease in dairy cows in Ethiopia and it was prioritized as one of the major diseases of dairy cows [16]. The incidence and distribution of the disease has not been studied systematically and information relating to economic loss, magnitude, distribution and risk factors of the disease is inadequate in Ethiopia [17]. Therefore, the objective of the present study is to assess the overall prevalence of mastitis in local and crossbreed dairy cows, to determine risk factors and to assess awareness status and management practice common among dairy cow owners in the study zone.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was carried out in four 'woreda' (districts) and nine 'kebelles' and one animal ranch of Western Zone of Tigray Regional State, North West Ethiopia. It is one of the five administrative zones of Tigray regional state with one urban district Setit Humera and three rural districts Kafta Humera, Welkait and Tsegede.

The zone is surrounded with Tahtay Adibayo, Tselemti and AsgedeTsimbla districts in the East, Sudan in West, Amhara region in South and Eritrea in the North. Western Zone of Tigray consists of three agro-ecological zones which comprised of 75% low land, 15.7% mid land and 9.3% high land. It is located with distance range of 580 to 750 km from Mekelle, the capital city of Tigray and covers an area of 1.5 million hectare with 48.82%, 13%, 23.43% and 27.62% accounts for Kafta Humera, Setit Humera, Tsegede and Welkait respectively [18]. 573,285 hectares (38.2%) and 927,000 hectares (62.8%) represent for total cultivated and uncultivated land respectively and 341,195.25 hectares (36.8%) of the uncultivated land is covered by different plant species excluding *Bowsellia* and *Acacia Senegal* while 185,510 hectares (20%) of the unfarmed land is exclusively covered by both *Bowsellia* and *Acacia Senegal* [19]. The geographical location of the zone is at altitude 13°42' to 14°28' north and 36°23' to 37°31' east [20]. The annual rainfall and temperature of the zone ranges from 600 to 1800 mm and 27°C to 45°C in the lowland areas (Kolla) and 10°C to 22°C in both midland and highland areas of the zone respectively. The altitude of the zone ranges from 500 to 3008 m.a.s.l. and livestock production is the predominant economic activity with about 95% of the total population engaged directly or indirectly in it [20]. Main cattle breeds raised in the Western Zone of Tigray are the local Arado (in both high land and mid land) and Begait cattle (in lowland). Semi-intensive production system is practiced in urban kebelles of the zone, while extensive production system is dominant in all districts. The main crops cultivated in the lowland areas of the zone are sesame, cotton and sorghum while teff, wheat, barley, noug, lentils, finger millet, field peas and faba beans are cultivated crops in both mid land and high land areas of the zone [19].

2.2 Study Animals

The study animals that had been sampled were lactating smallholder dairy cows of different herds with different calving history. The study included 355 Small holders lactating dairy cows which were indigenous local Arado (n=160), Begait breed (n=170) and cross breed (n=25) managed under the traditional extensive and semi intensive system of production.

2.3 Study Design

A cross sectional study was carried out from November 2017 to June 2018. During the

beginning of the study, community identification and assessment was completed and list of study kebelles were done purposively. The number of representative sampled animals was proportionally allocated to the selected peasant associations based on the number of dairy cows population and simple random sampling technique was used to select the study animals. Data related to production system, risk factors, farmer's knowledge about dairy cow mastitis and control were collected using semi- structured questionnaire format and screening test was conducted at the same time in nine kebelles of the study zone.

2.4 Sample Size

The sample size for the study was calculated based on the formula developed by [21] for random sampling method. A 5% absolute precision and 95% confidence interval was used for determining sample size. Since there was no a previous study on the prevalence of mastitis in the study area, an expected prevalence of 50% was used to determine the maximum sample size.

$$n = \frac{1.96^2 P_{exp} (1 - P_{exp})}{d^2}$$

Where,

- n = sample size
- 1.96 = the value of Z at 95% confidence interval
- P_{exp} = expected prevalence (50%)
- d = desired absolute precision (5%)

Therefore, the calculated sample size was 384. Due to various inconveniences 355 lactating dairy cows were taken.

2.5 Data Collection

Semi-structured questionnaires were developed and pre-tested, and all information relating to the study objectives were recorded. Age of the animals was determined from birth records and dentition characteristics and categorized as young adults (≤4 years), adults (>4 to ≤8 years) and old (>8 years). Stage of lactation was categorized as early (1–120 day post-partum), middle lactation (121–240 days) and late lactation (greater than 240 days). Parity was also categorized as few (≤3 calves), moderate (3–5 calves) and many (≥5 calves) taken from [22], [23]. The other risk factors were represented as 'yes' or 'no' for the presence or absence of the

risk stated in the hypothesis respectively. Data regarding the different potential risk factors and management practice were collected from 355 lactating cows and by interviewing 91 farm owners.

2.6 Screening Test

Subclinical mastitis was diagnosed using California Mastitis Test (CMT) and the nature of coagulation and viscosity of the mixture was recorded. After physical examination and strict aseptic procedure followed, a squirt of milk about 2ml was taken from each quarter of clinically free of mastitis lactating cows and was placed in each of four shallow in the CMT paddle and an equal amount of Delaval California Mastitis Test CMT was added to each cup and a gentle circular motion was applied to the mixture for 15 sec. The results were read as negative (0), weak positive (+1), distinct positive (+2) and strong positive (+3) according to [24].

2.7 Data Analyses

The collected raw data was entered into Microsoft Excel data sheets and analyzed using STATA 11.1 statistical software. Descriptive statistics, percentages, and 95% confidence intervals were used to summarize the proportion of infested and non-infested animals and the frequency of the questionnaire results also computed using the aforementioned statistical software. The effects of different environmental and host risk factors were analyzed by Pearson chi-square (χ^2) test. Statistical significance was set at $P < 0.05$.

3. RESULTS

3.1 CMT Screening Result

In the present study, out of the 355 local Zebus, Begait and crossbred lactating cows and 1314 functional quarter examined using California Mastitis Test (CMT), a prevalence of 99 (27.89%) cows and 142 (10.81%) quarters sub-clinical mastitis was obtained. With regard to the location of the positive quarters, 45(13.98%), 27(7.96%), 37(11.42%) and 33(10.03%) Right front (RF), Left front (LF), Right hind (RH) and Left hind (LH) position respectively found positive from the total functional teat examined (Table 1).

In the present study, the status (severity) of the infection according to the reaction of chemical in the California Mastitis Test (CMT) reagent was assessed and the result showed that, higher score of 61(4.64%), weak positive (+1), followed by 47(3.58%), distinct positive (+2), and 34(2.59%), strong positive (+3) and 1172(89.19%) with negative (0) score (Table 2)

In the present study, a total of 355 cows and 1420 quarters were examined, 88(24.79%) and 108(7.61%) cows and quarter level prevalence blind teat was found. From the total 88 of cows with one or more blind teats, 70(19.72%), 16(4.51%) and 2(0.56%) cows found with single, double and triple blind teats respectively. RF and RH quarters were the most prevalent quarters found with 33(9.30%) and 32(9.01%) blind quarter respectively (Tables 3 & 4).

Table 1. Total cows and quarter level prevalence of mastitis using California mastitis test

Quarter	No. examined quarter	CMT positive quarter and cows	Positive (%)
RF	322	45	13.98
LF	339	27	7.96
RH	324	37	11.42
LH	329	33	10.03
Total quarter examined	1314	142	10.81
Total cows examined	355	99	27.89

Table 2. Relationship between the positive CMT and infection status of the quarters

Severity indication	Total CMT positive quarter	CMT reaction (severity %)
Weak positive (+1)	61	4.64
Distinct positive (+2)	47	3.58
Strong positive (+3)	34	2.59
Negative (0)	1172	89.19
Total	1314	100

Table 3. Prevalence of single, double and triple blind quarters from the total examined cows

Blind quarter	Frequency of cows with blind quarter	% blind quarter from total examined cows (355)
Single	70	19.72
Double	16	4.51
Triple	2	0.56
Total	88	24.79

Table 4. Quarter level prevalence of blind teats

Blind quarter	No. examined quarter	Frequency of blind quarters	Positive (%)
RF	355	33	9.30
LF	355	16	4.51
RH	355	32	9.01
LH	355	27	7.61
Total	1420	108	7.61

From the total risk factors assessed in this study, age, udder lesion, lactation stage, body condition score and production system did not have statistically significant relationship ($P>0.05$) with the prevalence of mastitis although there was difference in prevalence among the category of risk factors considered. However, a statistically significant association ($P<0.05$) was found in between breed considered, udder type and parity of the dairy cows and incidence of mastitis. In comparing prevalence of mastitis among breed considered, higher prevalence in cross breed 14(56%), followed by Begait local breed

52(30.59%) and least in local zebu 33(20.63%) was obtained. Parity had also effect on the occurrence of mastitis. The result showed that the prevalence of mastitis was higher in animals ≥ 5 calving followed by cows with 3 to 4 calves and lowest in animals ≤ 2 calving (Table 5).

In the result of present study the association of mastitis induced blind quarter was assessed no statistical significant ($P>0.05$) difference was obtained in all the risk factors considered (Table 6).

Table 5. Association of subclinical mastitis prevalence to different categories of risk factors

Risk factors	Categories	Animal examined	Positive (%)	X ²	p-value
Breed	Local	160	33(20.63%)	14.6377	0.001
	Cross breed	25	14(56%)		
	Begait	170	52(30.59%)		
Age	Young	44	11(25%)	0.6121	0.736
	Adult	227	62(27.31%)		
	Old	84	26(30.95%)		
Udder and teat lesion	present	13	4(30.77%)	0.0557	0.813
	Absent	342	95(27.87%)		
Lactation stage	1-120 day	110	34(30.91)	1.2311	0.540
	121-240 day	196	54(27.55%)		
	>240 day	49	11(22.45%)		
BCS	Poor	28	7(25%)	0.1819	0.913
	Good	282	80(28.37%)		
	Very good	45	12(26.67%)		
Parity	≤ 2 calving	181	45(24.86%)	10.7617	0.029
	3-4 calving	130	33(25.38%)		
	≥ 5 calving	44	21(47.73%)		
Udder Type	Pendulous	73	35(47.95%)	18.3846	0.000
	Non pendulous	282	64(27.70)		
Production system	Semi-intensive	41	12(29.27%)	0.0440	0.834
	extensive	314	87 (27.71%)		
Total prevalence		355	99(27.89%)		

Table 6. Association of mastitis induced quarter to different categories of risk factors

Risk factors	Categories	Animal examined	Positive (%)	X2	p-value
Breed	Local	160	43(26.88%)	2.5673	0.277
	Cross breed	25	3(12.00%)		
	Begait	170	42(24.71%)		
Age	Young	44	11(25.00%)	0.8985	0.638
	Adult	227	53(23.35%)		
	Old	84	24(28.57%)		
Lactation stage	1-120 day	110	25(22.73%)	1.9450	0.378
	121-240 day	196	47(23.98%)		
	>240 day	49	16(32.65%)		
Parity	≤ 2 calving	181	43(23.76%)	0.2344	0.889
	3-4 calving	130	34(26.15%)		
	≥5 calving	44	11(25.00%)		
Udder Type	Pendulous	73	15(20.55%)	0.8865	0.346
	Non pendulous	282	73(25.89%)		
Production system	Semi-intensive	41	8(19.51%)	0.6922	0.405
	extensive	314	8(25.48%)		
Total prevalence		355	88(24.79%)		

3.2 Questionnaire Survey Result

The survey was distributed to 87(95.60%) males and 4(4.40%) females household to collect information relating knowledge about mastitis and its management's practices. Out of the 91 interviewee, 38(41.76%) were illiterates, 41(45.05%) had elementary school's education, 10(10.99%) of the farm owners were educated to high school level and the remaining 2(2.20%) had completed College (Table 7).

The management (housing, bedding, feeding etc.) and the degree of sanitation were also assessed during the study period. According to the present survey results, 76(83.52%) of the dairy cows owners housed their cows in open area,

2(2.20%) had simple enclosed area, 11(12.09%) had houses made of wooden and iron sheet and 2(2.20%) had houses made of brick and iron sheet. Similarly, the current assessment indicated that 82(90.11%) of the floor of the houses were earthy or soil floor type, 8(8.79%) had floor made of concrete and 1(1.10%) had floor made of stone and mud. Drainage condition of the houses were poor as indicated from 64(70.33%) respondents, 12(13.19%) had medium drainage condition and 15(16.48%) had good drainage. All the 91(100%) interviewed individuals had good ventilation. According to the responses of 32(35.16%) interviewed individuals regularly dispose dung and clean the animals' house but, the rest 59(64.84 %) of the dairy cows holders were not (Table 8).

Table 7. Demographic characteristics of the interviewee

Demographic factors	No. of respondents (%)
Sex	
Male	87(95.60%)
Female	4(4.40%)
Education	
Illiterate	38(41.76%)
Grade 1-8	41(45.05%)
Grade 9-12	10(10.99%)
College completed	2(2.20%)
Marital status	
Single	3(3.30%)
Married	76(83.52%)
Divorced	7(7.69%)
Widowed	5(5.49%)

Table 8. House condition and management of the farms

	No. of respondents (%)
Housing condition of the farm	
In open area	76(83.52%)
Simply enclosed area	2(2.20%)
Made of wooden and iron sheet	11(12.09%)
Made brick and iron sheet	2(2.20%)
Floor type	
Concrete	8(8.79%)
Earthy floor muddy or soil	82(90.11%)
Stone and mud	1(1.10%)
Drainage of house	
Good	15(16.48%)
Medium	12(13.19%)
Poor	64(70.33%)
Ventilation of house	
Good	91(100%)
Poor	0(0.00%)
Regular disposal of dung and cleaning of house	
Yes	32(35.16%)
No	59(64.84 %)
Hygienic condition of the house	
Good	12(13.19%)
Medium	17(18.68%)
Poor	62(68.13%)

During the survey, udder management before and after milking was assessed. According to the responses of 89(97.80%) respondents, milkers washed their hand prior to milking and 2(2.20%) did not. From the result of this study, 40(43.96%) the dairy cow's owner wash their hand with soap, 48(52.75%) with tap water only and 1(1.10%) interviewee wash their hands sometime with soap and tap water only. Among the 91 interviewed individuals, 13(14.29%) milkers in the farm disinfect their hands before proceeding to milk the next cows, while 78(85.71%) milkers disinfect their hands only at the beginning of milking and continue milking until the end of milking. During the survey, sequence of milking cows was assessed. Based on the response obtained, 85(93.41%) of the milkers did not follow sequence of milking and the rest 6(6.59%) of the milkers emphasized the need to follow the order of milking to prevent disease transmission (Table 9).

During the survey, the infestation status of bovine mastitis, knowledge of dairy cow owners and its management was assessed. Out of the 91 individual interviewed 84(92.31%) respondents knew bovine mastitis and 7(7.69%) did not know. Regarding the occurrence of the disease in their farms, 83(91.21%) said it was occurring in their farm but, 8(8.79%) individuals

did not record mastitis in their farms. The entire interviewed individual reported that tick infestation always occur in their farm with 50(54.95%) respondents reporting high infestation, 33(36.26%) reported moderate infestation and 8(8.79%) reported lower infestation. Concerning the treatment of unhealthy udder, 90(98.90%) of the individuals treat their cows when tick infestation was highest with 71(78.02%) being treated by spraying with chemical and 20(21.98 %) were using traditional medicine (Table 10).

4. DISCUSSION

This study determined the prevalence of bovine mastitis and risk factors associated with bovine mastitis in lactating cows in the studied zones. Out of the 355 bovine dairy cows examined, a prevalence of 99(27.89%) was obtained. The result of the present study is comparable with the findings of [25] who reported a prevalence of 25.1% in Addis Ababa, Ethiopia, [26] with a prevalence of 29%. The report of [17,27] who reported prevalence of 33% and 25%, respectively and 28.2% prevalence by [28] in Bahir Dar and its environs is in line with present result. On the other hand, the report of [38] who reported a prevalence of 52.8% in Areka town, Southern Ethiopia, [29] a prevalence of 63.4%,

[30] a prevalence of 61.11% in indigenous zebu and in Boran Holstein cross in Southern Wollo, [31] in Stella dairy farm with the prevalence of 68.1% and [32] reported a prevalence of 52.78% in Ethiopia, were higher than the present findings. The result of the present study also disagree with report of [33] who reported 52.78% prevalence in and around Sebeta, 53.25% prevalence in Dire Dawa Town by [34] and 46.7% in Adama Town by [35]. Moreover, the present study was less than relative to the available reports from other African countries such as 51.6% in Tanzania by [36] and 51.8% in Rwanda by [37] and 52% in Nigeria by [38]. On the other hand, the result of the present study is higher than the report of 10.6% prevalence from Tullo District West Hararghe by [39], 23.18% by [40] in Eastern part of Ethiopia and 19.14% report of [41] in Egypt. However, the report of the present finding is also by far, higher than the report of [42] who reported 5.3% prevalence, [43] who reported 7.3% in Adama, [44] who reported 18.9% incidence rate in Dire Dawa and

Haramaya University Dairy farm and [45] who reported 17% prevalence on the local Zebu lactating cows in and around Bahir Dar. In the current study, 142(10.81%) quarter level prevalence of subclinical mastitis was obtained. The quarter level prevalence of the present finding is lower than the report of [46,47,48,27] who were reported 21.94%, 44.80%, 37% and 28.20% respectively and 38.7% quarter level prevalence by [49] from lactating cows of Boran breed from Yabello, Borana Zone but, in line with report of [50,40] who reported 10.12% and 9.1% quarter level prevalence respectively whereas, it is higher than the report of [42] who found 6% quarter level positive in local indigenous breed around Debreziet. The variation in the prevalence of bovine mastitis in the report of different authors was probably due to laboratory techniques used, study design, climate and geographic areas, the level of production and management practices, season of study, infestation of ticks, proportion of exotic gene inheritance and breed of animals studied.

Table 9. Udder management before and after milking

	No. of respondents (%)
Hands washing before milking	
Yes	89(97.80%)
No	2(2.20%)
Washing hands with	
With soap	40(43.96 %)
Without soap (tap and river water)	48(52.75%)
Sometime with soap and without soap	1(1.10%)
No washing	2(2.20%)
Inter cow hand washing	
Yes	13(14.29%)
No	78(85.71%)
Wash udder before milking	
Yes	20(21.98%)
No	71(78.02 %)
With what do you wash the udder	
No wash	71(78.02 %)
With tap and river water	18(19.78%)
With boiled water	2(2.20%)
Do you use towel	
Yes	90(98.90%)
No	1(1.10%)
Do you follow Sequence of milking	
Yes	6(6.59%)
No	85(93.41%)
Do you milk cows with mastitis	
Yes	18(19.78%)
No	73(80.22%)
Milking cows with mastitis problem	
No milk	73(80.22%)
First	2(2.20%)
No order	16(17.58%)

Table 10. Disease problem in the udder and its management

	No. of respondents (%)
Have you heard about mastitis	
Yes	84(92.31%)
No	7(7.69 %)
Have you observed case of mastitis in your farm	
Yes	83(91.21%)
No	8(8.79%)
What are you going to do if your cows have mastitis	
Not treated	5(5.49%)
Treat by them selves	42(43.39%)
Take to vet clinic	32(35.16%)
Traditional method	7(7.69 %)
Do not know about mastitis	7(7.69 %)
Tick infestation in the farm	
Yes	91(100%)
No	0(00%)
Rate of infestation of tick	
Highly infested	50(54.95%)
Moderately infested	33(36.26%)
Slightly infested	8(8.79%)
Do you treat tick infestation	
Yes	90(98.90%)
No	1(1.10%)
Method of treatment	
Sprayed with chemical	71(78.02%)
Traditional treatment	20(21.98 %)
Have ever you culled mastitis cow previously	
Yes	25(27.47%)
No	66(72.53%)

According to the result of the present study, 45(13.98%), 27(7.96%), 37(11.42%) and 33(10.03%) prevalence of mastitis for Right front (RF), Left front (LF), Right hind (RH) and Left hind (LH) quarters position respectively was recorded. As compared to the others quarters the right front (RF) quarters were affected with the highest infection rate. The Right hind (RH) quarter was the second followed by Left hind (LH) and Left front (LF) quarter. The quarter wise prevalence of the present result disagree with the report of [51] who reported 28.1% in Left Front (LF), 33.1% in Left Hind (LH), 24.5% in Right Front (RF), and 17.3% in Right Hind (RH) quarters which was higher in prevalence in Left Front (LF) and Left Hind (LH) quarters. Higher prevalence of subclinical mastitis in Right front (RF) and Right hind (RH) compared to the other two quarter found in the present study was most probably due to the ease of grasping the right front quarters first while milking and the higher production capacity of hind quarters [11] and the chance of getting environmental and fecal contamination also in the case of hind quarters [33]. The result of the mastitis infection status

(severity) showed that 61(4.64%) were weak positive (+1), 47(3.58%) were distinct positive (+2), 34(2.59%) were strongly positive (+3) and 1172(89.19%) had negative (0) score which is lower than the result obtained by [52] who found 75% distinct positive (+2) and 30% strongly positive (+3).

This study revealed that 88(24.79%) cows were found with one or more teats blind and from the total of 1420 quarter examined, 108(7.61%) quarters were also blinded with highest incidence rate in Right front (RF) and Right hind (RH) quarters. This finding is higher than [40,53] who reported 2.2% and 0.21% quarters blind prevalence respectively. The result of the present study closely agree with the report of [54] who reported 25(9.4%) quarter prevalence in Assella Oromia Regional state, South Eastern Ethiopia but, slightly less than 33(11.1%) reported by [42] around Debrezeit, Ethiopia. Lack of screening subclinical mastitis and late or not treating clinical cases could possibly lead to blindness of mammary gland. Blind mammary quarters contribute to high subclinical mastitis and loss of

milk production with a subsequent impact on food security [33].

The present result revealed that statistically significant association ($P < 0.05$) in the prevalence of mastitis was found with breed, udder type and parity. This finding indicated higher prevalence of subclinical mastitis in cross breed dairy cows followed by Begait local dairy cows and lowest in local zebu breed. This result agree with the findings [33] who found higher prevalence of mastitis in cross breed cows than local breed and [14] also reported a significant difference ($P < 0.05$) in the prevalence rate was detected among local Zebu, Jersey and high grade Holstein cows around Wolayta Sodo, Ethiopia. In addition, [55] found a significantly higher prevalence rate in high grade Holstein-Friesian than Holstein indigenous Zebu cross bred and indigenous Zebu in Hawassa southern, Ethiopia. Breed influence on the prevalence of mastitis could be attributed to the difference in certain physiological and anatomical characteristics of the mammary glands such as capacity of milk production, teat structures, and udder conformation [13,56]. Large udder is easily injured and pus formed which creates media for the multiplication of bacterial pathogens and in case of wide teat canal, cows creates foci for the entrance of microorganisms as well as high milking cow affect by stress which may upset the defense mechanism of lactating dairy cows as described by [13]. High yielding cows have fewer efficacies of phagocytic cells associated with dilution [57]. The significant difference obtained between the pendulous and non-pendulous udder structure in this study is, higher prevalence of mastitis in cows with pendulous udder could be explained by the fact that pendulous udder expose teat and udder to injury and the pathogens may easily adhere to the udder or teat and get access to the gland tissue [58,57]. Parity number also had significant influence ($P < 0.05$) on the prevalence of mastitis in the present study. Highest prevalence was found in dairy cows ≥ 5 calving followed 3-4 calving and lest in cows with ≤ 2 calves. This finding is in agreement with the report of [22,40] who recorded higher prevalence of mastitis in dairy cows with highest parity number than lowest parity number. According to [59] primiparous cows have more effective defense mechanism than multiparous cows and affected by chronic subclinical mastitis especially caused by host-adapted pathogens such as *Staphylococcus aureus* [60].

Although from the questionnaire survey result was found that 51(56.4%) owners were educated up to high school level, 2(2.20%) had completed college, and the remaining 38(41.76%) were non educated. There is a need of governmental interference to have all educated animal owner that had better know how about modern dairy cows production system. Most of previous studies on mastitis are focused on exotic and cross breed of cows managed under intensive and semi intensive management and no adequate information is available regarding mastitis in local dairy cows according the report of [40] in Ethiopia and this study attempted to investigate bovine mastitis on local breed of dairy cows namely local Begait and Arado Zebu breed of cows owned and extensively managed by smallholder farmers and investors as Zebu cows have great economic importance for rural smallholder and large investors dairy enterprise throughout the study zone. Although Zebu cattle have been known for their relative resistance or tolerance to many infectious diseases, 33(20.63%) and 52(30.59%) prevalence of sub clinical mastitis was obtained in local zebu and Begait breed of local dairy cows respectively and with 43(26.88%) local zebu and 42(24.71%) Begait breed of mastitis induced blind quarter. In Ethiopia, the subclinical form of mastitis received little attention and efforts have been focused on the treatment of clinical cases [61] while the economic loss that comes from sub clinical mastitis is great as reported by [13]. According to [13,62] subclinical mastitis cause 30% quarter and 15% cows level reduction in milk yield in dairy cows. This is due to progressive destruction of the alveolar epithelial cells in the mammary gland and the high occurrence of mastitis induced blind mammary quarters, which has a direct influence on milk production with a subsequent impact on food security which signifies the importance of the problem in the study zone.

According the present survey result, 76(83.52%) of the dairy cows owners housed their cows in open area. Similarly, as indicated by 82 (90.11%) respondents, the floor of the houses were earthy floor, muddy or soily floor type with 64(70.33%) respondents reporting that poor drainage of house could be the cause of highest occurrence of subclinical mastitis and blind teats in the local breed of cows considered in this study as supported by [46] in semi-intensive and extensive dairy farms, cows were maintained in dirty and muddy common barns with bedding materials and manure that favor the proliferation

and transmission of mastitis causing pathogens specially environmental pathogen. In the study area, manual milking methods was practiced in the entire farms which was the major predisposing factor to mastitis in extensively managed local breed of cows. Most of the milkers have little educational background and have limited knowledge about the means of udder disease transmission. Concerning the implementation of mastitis preventive measures, 89(97.80%) of the milkers often wash their hands with running and tap water prior to milking but they did not disinfect their hands between milking of different cows as reported by 78 (85.71%) interviewed individuals. The milkers did not use individual towel for drying of teats according response of 90(98.90%) and did not follow sequence of milking as reported by 85(93.41%) respondents. During the survey, the condition of bovine mastitis and its management was assessed. Out of the 91 individuals interviewed, 84(92.31%) respondents had knowledge of bovine mastitis and 7(7.69%) did not have the knowledge of mastitis. Regarding the occurrence of the disease in their farms, 83(91.21%) said it occurring. All of the interviewed individuals said tick infestation always occur in their farm with 50(54.95%) reporting high infestation, 33(36.26%) reported moderately infestation and 8(8.79%) reported slight infestation and did not cull cows previously infected with mastitis and this create an opportunity for the high distribution of subclinical mastitis and nonfunctional quarters in the study area. Injuries caused by ticks are known to cause direct inflammatory reaction in the mammary gland, necrosis, and abscess formation, which may lead to udder damage and/or exposure to serious secondary infections [63].

5. CONCLUSION

Many previous studies on mastitis were focused on exotic and cross breed of cows managed under intensive and semi intensive management and no adequate information is available regarding mastitis in local dairy cows in Ethiopia. These studies investigated bovine mastitis in local breed of dairy cows owned or managed extensively by smallholder farmers and investors. The result of the present study indicated a relatively high prevalence of subclinical mastitis and higher incidence of one or more nonfunctional teat. Although age, udder lesion, lactation stage, body condition score, and production system affect the prevalence of the present result, breed, udder type and parity were

found to be associated with occurrence of the disease. Result from the questionnaire survey indicated that most farmers had knowledge of the extent of the problem of bovine mastitis. Most of the dairy owners housed their cows in open area with earthy floor, muddy or soily floor type, poor drainage and unhygienic condition with no regular disposal of feces and dung. Manual milking methods were practiced with milkers limited knowledge about the modes of transmission of udder infection. Milkers often wash their hands with running or tap water prior to milking but they did not disinfect their hands and teats between milking of different cows and they did not use individual towel for drying and were not following sequence of milking. Higher tick infestation occurs in the study area and culling of chronically mastitis infected cows was not practiced. Based on the conclusion set from the research work, the following recommendations were made:

- Better mastitis management practices should be designed and hygienic practices regarding milking (such as milkers washing their hands before the commencement of milking and sequence of milking) should be implemented
- Training and extension services should be launched by relevant authorities to animal owners on the issue of effective mastitis prevention and controlling measures
- Adequate housing with proper sanitation should provided

CONSENT AND ETHICAL APPROVAL

A local ethics committee ruled that no official ethics approval was needed to conduct this research. Before conducting the research, informed consent was obtained from the owners or managers of the dairy farms used in this study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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