

Thesis/Dissertation Ref. No. _____



**THE IMPACT OF PERIPARTURIENT DISORDERS, MASTITIS AND LAMENESS ON
REPRODUCTIVE PERFORMANCE OF DAIRY COWS IN SELECTED DISTRICTS OF
WOLAITA ZONE, SOUTHERN ETHIOPIA**

MSC THESIS

BY

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MVSC IN VETERINARY OBSTETRICS AND GYNECOLOGY

JUNE, 2023

BISHOFTU, ETHIOPIA

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REPRODUCTIVE PERFORMANCE OF DAIRY COWS IN SELECTED DISTRICTS OF
WOLAITA ZONE, SOUTHERN ETHIOPIA**



**A Thesis Submitted to College of Veterinary Medicine and Agriculture of Addis Ababa
University in Partial Fulfillment of the Requirement for Degree of Masters of Science in
Veterinary obstetrics and gynecology**

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June, 2023

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DEDICATION

This thesis manuscript is dedicated to my wife, Aynalem Kensero for her unreserved encouragement, nursing me with affection and love, which is the key of my success in my entire life.

STATEMENT OF AUTHOR

I Gizaw Mekonnen hereby declare that the thesis submitted by me entitled "The impact of Periparturient Disorders, Mastitis and Lameness on Reproductive Performance of Dairy Cows in Selected districts of Wolaita Zone, Southern Ethiopia" for Master of Veterinary Science in Veterinary Obstetrics and Gynecology, College of Veterinary Medicine and Agriculture, Addis Ababa University which is my original work and has not been submitted for the award of any degree, diploma, scholarship or other similar titles of any other university or institution and that all sources of materials. I have used or quoted for this work, been properly credited and acknowledged with a full reference.

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Gizaw was born in 1997 from his father Mekonnen Meku and his mother Meselech Hachamo in Legama, a small village in Boloso Sore District, Wolaita Zone, southern Ethiopia. He attended primary school in Legama full primary school starting in 2002 and attended his high school in Areka secondary and preparatory school until 2010. After he completed high school, he joined Wolaita Sodo University and has been attending veterinary medicine since 2015. After graduation, he worked at Wolaita Sodo University in southern Ethiopia as a lecturer for one year. He again joined Addis Ababa University, College of Veterinary Medicine and Agriculture to study his master of veterinary science in veterinary obstetrics and gynecology from October 2021 to date.

ACKNOWLEDGEMENTS

I would like to thank God for his invaluable gift of perfect health, strength, endurance, hope, and protection. I am incredibly grateful that Wolaita Sodo University has awarded me the MVSc. I also want to thank Addis Ababa University for allowing me to enroll in the MVSc degree and paying my research expenses. I wish to express my sincere gratitude and appreciation to my major advisor, Professor Fikadu Regassa, for his unwavering guidance, supervision, insightful suggestions, and intensive assistance, as well as for the freedom of discussion and his kind personal encouragement from the early stages as well as the elaboration of the thesis for final processing. I also express my sincere gratitude to my co-advisor, Professor Gebeyehu Goshu, for his support, insightful criticism, direction, openness to discussion, careful supervision, and friendly behavior throughout the research process. Furthermore, I would like to express my sincere thanks and admiration to Mr. Enekesh Loha for his encouragement, insightful criticism, open dialogue, knowledge of dairy farm locations, and emotional support throughout my work. I would also like to express my sincere thanks and appreciation to the farm managers for their cooperation and kind responses to the requested information during retrospective data collection. I would also like to thank the Wolaita Zone Livestock and Fisheries Resource Department for supporting me in selecting potential dairy farms suitable for data generation. Last but not least, I would really like to thank my family for allowing me to have any support in my life.

LIST OF ABBREVIATIONS

AFC	Age at First Calving
AFS	Age at First Service
BCS	Body Condition Score
CaCL ₂	Calcium Chloride
CaSO ₄	Calcium Sulphate
CCI	Calving to Conception Interval
CFSI	Calving to First Service
CI	Calving Interval
CI	Confidence Interval
CLE	Clinical Endometritis
CSA	Central Statistical Agency
DMI	Dry Matter Intake
DO	Days Open
FSCR	First Service Conception Rate
GDP	Gross Domestic Product
NEB	Negative Energy Balance
Nacl	Sodium Chloride
NSAID	Non-Steroid Ant-inflammatory Drugs
NSPC	Number of Services Per Conception
PMN	Polymorphonuclear Leucocytes
PTH	Parathyroid Hormone
RFM	Retained Fetal Membrane
RP	Retained Placenta
VD	Vaginal Discharge
WZFLDD	Wolaita Zone Fishery and Livestock Development Department

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ABSTRACT

A cohort study using retrospective data from 2020 to 2022 was conducted to determine the impact of periparturient disorders, mastitis, and lameness on the reproductive performance of dairy cows in selected districts of Wolaita Zone, Southern Ethiopia, from November 2022 to April, 2023. The retrospective cross-sectional study was conducted to determine the prevalence of disorders. Multi-stage purposive sampling was used to select districts and dairy farms. Retrospective data on 1326 dairy cows was collected from 40 dairy farms. Logistic regression, chi-square, and t-test were used to analyze the data. Based on the analyzed data, 40.20% (533/1326) of dairy cows were affected by at least one disorder. The prevalence of the disorders that include endometritis, retained placenta, dystocia, hypocalcemia, mastitis, and lameness accounted 14.33%, 9.58%, 9.58%, 8.60%, 13.12%, and 10.56%, respectively. The occurrence of periparturient disorders, mastitis, and lameness showed statistically significant difference ($p < 0.05$) with regard to body condition, parity, age, and calving season. Although the location of the farm had no significant effect on the occurrence of mastitis and lameness, it was a significant environmental factor for the occurrence of periparturient disorders. Dairy cows calving from June to August had a high probability of being affected by periparturient disorders and mastitis. Lameness was more common from September to November. In the current study; periparturient disorders, mastitis, and lameness had a strong negative impact on the calving-to-conception interval, calving-to-first service, and number of services per conception, but dystocia had no significant impact on the calving-to-first-service interval. Moreover, lameness had a significant impact on age at first calving, but it had no impact on age at first service. The first-service conception rate was higher in normal dairy cows than diseased cows ($p < 0.05$). Thus, Periparturient disorders, lameness, and mastitis had an impact on the reproductive performance of dairy cows in the study area. It is recommended that proper feeding, husbandry, udder health, and foot care of dairy cows during the transition period need to be implemented. Early detection of disorders is essential to minimize the reproductive consequences of health problems.

Key Words: *Dairy Cows, Lameness, Mastitis, Periparturient Disorders, Reproductive Performance, Southern Ethiopia, Wolaita Zone*

1. INTRODUCTION

Ethiopia maintains a huge number of livestock population (Gizaw *et al.*, 2007). There are thought to be 70 million cattle, 42.9 million sheep, 52.5 million goats, 2.15 million horses, 10.80 million donkeys, 0.38 million donkeys, around 8.1 million camels, and 48.9 million poultry in Ethiopia, according to the CSA (2021) report. Rural smallholders, pastoral and agro-pastoral smallholders, urban and peri-urban smallholders, and specialized commercial milk production systems are the four basic livestock production systems that make up the national dairy cattle industry (Bahlibi, 2015). Regardless of the type of livestock production system, dairy cattle also play an amazing role in reducing poverty by mitigating the financial crisis in the world and producing regular income for small dairy farms (Fedhiko *et al.*, 2021).

The sector generated up to 40% of GDP from agriculture and 20% of the country's foreign exchange earnings (World Bank, 2017). Almost 85% of Ethiopia's population depends on the agricultural sector, which is the backbone of the country's economy (Alemselam *et al.*, 2015). So, the rural population is largely dependent on livestock and crop production systems in Ethiopia. Livestock and their products are essential sources of food and revenue. They could serve as a significant source of animal protein, energy for cultivating crops, transportation, export goods, manure for agriculture and household energy, security during crop failures, and a way to build wealth (Fesseha *et al.*, 2021).

Normal cow breeding is interested in satisfying the importance of dairy cattle. In order to reproduce routinely, a cow should have functional ovaries, exhibit estrous behaviour, be able to mate, conceive, support fetal development, continue estrus cyclicity, and restore uterine function after calving (Filmon *et al.*, 2018). The rationale for reproductive management in dairy cattle is for cows to become pregnant in a viable manner and at a productive interval after calving (Dawit and Fesseha, 2020). Thus, high reproductive efficiency is essential for efficient dairy operations and requires a shorter calving interval that maximizes milk production in the herd. Good estrus detection, good insemination technique, quality semen, and a healthy uterine environment are essential components of high reproductive efficiency (Abunna *et al.*, 2018).

The reproductive performance of cows is one of the key parameters reflecting the economic success of dairy farming (Drillich and Wagener, 2018). The reproductive performance parameters are age at first service (AFS), age at first calving (AFC), calving interval (CI), day opens (DO), and number of services per conception (NSPC) (Dinkissa and Guye, 2022). Thus, the dairy industry needs a successful reproductive goal that includes 12 months of calving interval, 85 days open, 1.6 services per conception rate, and 85% of cows observed in estrus (Dawit and Fesseha, 2020).

However, a number of challenges including diseases, management, and the limited genetic potential of dairy cattle, are linked to low economic returns from dairy and dairy products (Lobago *et al.*, 2006; Gizaw *et al.*, 2007). These factors result in poor reproductive performance in dairy cattle (Dawit and Ahmed, 2013) due to disruption of ovulation as well as interference with fertilization and parturition (Gezu and Azage, 2018).

From constraints, the diseases have a negative impact on reproductive performances in dairy cows (Goto *et al.*, 2019). The foremost common diseases in dairy cows are periparturient disorders, mastitis, and lameness (Dobson *et al.*, 2007; Alexius, 2017). Periparturient disorders occur more often in dairy cows than other disorders (Shiferaw *et al.*, 2005). The important periparturient disorders in dairy cows comprise metritis, endometritis, hypocalcemia, dystocia, retained placenta, and ketosis (Ambaw *et al.*, 2017; Kabir *et al.*, 2022). These disorders in dairy cows adversely impact reproductive performance (Goto *et al.*, 2019) and significantly influence reproductive efficiency in a dairy herd (Qu *et al.*, 2014). Besides, they have impact on fertility and decreased milk output (Mellado *et al.*, 2018). Beyond this, other factors like pregnancy losses and calf mortality (Echternkamp *et al.*, 2007) collectively have a negative impact on reproduction (Fitzgerald *et al.*, 2014). These are essentially causing financial loss to the dairy industry due to slower uterine involution, decreased conception rate, prolonged calving to conception interval and calving interval, high cost of medication, drop in milk production, reduced calf crop, and early culling of possibly useful cows (Filimon *et al.*, 2018).

Another common disease in dairy farming is mastitis. Mastitis is an inflammation of the mammary gland. It is a common disease of dairy cattle and causes decreased milk yield over the

lifetime of the cow (Cheng and Han, 2020). Mastitis causes the death of animals, affects the quality of milk, leads to public wellbeing hazards and condemnation of milk, and subsequently leads to financial losses due to veterinary costs and the culling of chronically contaminated dairy animals in Ethiopia as well as other countries (Belay *et al.*, 2022). In addition, lameness is also an economically important disease in dairy cows. Lameness is an expression of pain, which can have several causes, including trauma, infectious diseases, and disfunction of one or more hooves or limbs (Bruijnis *et al.*, 2012). One of the key mechanisms by which lameness diminishes reproductive performance is interference with standing to mount. Lameness influences fertility at different stages of the reproductive cycle (Alawneh *et al.*, 2011). So, it has a negative impact on reproductive performance (Alsaad *et al.*, 2012). Dairy cows affected by these disorders fail to routinely and annually give birth to calves, which is caused by a reduction in the physiological function of reproductive organs (Tolosa *et al.*, 2021).

Reproductive inefficiency is one of the costliest issues facing the dairy industry nowadays (Ghavi, 2013). Reduced reproductive efficiency can decrease the profitability of dairy production by increasing days open, calving interval, the number of services per conception, culling rate, and veterinary services (Ibtisham *et al.*, 2018).

1.1. State of Problem

Livestock and their products are an important source of food, especially dairy products. The demand for dairy products is increasing due to increasing human population growth (Grout *et al.*, 2020). However, Ethiopian dairy production has been lower than expected, and many factors could explain this, including livestock competition for land, animal diseases, a shortage of feed, and poor genetic potential of dairy cows (Gizaw, 2021). Periparturient disorders, mastitis, and lameness often affect dairy production by declining reproductive performance (Arero, 2022). Therefore, these health problems constitute an obstacle to reproduction.

The calving interval, daily milk yield, days open, number of services per conception, age at first service, and age at first calving are some of the major measures of reproductive performance parameters for dairy cattle production (Ayalew *et al.*, 2018), but these parameters are below the

normal standard in dairy cattle production. Yet, several researchers studied only the prevalence of periparturient disorders, such as mastitis and lameness, but they were not focused on the impact of these disorders on reproductive performance. Besides, the absence of well documentation regarding reproductive performance and associated risk factors. In this manner, assessing the prevalence of periparturient disorders, mastitis, and lameness and understanding the impact of these problems on reproductive performance are critical focuses for finding practical solutions and suggesting longer-term alternatives for producers to improve reproductive performance of dairy cows. The hypothesis tested in the present study was that periparturient disorders, mastitis, and lameness have an impact on the reproductive performance of dairy cows. Thus, dairy cows affected by these disorders have lower reproductive performance than normal dairy cows.

Therefore, the objectives of this study were:

- To evaluate prevalence of periparturient disorders, mastitis and lameness in dairy cows and associated risk factors in study area.
- To investigate the impact of periparturient disorders, mastitis and lameness on reproductive performance of dairy cows in selected districts of Wolaita Zone, Southern Ethiopia.

2. LITERATURE REVIEW

2.1. Reproductive Performance

In the dairy cattle sector, reproductive performance is currently one of the main priorities. It is often a key factor in determining the biological and economic efficiency of livestock production in tropical regions (Ansari *et al.*, 2010). The reproductive efficiency of the breeding female is probably the most important component necessary for a sustainable milk production system (Niraj *et al.*, 2014). Reproductive performance can be represented by several key indicators such as age at first service and calving, conception rate, first service conception rate, breeding interval, number of services per conception, days open (DO), and calving interval (CI) (Mawarni *et al.*, 2022).

Several factors contribute to the declining fertility of dairy cattle. The effect of these factors on fertility varies from herd to herd and region to region. The causes of fertility decline in dairy cattle are multifactorial origin (Ayalew *et al.*, 2018). The most common factors causing the decline in reproductive performance are management, nutrition, and genetics (Dobson *et al.*, 2007).

The reproductive performance of dairy cows has been found to be below the normal standard desired for profitable milk production in various parts of Ethiopia. These undermining of reproductive performance had the potential to cause low reproduction and production in dairy cattle (Adisu and Zewdu, 2021). Improving the reproductive capacity of dairy cows should be considered to produce more efficient dairy cows, so that one calf per year can be achieved (Cardoso *et al.*, 2021). Since the genetic improvement of any trait depends in part on the heritability of that trait, and the accuracy of the heritability estimate increases by reducing environmental variation, adjusting performance records for known environmental effects should make selection more efficient (Hammoud *et al.*, 2010). Proper management in terms of nutrition, health care, housing, estrus detection, and timely insemination would improve reproductive performance in various production systems (Dinkissa and Guye, 2022).

2.1.1. Days Open

Days open is the period between calving and conception in dairy cows (Mulugeta and Belayneh, 2013). The ideal DO is thought to be between 60 and 80 days (Niraj *et al.*, 2014). A herd average of less than 85 open days shows that cows are being bred early; 85 to 115 days are considered ideal for the dairy herd; 116 to 130 days demonstrate slight problems; 131 to 145 days show moderate problems; and more than 145 open days are considered severe reproductive problems within the dairy herd (Tolasa and Andure, 2021).

It is influenced by the time it takes the uterus to fully involute, the return of the ovarian cycle to normal, the occurrence of silent ovulation, the precision with which the heat is detected, management, the quality of the semen, the skill of the inseminator, and the productivity of the bull (Abunna *et al.*, 2018). A longer period of time before the initial estrus and silent estrus may have contributed to the difficulties in detecting heat and convenient insemination of the cows, which led to delayed days open (Cabrera *et al.*, 2014).

The expanding days open in dairy cows due to reproductive disorders and diseases is very crucial issues in dairy farms (Goto *et al.*, 2019). Days open are significantly impacted by periparturient disorders, mastitis, and lameness in dairy cows. Periparturient disorders significantly impact on reproductive performance of dairy cows by lengthening the number of days open due to an delay uterine involution (Luchterhand *et al.*, 2016). Mastitis-infected animals in both zebu and crossbred cattle exhibited increased day open compared to healthy animals before first service or after first service due to toxic effects on reproductive organs (Manimaran *et al.*, 2014). Lameness has been negative impact on days open due to delayed ovarian cyclicity and estrus expression (Huxley, 2013).

Minimizing days open is financially invaluable (Temesgen *et al.*, 2022), by expanding the number of calves, increasing lifetime productive days, decreasing breeding costs, and decreasing culling rates (Cabrera *et al.*, 2014). A cow with great fertility is characterized by a short period of days open, encompasses a high probability of becoming pregnant when inseminated at the

correct time, shows strong signs of estrus, and has the capacity to carry the resulting fetus up to parturition (Abrham *et al.*, 2020).

The days open vary from region to region and area to area (Damitie *et al.*, 2016). The overall mean \pm SD of days opens in dairy cows in Bishoftu Town, Ethiopia, was 113.9 \pm 66 days (Abbuna *et al.*, 2018). The day opens for Horro and Horro x Jersey in sub-humid environments of Bako were 134 and 109 days, respectively. The DO of Friesian x zebu cattle in and around Gondar, northwestern Ethiopia, was 87 days (Nibret, 2012).

2.1.2. Age at First Service

The age of first service is the age at which cows reach the physical condition and sexual maturity required for first service. It is one of the most important reproductive performance parameters in dairy cattle (Novakovic *et al.*, 2011). The target age at first service is recommended at 18 months, when Holsteins are expected to reach approximately 300 kg and crossbreds are expected to reach 275 kg (Watanabe *et al.*, 2017). Body condition score, diseases and nutritional status of animals are main factors that affect age at first service. Age at the onset of puberty is correlated to body weight of dairy cows. Nutritional management resulting in poor body weight gain early in development causes reproductive problems because it delays the onset of puberty and further increase the age at first service (Abunna *et al.*, 2018).

Previous studies revealed that the mean age at first service varied in different study sites. The age of first service in indigenous dairy cows differed significantly ($P < 0.05$) in all production systems with mean values (41.34 \pm 12.23, 37.561 \pm 3.85 and 30.87 \pm 8.65) in rural, suburban, and urban settings, respectively (Tolasa and Andure, 2021). According to Nibret (2012), age at first service of crossbred cows in Asella tow was average age at 24.93 months. In addition, the average age of a local heifer at first service is 42.48 months, which is reported by Adebabay (2009) at Bure District. The mean age at first service of Ogaden heifers at Haramaya University was 34.4 \pm 2.28 months, with a minimum and maximum value of 22.6 and 51.5 months, respectively (Getinet *et al.*, 2009).

Belay *et al.* (2012) and Hunduma (2013) reported 24.3 and 24.9 months of age at first service in crossbred dairy cows under a small-scale milk production system in Jimma, and Asella, respectively. Age at first service in southern Ethiopia in the Sidama zone was 40.74 months (Yetera *et al.*, 2018).

2.1.3. Number of services per conception (NSPC)

NSPC is used as an indicator of fertility, and the optimal value is estimated between 1.6 and 1.8 (Borkowska *et al.*, 2012). For conceptions around 2, the number of services is still acceptable, but values above 3 indicate reproductive health problems (Siatka *et al.*, 2017).

Various factors affect NSPC, such as nutritional status of cows, physiological status, housing system in the farm, season, proper observation of heat and reproductive disorders (Cielava *et al.*, 2017). However, the main factors that affect NSPC are reproductive disorders and the heat detection system in the farm. If estrus detection is done correctly and the insemination process follows with good performance, it can improve insemination efficiency (Bujko *et al.*, 2013; Cielava *et al.*, 2014).

Several authors reported disease of the reproductive system is one of the main factors that affect the lifespan of dairy cows because required multiple inseminations per conception which further leads to culling from herd (Wathes *et al.*, 2008). Among the disorders, peri-parturient disorders have a negative impact on the number of services per conception (Nabenishi *et al.*, 2011). Besides, mastitis has a negative impact on the number of services per conception in Holstein-Friesian cows due to the disturbance of estrous cycle (Ahmadzadeh *et al.*, 2009). The elevated somatic cell count (SCC) in milk can cause delayed signs of estrus (Morris *et al.*, 2013). The period before first insemination found that the increase in SCC beyond 283 thousand/ml was accompanied by an increase in NSPC (Siatka *et al.*, 2017).

According to Vacek *et al.* (2007), there was significantly negative effect of mastitis on the number of services per conception in the Czech population of Holstein cows. The dairy cows affected by clinical mastitis per lactation exhibited higher SPC values (2.58) compared to those

with no or one incidence of subclinical mastitis (1.94 vs. 2.34, respectively). Furthermore, Gunay and Gunay (2008) observed that clinical mastitis increased SPC from 2.1 to 3.4 and 1.8 in the affected groups and normal cows, respectively, and identified this as a factor lowering fertility. The increased number of services per conception is often a result of the rising SCC (Lomander *et al.*, 2013).

The increase in number of services per conception often indicates problems in the livestock system, including negative effects on the profitability of farmers and culling (Honarvar *et al.*, 2010). With the increase in number of services per conception in the first calving came the increase in age at calving in later lactations, which lowers the number of potential lactations in the cow's life and also points to the problems associated with reproductive performance in farms. The NSPC was 1.76 times higher in the first lactation and 1.80 times higher in the fifth lactation than in any other period of lactation, with 56.7% and 55.5% of serviced cows pregnant, respectively (Lasma *et al.*, 2017).

Table 1: Number of services per conception in indigenous and cross breed cattle in Ethiopia

Breed	Location	NSPC	Sources
Local	Gondar, Ethiopia	2.2	Kumar <i>et al.</i> (2014)
Horro	in and around Horro-Guduru	2.1	Damissu <i>et al.</i> (2013)
Borena	Tatesa Cattle Breeding Center	1.6	Yifat <i>et al.</i> (2012)
Fogera	North West Ethiopia	1.28	Menale <i>et al.</i> (2011)
Horro-jersey	in and around Horro-Guduru	1.8	Damissu <i>et al.</i> (2013)

2.1.4. Age at first calving

The age at first calving is the time between birth and first calving. The heifers calve between 23 and 25 months of age, which is considered the optimal age to increase profitability in the dairy industry (Hammoud *et al.*, 2010). The first calving is an indicator of the beginning of a cow's productive life. Thus, the age of first calving changes a heifer from a non-productive, expensive

item to an income-generating cow. It is closely related to generation interval and, therefore, influences response to selection (Dayyani *et al.*, 2013). Nutrition, management, disease, and environmental conditions are common factors that affect age at first calving (Kelay, 2002).

Age at first calving had an impact on the productive and reproductive abilities of females by influencing reproductive efficiency and milk output (Gebrekidan *et al.*, 2012). In addition, it contains a critical impact on the total cost of raising dairy replacements, with calving heifers being more expensive to raise than younger heifers (Adisu and Zewdu, 2021). Early AFC reduces the unproductive period, and the higher the AFC causes higher the additional rearing cost of the animal (Panja and Taraphder, 2012). So, reduction in AFC can also improve farm profitability by increasing lifetime milk production and milk production per year of herd life (Lokamar *et al.*, 2020).

In indigenous breeds, the ideal first calving age is 3 years, but in crossbred cattle, it is 2 years. Longer age at first calving results in higher production during the first lactation but lower lactation period due to fewer calves during her lifetime. However, the age at first calving is below the ideal range, the newborn calves are weak, difficulty at time of parturition, and produce less milk during the first lactation (Ayalew *et al.*, 2018). Assemu *et al.* (2016), who reported the age at first calving for Horro and Fogera cows as 46.79 ± 1.03 and 42.3 months, respectively.

2.1.5. Calving Interval

The time period between two subsequent parturitions is referred to as the "calving interval" (CI) (Lokamar *et al.*, 2020). It is a fertility trait that can be used in selection programs to minimize factors that had the negative effects on fertility (Mostert *et al.*, 2010). It is probably the best indicator of reproductive efficiency and expresses the economic importance of reproduction. The calving interval is a key factor in the dairy industry that determines overall milk production and heavily influences by management and the environment (Mawarni *et al.*, 2020).

Theoretically, the CI could be approximately one year, with 285 days of gestation and 80 days of open (Bene *et al.*, 2022; Inchaisri *et al.*, 2010). To obtain this calving interval, a postpartum cow

has to restart ovarian activity, be detected in heat, be mated, and conceive within 85 days after calving (Temesgen *et al.*, 2022).

Though the calving interval is the best indicator of reproductive efficiency, extended calving intervals are one of the major problems that reduce the lifetime productivity of dairy herds (Belay *et al.*, 2012). Poor reproductive performance, manifested as prolonged calving intervals, can result in reduced milk yield, increased culling rates, and increased replacement costs (Gezu and Azage, 2018).

The profitability of milk production is strongly correlated with the calving interval. For profitable milk production, a CI of 365 days is typically regarded as optimal. If the calving interval is longer, cows have fewer calves overall and produce less milk overall throughout the course of their lives. Factors contributing to long-term CI are the age of cows, breed of cows, calving season, and forage availability in any particular year (Abrham *et al.*, 2020).

A 12-month calving interval is generally considered the most economically desirable period for dairy cows (Marai and Habeeb, 2010). However, such a standard lactation length might not work for smallholder dairy cows, in which the lactation length is extended considerably in most cases (Gezu and Azage, 2018). It has been a general practice among dairy farmers that calving intervals should be as short as possible to produce more offspring and achieve a higher milk yield per cow per day (Remmik *et al.*, 2020). On the other hand, shorter calving intervals also mean that cows spend a longer share of their productive life dry, and more calving also means more risk for postpartum diseases and disorders (Mellado *et al.*, 2018).

The rapid expansion of the breeding stocks depends in large part on the reproduction of dairy cows with frequent and short calving intervals (365–420 days) (Ayalew *et al.*, 2018). The longer CI may mainly be attributed to the result of longer CFSI and DO, which could be related to environmental factors, mismanagement practices like poor housing, poor nutrition, or failure to detect heat by the farmer (Tadesse *et al.*, 2010). Several studies showed that crossbreeds have a shorter calving interval than indigenous cattle (Cielava *et al.*, 2015). Another study that supports

this conclusion found that indigenous breeds have longer calving intervals than crossbreds (Mulugeta and Belayneh, 2013) and was reported in the North Showa zone.

The overall mean calving interval of dairy cows was found to be 23 ± 4.3 months, with local cows having a longer overall calving interval (24.94 ± 4.1 months) than crossbreed cows (22 ± 4.4 months), while local cows in the North Shoa zone had a shorter overall calving interval (Mulugeta and Belayneh, 2013). The overall calving interval in the Gojam zone is greater in the urban production system (26.72 ± 6.55 months) than in the peri-urban (20.52 ± 3.78 months) and urban (19.20 ± 2.33).

Among the indigenous cattle breeds of Ethiopia, the shortest calving interval (CI) was recorded from the Horo breed of cattle, with an average calving interval of 13.59 ± 0.26 months, and it is characterized by good reproductive efficiencies (Adisu and Zewdu, 2021). The average CI was observed for the Arsi breed in Ethiopia and for local cows in Chacha Town and a few surrounding selected kebeles in the North Shoa Zone of the Amhara Region of Ethiopia (24.9 ± 4.1 months) (Mulugeta and Belayneh, 2013).

Table 2: Calving interval of dairy cows in different part of Ethiopia

No	Breed	Calving Interval	References
1	Fogera	21.18 ± 0.7	(Centers for Disease Control and Prevention, 2020)
2	Arsi	14.2 and 45	(World Health Organization, 2020)
3	Horro	13.59 ± 0.26	(Hussien and Siddappa, 2020)
4	Boran	20.8	(Lu <i>et al.</i> , 2020)
5	High land zebu	15.1	(World Health Organization, 2020)
6	Ogaden	16.4	(Cui <i>et al.</i> , 2019)

2.2. Periparturient Disorders

Periparturient disorders are the most frequent issues influencing dairy cows' reproductive efficiency. These problems are responsible for reducing milk yield and the subsequent decline in reproductive performance of dairy cows, which ultimately causes premature and forced culling of high-producing dairy cows (Amene *et al.*, 2021). The presence of these problems results in considerable economic loss to the dairy industry due to a lesser number of calf crops, slower uterine involution, prolonged inter-conception and calving intervals, early decrease of potentially used cows, decreased milk yield per lactation. In addition, they can be cause decline overall lifetime production, and increased costs due to veterinary services and earlier culling of cows (Bahlibi, 2015).

Among the major periparturient disorders that have a direct impact on the reproductive performance of dairy cows are abortion, dystocia, retained fetal membrane, pyometra, metritis, and prolapse. They are classified as before parturition, during parturition (abortion, vaginal prolapse, and dystocia), and after parturition (retained fetal membrane and uterine prolapse) (Wujira and Nibret, 2016) which found to be the leading reproductive problems (Tagesu, 2018).

2.2.1. Dystocia

Dystocia is called “difficult delivery”. Dystocia is opposed to eutocia, and requires assistance varying from slight to extreme during delivery (Bicalho *et al.*, 2007; Kebede *et al.*, 2017). Dystocia occurs when the size of the fetus is incompatible with the size of the pelvic opening of the cow, when the fetus is abnormally presented (breeched, head, or foot back), or when the cow does not experience normal parturition due to weakness, stress, or hormonal abnormalities (Gaafar *et al.*, 2011).

An understanding of the effects of parturition and dystocia on perinatal calf viability is paramount for the development of breeding and calving programmed that will minimize calf losses (Wujira and Nibret, 2016). Dystocia is one of the leading causes of calf mortality in cattle.

Dystocia is an undesirable reproductive event resulting in an increased risk of calf morbidity and mortality (Bicalho *et al.*, 2007) especially in neonatal period (Lombard *et al.*, 2007).

Dystocia has a direct negative impact on calves by causing prolonged hypoxia, significant acidosis, lethargy, and increased stillbirths. Calves born to dams that suffered from dystocia were five times more likely to die neonatally than those following normal calving (Noakes *et al.*, 2018). In addition to the greater mortality and morbidity of calves, there is some evidence that dystocia may have long-term implications for the performance of dairy heifer calves. High-yielding cows in early lactation experience the most production losses, which may be related to decreased consumption of dry matter (Newby *et al.*, 2010).

Etiology of dystocia

The causes of dystocia are categorized into maternal and fetal origins. Problems with the dam that impede or prevent delivery include a lack of expulsive force, incomplete cervical dilatation, irreducible uterine torsion, pelvic deformities, and uterine tears (Newman and Anderson, 2005). Hypocalcemia can be also cause of dystocia. The cause of uterine torsion is unknown, but it is sometimes associated with uterine instability and motion (Newman, 2008).

Other causes of dystocia are fetal origin. Deviation of the head and flexion of the various joints in anterior presentation, flexion of both hind limbs (breech) in posterior presentation, or twins may cause dystocia (Roberts, 2004). The most important fetal cause of dystocia is fetal oversize. The most common cause of dystocia in cattle, particularly heifers, is feto-pelvic disproportion, which can result from calves being too large for the size of the mother's pelvis (Noakes, 2009). Another fetal cause of dystocia is fetal maldisposition (Purohit *et al.*, 2011). Abnormal fetal position most commonly presents as posterior malpresentation, foreleg malposition, breech malpresentation, or cranial malposition (Noakes, 2009). The third-most common fetal cause of dystocia is twinning. Multiple calving is more difficult than single calving (Gaafar *et al.*, 2011). Cows with twins have a shorter gestation length and more dystocia (Olson *et al.*, 2009).

Epidemiology of Dystocia

The incidence of dystocia in cattle has been widely studied because of its effects on productivity. Compared to beef cattle, it is less frequent in dairy cattle. Breed, parity, the calf's sex, birth weight, the size of pelvis, the gestation period, nutrition, the year, and the calving season are a few of the variables that might affect dystocia (Noakes *et al.*, 2009).

In addition, however, genetic, environmental, and periparturient management are additional factors that have varying degrees of influence on dystocia. Species and breeds had effect on the occurrence of dystocia. The most frequently affected species are cattle. Dystocia occurs more frequently in dairy cows with calved male calves than in those with calved female calves and in primiparous than in multiparas (Arnott *et al.*, 2014).

Clinical manifestations of dystocia

Specific signs of dystocia are prolonged, nonprogressive, the cow standing in an abnormal posture during first-stage labor and the cow may stand with a dipped back in the saw horse posture in cases of uterine torsion, and failure of the calf to be delivered within 2 hours of the amnion appearing at the vulva (Weldeyohanes and Fesseha, 2020).

On onset of labor without delivery of the fetus and/or fetal membranes and later regression of parturition signs, showing signs of mild discomfort, the animal may adopt a rocking horse stance and show mild colic pain (Purohit *et al.*, 2011).

Diagnosis of Dystocia

Dystocia is diagnosed based on the history and physical examination (Momont, 2005). As a result, the owner should be questioned about the case's brief history (Purohit *et al.*, 2012).

In order to identify whether the fetus is alive or dead, it needs to be examined. The reaction movements in the natural orifices, such as the tongue reflex after grasping it, the jaw movement,

the eyelid reflex, sphincter contraction, and pulse in the umbilical arteries, indicate the presence of a viable fetus (Abera, 2017).

Treatment and Management of Dystocia

Medical management

It may be considered based on whether the dam and fetuses are stable, fetal position and presentation, and the presence or absence of obstruction (Abdullah *et al.*, 2015). When dystocia is suspected, the administration of specialized ecbolic medications like oxytocin, calcium, and glucose therapy may be necessary. Antibiotics and nonsteroidal anti-inflammatory medications are prescribed in cases of uterine torsion (Kahn, 2005). To cause uterine contractions, which may be helpful for uterine contents ejection, prostaglandin F₂ alpha and its analogues are advised (Beagley *et al.*, 2010).

Obstetrical Operations

The main goals of obstetric procedures are to deliver a healthy fetus and protect the dam (Vermunt, 2008). The four main categories of obstetric procedures are caesarean section, fetotomy, forcible extraction, and mutation (Benesch, 2001).

Mutation is defined as those operations by which a fetus is returned to a normal presentation, position, and posture by repulsion, rotation, version, and extension of the extremities (Roberts, 2004). Forced extraction is the removal of the fetus from the mother's birth canal with the use of force. Obstetric chains or ropes around the calf's pastern can be utilized to accomplish controlled traction. For forced traction, vaginal lubrication is essential (Kurnar, 2009).

A fetotomy is a procedure in which a fetus is divided into two or more sections inside the uterus and vagina (Patil *et al.*, 2014) in order to lower its size and make delivery through the birth canal possible (Noakes, 2001). Caesarean section refers to the laparohysterotomy procedure that is typically used to deliver the fetus at parturition (Kumar, 2009). The objectives of the caesarean

section are to preserve the dam and calf as well as maximize the dam's potential for future reproduction (Newman and Anderson, 2005).

Prevention and Control Measures

Preventing and reducing the incidence of dystocia is essential in dairy farms. This can be avoided with proper breeding management and good farming practices. Heifers are susceptible to dystocia since they are typically smaller size than cows. Heifers should be born with an average body weight of at least 60% of their adult weight (Noakes *et al.*, 2018).

Pelvic assessment is very important method of preventing dystocia. Heifer with at least 11 centimeters wide and 12 centimeters high pelvic size before the breeding season can be selected to be mixed with bulls that calve easily. Bulls can be easily selected at calving and can estimate birth weight. Heifers with a smaller size of pelvic width and height should be targeted for culling from herd (Lamb, 2012).

Regular monitoring of dairy cows in farms should be provided. Producers should be well trained to properly respond to dystocia and to know when to call a veterinarian (Schuenemann, 2012). The well nutrition program helps control problems associated with mineral deficiencies (Kahn, 2005; Anderson, 2012).

2.2.2. Retained placenta

The fetal membranes normally expel within 8 hours after the calf is delivered. The transition period is manifested by a high incidence of both metabolic and infectious diseases (Dervishi *et al.*, 2016). Retained placenta is defined as the failure of the fetal membranes to be expelled within 24 hours of calving in cows. It can occur due to different conditions such as immune suppression, infections, elevated lipid mobilization, and a depleted status of antioxidants, including tocopherol, and it raises the risk of other diseases in the early stages of lactation (Mohammad *et al.*, 2011).

Retained placenta causes the dairy sector to suffer significant financial losses by lengthening days open, services per conception, and days from calving to first service. Besides, it increases the risk of mastitis, which reduces milk output and increases the likelihood of metritis and infertility (Huzzey *et al.*, 2009). With an estimated cost of \$285 per case and an average incidence rate of retained placenta of 7.8%, this condition is regarded as a financially significant problem for the dairy industry (Ametaj *et al.*, 2010).

Etiology of retained placenta

Both infectious and non-infectious diseases can result in retained placenta (Mohammad *et al.*, 2011). Infectious diseases such as brucellosis, leptospirosis, infectious bovine rhinotracheitis virus, pine needle abortion, and bovine virus diarrhea can induce retained placentas in dairy cows (Aulakh *et al.*, 2008). The hormonal and metabolic changes necessary for normal placental delivery imply that disruption of one or more of these processes can result in placental retention (Beagley *et al.*, 2010). Hereditary stress, inbreeding, and obesity are among management-related reasons of retained placenta (Amin and Hussein, 2022).

Pathogenesis of retained placenta

Inconsistent cartilage-cotyledon connection after birth is the primary contributor to retained placenta. It happens because the mother's immune system is unable to completely eliminate the placenta at the end of pregnancy (Frazer, 2005). The cortisol levels rise dramatically during the periparturient phase, especially the day before calving. An effective immune suppressant is cortisol. When an animal is stressed, this hormone limits leukocyte development and their functions. Reduced neutrophil phagocytosis, reduced lymphocyte cytotoxicity, and suppressed activity of their cytokines all work together to prevent the normal, efficient maternal immune recognition and rejection of fetal membranes which expressed by trophoblast cells and ultimately cause their retention in cows (Mordak and Stewart, 2015).

Clinical manifestation

The cow was bright, alert, and brilliant. The normal ranges for temperature, pulse, and respiration were observed. The reddish discharge coming from the vulva entry is the most prominent clinical sign. The case was identified as having a retained placenta based on the history and clinical signs (Bitrus *et al.*, 2016).

Treatment

The treatment plan in this case includes the removal of the retained placenta, which could affect the cow's capacity to reproduce in the future. An intrauterine lavage is advised since the case involves a retained placenta (Brahmanand and Sharm, 2022). A modified intravenous line is inserted via the vulva into the uterine body to wash the uterus with 0.9% NaCL. The brownish, foul-smelling discharges are flushed out by continuous flushing of 0.9% NaCL. As a final lavage, oxytetracycline (20 mg/kg) is flushed into the uterine body. During the course of treatment, flunixin meglumine is administered intramuscularly once day for three days as an anti-inflammatory, anti-pyretic, and analgesic. To treat present infections and prevent secondary bacterial infections, a broad-spectrum, long-acting oxytetracycline (20 mg/kg) antibiotic is also administered intramuscularly once (Dervishi *et al.*, 2016). Prostaglandins and oxytocin are the two hormone products that are most frequently used to treat RP. Due to their role in uterine contractions, these compounds may be useful in the treatment of RP brought on by uterine inertia (Opsomer and Kruif, 2009).

2.2.3. Hypocalcemia

It is defined as a deficit in blood calcium concentration. When the blood calcium content falls below 2.0 mmol/l, it happens in a variety of livestock species, including cattle, goats, and sheep (Quader *et al.*, 2017). It is regarded as the most significant abnormality of the macro-mineral metabolism in transition dairy cows. The main cause of this metabolic disease is an imbalance between Ca in milk and Ca influx from the gut and bone to the extracellular pool (Radostits *et al.*, 2007). The increasing incidence of disorders in the transition period is strongly correlated

with the development of hypocalcemia in dairy cows. Dairy cows with hypocalcemia are up to eight times more likely to develop mastitis in the following lactation, three times more likely to develop dystocia, and two to four times more likely to develop displaced abomasum (Rizk *et al.*, 2020).

Hypocalcemia greatly reduces milk production, rumen motility, and abomasal motility, which further increases the risk of abomasal displacement. It also reduces feed intake so that increased body fat mobilization occurs in early lactation and directly impairs immune cells' responses to an activating stimulus (Inoue *et al.*, 2006).

Etiology of hypocalcemia

Hypocalcemia can be caused by hypoparathyroidism, and problems with vitamin D action and metabolism (Schafer and Shoback, 2016).

Pathogenesis of hypocalcemia

As an endocrine system involved in calcium homeostasis, calcitonin is secreted when elevates blood calcium, while parathyroid hormone is secreted when circulatory calcium concentration decreases (Priyantha, 2021). The level of calcium in plasma is well regulated, and when the level decreases, the parathyroid gland will excrete parathyroid hormone (PTH). This increases the mobilization of calcium from the skeleton and also raises the renal threshold for calcium in the kidneys (Nuraddis and Manzoor, 2021).

Changes in Ca metabolism induced by lactation are more significant than parturition in the pathogenesis of parturient paresis, as the loss of blood Ca to milk may exceed 50 g per day. Before calving, the approximate daily requirement for Ca is only 30 g, comprising 15 g in fecal and urinary loss and 15 g in fetal growth. This demand for Ca may only be satisfied by increasing absorption from the rumen or intestines and increasing mobilization from tissue (Schafer and Shoback, 2016).

However, calcium demand is 50g per day at lactation; the rest of the calcium needs to be supplemented. When intake and homeostatic mechanisms cannot meet the increased demands for calcium metabolism, the pathogenesis of hypocalcemia is initiated.

Clinical presentation of hypocalcemia

Clinical signs of hypocalcemia in dairy cattle range from reduced voluntary dry matter intake to paresis and can even lead to death (Mamaril *et al.*, 2022). The clinical signs of hypocalcemia are divided into three stages (Bhanugopan *et al.*, 2014).

In stage I, the cow does not show paresis; it may even go unnoticed; its signs are tenuous and transient. In addition, we can see hypersensitivity, nervousness, excitability, muscle tremors, anorexia, ataxia, and general weakness. Some cows lose weight quickly and drag their hind limbs. If the animal avoids walking or moving, body temperature can be normal (Arechiga *et al.*, 2022).

Stage II (Sternal Recumbency): Cows in Stage II hypocalcemia are down but not flat out on their side. They exhibit moderate to severe depression, partial paralysis, and typically lie with their heads turned into their flanks (Samuel *et al.*, 2012). This is frequently seen with lateral kinks or S-shaped neck curvatures (Tadesse and Belete, 2015). Affected Cow's temperature is subnormal, muzzle dry, coldness of skin and extremities. The heart rate can be rapid, exceeding 100 beats per minute; gastrointestinal atony predisposes to constipation and mild bloating; in addition, the animal exhibits incoordination when walking (Nuraddis and Manzoor, 2021).

Stage III hypocalcemia causes cows to gradually lose consciousness until they are in a coma. They can't keep their sternal recumbency and can only lie flat on their sides (Patel *et al.*, 2011). They can have considerable bloat, have extremely flaccid muscles, and possibly be unresponsive to stimulation. Heart rate can increase to 120 bpm as cardiac output declines, and peripheral pulses may go undetected. Cows at stage 3 may only survive for a short time if untreated (Cariappa *et al.*, 2021).

Treatment of hypocalcemia

Treatment is simple, as is the application of calcium, and the clinical response is also being considered satisfactory, totally based on the stage of the disease. Intravenous administration of calcium borogluconate with or without magnesium is common practice in the treatment of milk fever in dairy cows. However, calcium borogluconate alone was shown to be sufficient for the treatment purpose in dairy cows (Sasaki *et al.*, 2013). Supportive treatment with electrolytes, vitamins, and glucose is also recommended and practiced for a better prognosis. Anti-inflammatory drugs and glucocorticoids are also recommended to minimize tissue injuries and prevent stress factors (Priyantha, 2021).

In the case of phase I hypocalcemia, oral CaCl_2 is given for dairy cows. These are commercially available and preferable to calcium drenches that are more likely to be aspirated. Most formulations contain 40–50 g of calcium per dose as a CaCl_2 salt; some formulations also have CaSO_4 included. Oral calcium increases the serum calcium concentration within 5 minutes and stays elevated for approximately 6 hours. Retreat at 12–24 hours, but don't exceed 120 g of calcium in a 24-hour period. However, in phases II and III, Intravenous calcium (as calcium gluconate, 23%). Borogluconate and calcium salts are preferred to chloride salts because they are much less irritating to tissues. The approximate dose is 2.2 g of calcium per 100 kg of body weight, with cardiac monitoring by auscultation during administration (Constable, 2022).

Prevention

There are many methods that can be used to prevent hypocalcemia. These principles can be applied at different times, such as late pregnancy and after calving (Zaidi, 2016). Some control principles are used for prevention, such as oral drenching with calcium before calving, managing vitamin D and its metabolites and analogues intake and administration before calving, controlling body condition, controlling dietary magnesium and dietary carbohydrate intake peripartum, shortening the dry period, prepartum milking, and reduced milking in early lactation (Kocabagli, 2018). In addition, the most important cause of milk fever is the high K in the dry

period due to the use of high amounts of leguminous roughages or unsuitable mineral additives (Kocabagli, 2012).

2.2.4. Ketosis

It is a common metabolic disease that affects dairy cattle in the last trimester of pregnancy and the first few weeks of lactation (Gulinski, 2021). The development of a significant imbalance between the supply and demand of glucose is most likely the triggering factor. The result of this imbalance is a reduction in insulin secretion, an increase in fat mobilization, and an increase in hepatic ketogenesis (Asrat *et al.*, 2013),

Etiology of ketosis

The period between late pregnancy and early lactation is undoubtedly a time when metabolic problems caused by diet, like ketosis and fatty liver in dairy cows, are more common. Periparturient dairy cows are often in a state of NEB that is induced by a low intake of dry matter and an increased demand for energy to support milk production (Shin *et al.*, 2015), which result in the mobilization of body fat reserves and hypoglycemia (Elitok *et al.*, 2010). Any factors resulting in a reduction in dry matter intake (DMI) increase the risk of ketosis. Around calving, lactating dairy cows naturally decrease DMI due to the advanced stage of gestation as well as metabolic changes that occur in the transition period. This decrease in DMI typically leads to NEB, which results in impaired metabolism of carbohydrates and fatty acids that leads to excessive production of ketone bodies (Tadesse, 2019; Seifi *et al.*, 2011) because dairy cows to require more glucose and produce less propionate in the early postpartum period (Bansod *et al.*, 2022). Biochemical and hormonal factors, as well as the significance of risk factors for disease onset, can contribute to ketosis (Duffield *et al.*, 2009).

Silage containing a high content of butyric acid is also a cause of ketosis (Bansod *et al.*, 2022). Hay crop silages chopped too wet or those low in water-soluble carbohydrates favour the growth of *Clostridium sp.* bacteria. *Clostridium sp.* bacteria convert sugars or lactic acid to butyric acid,

which can disturb metabolism. Thus, butyric acid concentrations of more than 0.1% of DM in silage could result in a loss of energy (Samiei *et al.*, 2015).

Factors like low nutrition, age, heredity, poor body condition score, and impaired energy balance are possible causes of NEB that may lead to periparturient fatty liver and ketosis. The NEB of cows during the prepartum period renders them more vulnerable to developing displacement of abomasum, impaired lactation, and poor reproductive performance (Kushwah *et al.*, 2020).

Clinical manifestation of ketosis

Clinical signs include weight loss, hypoglycemia, hyperketonemia, decreased milk production (Elitok *et al.*, 2010), and acetone odour in their mouth and urine (Gulinski, 2021).

Treatment

Cows can recover from ketosis on their own. However, it takes a long time to recover from the condition, which results in financial loss because the affected cow produces less milk while recovering. Hence, prompt medical attention is required (Gordon *et al.*, 2013).

Increasing the cow's feed intake is one method of management for bovine ketosis, while other methods include injection of intravenous dextrose solutions, glucocorticoids, and oral propylene glycol. If a cow is largely or completely anorexic, treatment usually begins with an intravenous injection of glucose or possibly fructose (Getachew, 2019).

The intravenous injection of 500 mL of 50% dextrose solution for two days is the most effective with respect to early recovery time and restoration of milk yield in comparison to others such as sodium propionate, nicotinic acid, methionine, and propylene glycol (Kushwah *et al.*, 2020).

Prevention

The mainstay of efficient prevention is ensuring that cows have continual access to regular nourishment that is well-balanced, has high-quality ingredients and contains sufficient amounts of carbohydrates (Ranaraja *et al.*, 2016). Keeping cows in good health throughout the perinatal period is crucial for prevention of ketosis. During this time, body conditions should range from 3.0 to 3.5, as assessed in the five-point body condition scoring (BCS) system (Gulinski *et al.*, 2021).

2.2.5. Endometritis

Endometritis is an inflammation of the inner lining of the uterus that doesn't cause visible signs but merely reaches as deeply as the stratum spongiosum. There are two forms of endometritis. These are clinical endometritis and subclinical endometritis. Clinical endometritis is manifested by mucopurulent or purulent discharge via vagina within 21 to 90 days following delivery (Tayebwa *et al.*, 2015). In the absence of any clinical signs, subclinical endometritis is defined according to the stage of postpartum by the presence of >8% neutrophils in uterine cytological samples 21–33 days postpartum, >6% neutrophils at 34–46 days postpartum, or >4% neutrophils after 48 days postpartum (Madoz *et al.*, 2014).

Clinical and subclinical endometritis negatively affect the performance of the world's dairy industry, economic losses are related to delay in the resumption of ovarian activity, increased number of services per conception, decreased milk yield, costs of treatment of the disease (Leblanc, 2014), increased days to first service and days open, and decreased conception rate (Ribeiro *et al.*, 2013).

Etiology

Endometritis is considered a multifactorial disease with many factors having a direct, indirect, determining, or predisposing influence. Many factors have been reported to be responsible for the occurrence of endometritis. Among factors, the most common are dystocia, twins, induction of parturition, retention of the fetal membranes and restoration of the ovarian cyclical activity, milk yield, metabolic diseases, and bacterial contamination of the uterus (Kumar *et al.*, 2020).

Among the pathogenic bacteria, the most common that cause endometritis include *Escherichia coli*, *Arcanobacterium pyogenes*, *Fusobacterium necrophorum*, *Bacteroides spp.*, *Staphylococcus spp.*, *Pasteurella species*, *Haemophilus somnus*, *Pseudomonas aeruginosa*, *Clostridium spp.*, and *Streptococcus spp.* Among them, *Arcanobacterium pyogenes*, coliforms, gramme-negative anaerobes, *Fusobacterium*, and *Bacteroides species* are commonly encountered (Negasee, 2020). However, *Escherichia coli* and *Trueperella pyogenes* are the most frequently isolated bacteria from the uterine lumen in cows with uterine infections (Arundhat *et al.*, 2015).

Clinical manifestation

Acute endometritis is usually found after 21 days postpartum with a large number of uterine exudates containing a foul-smelling red and brown watery fluid (Deori *et al.*, 2015). Chronic endometritis is observed in animals from 21 days after parturition with an abnormal mucopurulent or purulent vaginal discharge or clear mucus with flakes of pus, cloudy mucus, or mucopurulent discharge and a uterus not fully involuted (Dobson *et al.*, 2007).

Diagnosis

The classical diagnosis of endometritis on the basis of clinical manifestation and rectal examination is common. Ultrasonography and a new diagnostic tool (Metricheck) are appropriate for the diagnosis of endometritis. The most common diagnostic technique for

endometritis in clinical practice is rectal palpation, whereas vaginoscopy is an uncommonly employed diagnostic tool (Parmar, 2021).

Treatment

Good management practices in the prepartum period can minimize or even avoid cow uterine infections and prevent the prevalence of endometritis (Arundhat *et al.*, 2015). In contrast, suboptimal management of transition cows exposes susceptible cows to uterine diseases in which endometritis is important (Kumar *et al.*, 2020).

A single intramuscular injection of 20 mg/kg of oxytetracycline can be used to treat uterine bacterial disease infections (Arundhat *et al.*, 2015). Penicillin is one of the most widely used antibiotics for endometritis because it may penetrate all layers of the uterus and kill the majority of bacteria that enter the endometrium (Negasee, 2020).

2.2.6. Metritis

It is an infection of the uterus that develops after delivery and affects both the endometrial and muscular layers of the uterus (Arundhat *et al.*, 2015; Negasee, 2020). The majority of instances happened in the first 10 to 14 days following delivery (Deori *et al.*, 2015). It causes a great economic loss to the farmers, especially in multiparous dairy cattle, as a result of a decrease in reproductive performance due to delayed uterine involution, an increase in calving interval, days open, and the number of services per conception (Molina and Lucy, 2018; Toni *et al.*, 2015).

Etiology of metritis

According to Deori and Phookan (2015), bacteria that cause venereal dysfunctions, such as *Tritrichomonas foetus* and *Campylobacter foetus* may persist for months in the female reproductive system and cause uterine infections. Bovine Herpesvirus-1 and the agents of *Bovine Viral Diarrhoea-Mucosal Disease* and *Parainfluenza* are examples of viral pathogens that have also been linked to the development of bovine uterine infections and well-defined clinical

scenarios that are likely to affect the reproductive system (Pantaleo *et al.*, 2014). As reported by Ordell *et al.* (2016), *Escherichia coli* was the most common bacterial pathogen isolated from the uterus in cases of metritis.

Clinical manifestation

Puerperal metritis is defined as having an enlarged uterus, fetid watery red-brown vaginal discharge (VD), fever, and signs of a systemic condition. Clinical metritis is defined as having an enlarged uterus and fetid watery red-brown vaginal discharge but no signs of a systemic disease (Giuliodori *et al.*, 2013).

Animals with metritis exhibit both local and general signs. The metritis affected cows can develop pyrexia, septicemia, and toxemia. Although it is more frequently below average, the affected cows' temperatures can rise to 40 to 41°C. There is an enhanced respiration rate and a high pulse rate (about 100/minute) (Duricic *et al.*, 2014).

Treatment of metritis

Ceftiofur sodium at a rate of 1 mg/kg IM may be used as systemic antibiotic therapy for 3–5 days with no withdrawal requirement. Ceftiofur sodium has been reported to concentrate in the uterus at levels exceeding the mean inhibitory concentrations for *Arcanobacterium pyogenes*, *Fusobacterium necrophorum*, and *Escherichia coli* (Balasundaran *et al.*, 2011). Ceftiofur was given at a dose of 2.2 mg/kg daily for 5 days, along with procaine penicillin G or procaine penicillin G plus intrauterine infusion of oxytetracycline, in research involving cows suffering from postpartum metritis (Duricic *et al.*, 2012).

When Corpus Luteum (CL) is present in one of the ovaries, treatment with prostaglandins or their equivalents is particularly efficient in emptying the uterus by uterine contraction. When the cows are about 30–45 days old, prostaglandins can be helpful. It will aid in uterine discharge and trigger the cows' initial postpartum estrus. Oxytocin is yet another hormone that may be employed. In essence, it is critical for uterine contraction when calving. Although it continues to

elicit uterine contractions for a few days after calving, it is debatable whether it enhances postpartum reproductive capacity (Deori and Phookan, 2015).

2.3. Mastitis

Mastitis is a condition when the udder becomes inflamed. It is of particular concern for farmers in developing countries like Ethiopia (Abebe *et al.*, 2016; Nielsen *et al.*, 2010). It is the most widespread and costly disease in dairy cattle occurring throughout the world, causing economic losses due to reduced yield and poor quality of milk (Cheng and Han, 2020; Ejeta *et al.*, 2022) because of a 30% reduction in productivity per affected quarter and a 15% reduction in production cows or lactations (Kefele and Biruk, 2018).

2.3.1. Etiology

Mastitis is caused by various type of pathogens. Classically, mastitis pathogens have been classified as contagious pathogens and environmental pathogens (Burvenich *et al.*, 2003). For this reason, mastitis can be classified into contagious and environmental mastitis. The contagious pathogens are adapted to survive within the host, particularly within the mammary gland. The major contagious pathogens comprise *Streptococcus aureus*, *Streptococcus dysgalactiae*, and *Streptococcus agalactiae*. During milking, contagious pathogens are transmitted from cow to cow (Abebe *et al.*, 2016).

In contrast, environmental pathogens are best described as opportunistic invaders of the mammary gland, not adapted to survival within the host; typically, they invade, multiply, form a host immune response, and are rapidly eliminated. Environmental pathogens found generally in the digestive tract of cattle or their surroundings, such as faces, soil, bedding material, and manure (Kumbe *et al.*, 2020). This increases the probability of infection of the mammary glands, leading to clinical mastitis (Charlene, 2013). The major environmental pathogens are gram-negative bacteria that are typically present in the environment, such as *Escherichia coli*, *Klebsiella spp.*, *Enterobacter spp.*, *Serratia spp.*, *Pseudomonas spp.*, and *Proteus spp.*, as well as

some gramme-positive bacteria that cause mild to moderate mastitis, such as *Streptococcus uberis* and *Streptococcus dysgalactiae* (Tarazona *et al.*, 2019).

2.3.2. Prevalence of bovine mastitis in Ethiopia

Bovine mastitis is one of the conditions that affect dairy cows most frequently, according to various studies conducted in Ethiopia. According to studies by Abera *et al.* (2010); Girma *et al.* (2012); Belayneh *et al.* (2013); Zeryehun *et al.* (2013); Lidet *et al.* (2013) the estimated prevalence of mastitis at the cow level in the nation ranges from 23.2 to 81.1%. Besides, 75.22% of dairy cows affected was reported by Sori *et al.* (2010) in Jimma Town, south-west Ethiopia. Mastitis was prevalent in 68.11% of the population at the Alage ATVET College Dairy Farm in southern Ethiopia, as reported by Tuke *et al.* (2017). According to Zeryehun *et al.* (2013), 74.3% of small-scale dairy farms in and near Addis Ababa, Ethiopia, had mastitis. Zeryehun and Abera (2017) observed that the prevalence of mastitis was 64.3% in some regions in the eastern Harrarghe Zone of eastern Ethiopia. According to dairy farms in and near Bahir Dar, Ethiopia, exhibit a 12.3% prevalence of bovine mastitis. Bahir Dar (12.3%) (Bitew *et al.*, 2010), SNNPR (40.40%) (Deogo and Tareke, 2003); Ambo (41.7%) (Kebebew and Jorga, 2016); Holeta (44.1%) (Delelesse, 2010); Tigray (45.5%) (Baraki *et al.*, 2021); and from the central Ethiopian highlands (46.6%) (Mungube *et al.*, 2004) are some of the studies that were recently studied. It is obvious that the prevalence of mastitis might differ from region to region in Ethiopia due to the country's different agro-ecological circumstances (Fesseha *et al.*, 2021).

2.3.3. Risk factors associated with masititis

According to Baraki *et al.* (2021), the three categories of potential risk factors for mastitis on dairy farms include quarter, cow, and environmental risk factors, parity, season, stage of lactation, and teat end form are the risk factors for periparturient diseases, metabolic disorders, and mastitis (Zeryehun and Abera, 2017)

Teat end shape: Changes in the teat tissue near the teat orifice may make it more likely for bacteria to enter the udder and put the cow at risk for mastitis. When bacteria have passed

through the teat canal, they may be moved to the quarter cistern and milk ducts by compression of the teat cistern during pulsation. There is a good chance that those germs will be flushed out later on during milking if this occurs in the early stages of milking (Masoud *et al.*, 2011).

Mastitis occurrence and teat end morphology are strongly correlated. When compared to cows with pointed teat ends, cows with flat or round teat ends were approximately 8 times likely to occurring mastitis. This result may be explained by the presence of wider streak canals in teats with rounded or flat ends, which allow more pathogen penetration (Yuki *et al.*, 2020).

Season of year: Seasons and the prevalence of mastitis are related. Mastitis is more common during the wet seasons, which may indicate that inadequate sanitation is a contributing factor. Cows were kept in soiled, muddy common barns on semi-intensive and extensive dairy farms, where the bedding materials encouraged the growth and spread of mastitis bacteria (Lundberg, 2015). Therefore, the cleanliness of milking is substantially correlated with the prevalence of mastitis. Cows at farms with poor milking hygiene standards suffer more harm than those at farms with excellent milking hygiene standards. This might be caused by improper cleaning of the udders which could act as transmission vectors, particularly for infectious mastitis (Ismael, 2018).

Stage of lactation: the early stage and the period of involution of the mammary glands were the most susceptible stages. This is possibly due to the absence of a dry cow therapy regime, which is considered a major factor contributing to the high prevalence at early lactation (Ismael, 2018).

Breed: The occurrence of mastitis and the breed of animals are strongly correlated. Due to variations in the physiological and anatomical features of the mammary glands, breeds may have an impact on the prevalence of mastitis (Demelash *et al.*, 2003). According to a previous study, there is a significant association between breed and the presence of mastitis. The occurrence of mastitis was 16.4 times higher in Holstein-Friesian x Zebu crosses than in pure local Zebu cattle. This shows that pure local breeds are more resistant to contracting mastitis than European breeds (Abebe *et al.*, 2016). This is due to different innate immune responses between local breeds and

exotic breeds. Thus, the immunity potential of local breeds is higher than that of exotic breeds (Diego and Helio, 2011).

Age: The prevalence of mastitis was also linked with the age of dairy cows, being higher in animals of old age. The prevalence of mastitis is increasing with the age of dairy cows. This could be related to an animal's immune system's capacity to defend itself against pathogenic invaders. (Yusuf-Isleged, 2022).

Older cows (>10 years) have a higher probability of developing mastitis (44.6%), especially subclinical mastitis (38.6%), compared to younger cows (23.6%), where clinical mastitis predominated. The likelihood of living in infected quarters rises with age, reaching its peak at 7 years. Older cows, especially those who had more than four lactations, had a higher chance of developing mastitis (Mahajan *et al.*, 2011).

Body condition: Another important risk factor for the frequency of mastitis in cows is body condition. Cows in poor bodily condition were far more likely to develop clinical mastitis (Behailu, 2020). This may be due to the compromised immunological function of the cows, which makes the udder more susceptible to infection by different opportunistic infections. Poor body conditions can result from a number of factors, such as starvation, parasite infection, and reproductive stress (Fesseha *et al.*, 2021).

Herd size: Herd size has a considerable impact on the presence of mastitis (Tesfaheywet and Gerema, 2017). In herds that are under intense management, mastitis has a high likelihood of occurring. Due to high stocking densities, unclean ground, inadequate ventilation, and excessive humidity, cows in intensively managed large herds may be exposed to more mastitis germs in their surroundings, which may increase their risk of developing the disease. Clinical mastitis was substantially more likely to develop in cows with poor body condition, leaking milk, or prior udder infections (Behailu, 2020).

Parity of the cow: The prevalence of mastitis significantly increases with increasing parity number of the cow (Nibret *et al.*, 2012; Abdeta and Gemechisa, 2020). Sharma *et al.* (2007)

examined pregnant cows from various organised or unorganised dairy farms that ranged in parity. Cows with more than seven calves (>7) are nearly 13 times more likely (62.9%) to get an udder infection than cows with three or fewer calves (11.3%).

Genetics: Because animal traits like milk production ability, teat structure, and udder conformation vary in heritability among species, there is a link between animal genetics and the prevalence of mastitis. The pathogenicity of organisms in mammary glands is determined by these heritable variables. It's also likely that the genotypes of the organisms engaged in intra-mammary infection differ in their potential for mammary pathogenicity (Demelash *et al.*, 2003).

2.3.4. *Treatment of mastitis*

Ethiopia has paid little attention to mastitis and has concentrated treatment efforts on treating clinical instances (Belay *et al.*, 2022). Eliminating the causative germs is the best way to treat mastitis when it is practical. The best antibiotic may be chosen more easily with the use of a rapid or on-farm bacteriological diagnosis (Pyorala, 2009). Mastitis is treated by eliminating the underlying infection that gave rise to it from the affected area as early as feasible. NSAID drugs may be necessary for reducing the edoema, heat, and pain signs in the mammary gland. Mastitis should often be treated for at least three days, according to Jadhav *et al.* (2010).

Mastitis must be identified and treated as soon as possible in order to prevent further harm to the glands that make milk and the spread of the bacterium from cow to cow. As the first step in mastitis treatment, the diseased cows must be fully milked. The milk needs to be disposed of properly. The most common type of treatment for mastitis is antibiotics, but you should consult with a veterinary expert before using drugs (Fesseha *et al.*, 2021). There are basically two different types of therapy. These categories include systemic and intramammary antibiotics (Debela and Birhanu, 2021). Intra-mammary infections have been treated with both intra-mammary and systemic antibiotic therapy (Tiwari *et al.*, 2013). Intramammary antibiotics should be the first line of treatment for cows with mild, uncomplicated mastitis in a single quarter. Systemic antibiotics should be used when more than one quarter is impacted or when udder changes are evident. Combination therapy, which uses both intramammary and systemic

antibiotics, may increase the proportion of organisms that are successfully treated, but it should only be used under medical care (Rahmeto, 2020).

Direct intra-mammary infusion of the special antibiotic tubes designed for the treatment of mastitis, administered twice daily for three successive milkings, is typically the recommended medication therapy (Kinfе, 2017). The most common antibiotics are penicillin, oxytetracycline, lincomycin, and neomycin. The phagocytic capabilities of polymorphonuclear leukocytes (PMN) may be initiated by antibiotics. This could result in a recurrence of intramammary infections (Sentitula *et al.*, 2013).

2.4. Lameness

Lameness is one of serious challenging in dairy farming due to having impact on production and reproduction of dairy cows. Lameness is one of the most serious problems for dairy cows. It can be infectious or non-infectious based on etiology (Mitev *et al.*, 2011). The primary cause of lameness in dairy cows is claw lesions, which can be infectious and include digital dermatitis, interdigital dermatitis, heel erosion, and foot rot. The second cause of lameness is non-infectious, such as white line disease, sole ulcer, sole hemorrhage, and interdigital hyperplasia (Mellado *et al.*, 2018).

Claw lesions have been demonstrated to be influenced by nutritionally induced inflammation, hard floor surfaces, and physiological changes influencing the digital cushion (Bell, 2015). Claw lesions have also been identified in non-lame cows as subclinical affections (Sheferaw *et al.*, 2022).

Previous studies reported that husbandry related factors associated with occurrence of lameness. For example, using information from the farms recruited for the study, Browne *et al.* (2022) reported that risk factors in the housing and grazing environments associated with increased lameness were the presence of damaged concrete in pens, cows pushing each other or turning sharply near the parlor entrance or exit, and the use of automatic scrapers. In addition, the management factors associated with increased lameness included not treating lame cows within

48 h of detection, insufficient time given to detecting lameness across the entire herd, and the common occurrence of severe heel erosion, interdigital growths, or toe necrosis as reported by the farmer (Ghavi, 2013)).

Other studies have demonstrated a relationship between lameness and the quality of walking surfaces, exposure to slurry in the housing environment, and comfort in the lying area (Bell, 2005). Although the causes of lameness in dairy cows are frequently complex and multifactorial, they are generally understood to include poor quality floors in cattle housing, poor cow tracks, cows being forced to stand for an excessive amount of time on hard surfaces, ineffective foot trimming, infectious diseases, and subpar nutrition (Ranjbar *et al.*, 2016).

Lameness is a major cause of economic loss for the dairy sector (Mandel *et al.*, 2018). It is one of the most significant welfare challenges in the raising of dairy cattle nowadays (Browne *et al.*, 2022) due to its negative impact on cow mobility, posture, and gait (Archer *et al.*, 2010). Due to poorer milk production, difficult or impossible mating, higher pharmaceutical expenses, increased labor costs, and early animal culling, it has a substantial negative economic impact on farms (Huxley, 2013). In addition to its negative economic effects, lameness in cows causes them pain, which alters how they behave (Sheferaw *et al.*, 2022).

Reproductive performance is adversely affected by lameness (Tyagi *et al.*, 2017). As a result, the hypothalamus-pituitary-ovarian axis's functionality is greatly impacted, which in turn causes reduced reproductive function. Lamé cows appear to have greater rates of postpartum uterine infections, higher levels of negative energy balance, poorer ovarian cyclicity during puerperium, decreased ability to conceive, and higher pregnancy loss rates (Tsousis *et al.*, 2022).

According to Tsousis *et al.* (2022), compared to healthy cows, lame cows had increased NSPC (2.07 vs. 1.94), CFSI (108.23 vs. 101.33 days), and CI (449.66 vs. 441.31 days), but these differences were not statistically significant. According to a study conducted on German dairy herds, lameness negatively affects cows' ability to reproduce, including their ability to conceive within the first month of lactation, calves to the first service interval, and calves to the conception interval (Orgel *et al.*, 2016). The reasons behind cause decline reproductive

performance are negative energy balance, pain, hormonal insufficiency (Mellado *et al.*, 2018), delayed cyclicity, increased incidence of ovarian cysts, and reduced ovulation (Morris *et al.*, 2009).

3. MATERIALS AND METHODS

3.1. Description of Study Area

The study was conducted from November, 2022 to April, 2023 in Wolaita Zone, southern Ethiopia. It is located 390 kilometers south of Addis Ababa. It is at an altitude of 2025 meters above sea level, 8°50' N latitude, and 37° 45' E longitude. The maximum rainfall in the study area between July and September is 801–1600 mm, with an annual average of 15.1-31 °C. With a population density of approximately 385 people per square kilometer (ppkm²), the region is the most populous in the country. It is estimated that there are 886,242 cattle, 117,274 sheep, 99,817 goats, 41,603 horses, and 442,428 chickens in the Wolaita area (WZFEDD, 2022).

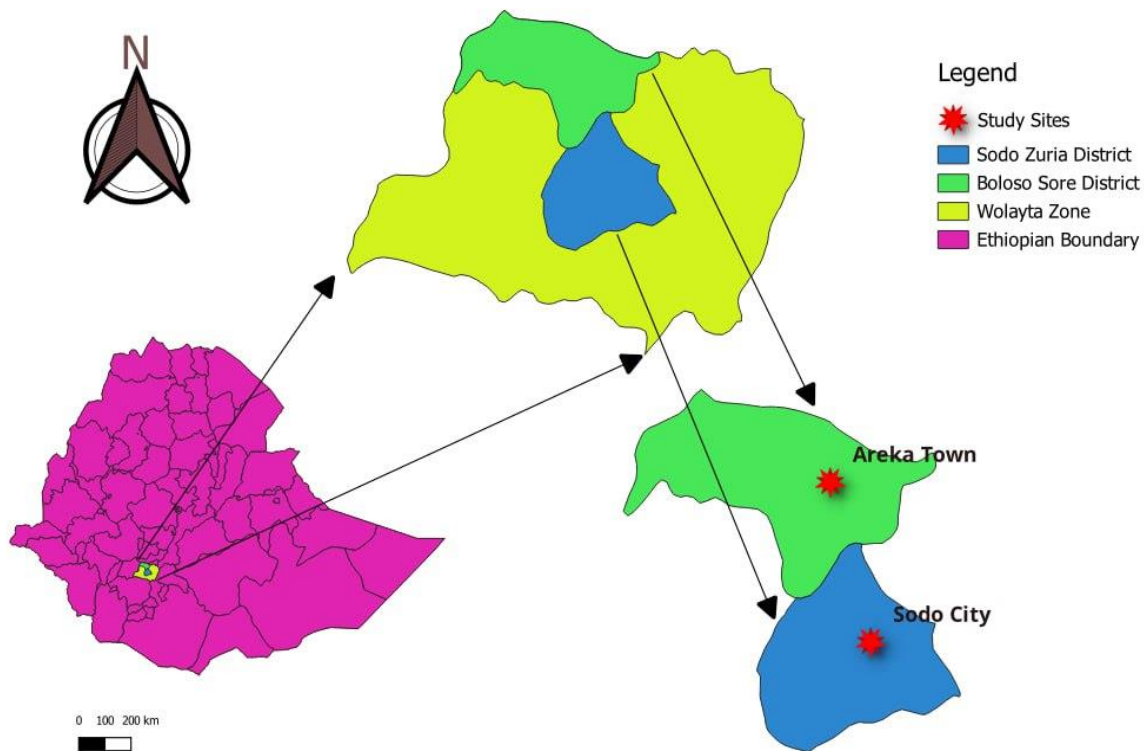


Figure 1: Map of study area

3.2. Study animals

The study was conducted on dairy cows owned by dairy farmers in Wolaita Zone, southern Ethiopia. Dairy cows with different parity, age, calving season, reproductive performances, and conditions, along with periparturient disorders, mastitis, and lameness, were collected from the farm data record book. The age of cows was classified as younger (3–6 years), adult (7–9), and old (>9) based on birth records (Wakeman and Pace, 1983). The parity was recorded and grouped into few (one-to-three calves), moderate (four to six calves), and high (7 and above calves) (Fesseha *et al.*, 2021). Body condition scores were given to all of the study animals on the way to the evaluation of periparturient disorders, mastitis, and lameness. Body condition scoring was done using a 1–5 scale based on palpation of the backbone and lumbar system and assessment of the coverage of fat and muscle (Matthewman, 1993) (Appendix 1).

3.3. Inclusion Criteria and Exclusion Criteria in Study

3.3.1. Inclusion Criteria

All dairy farms in the study area that had well-recorded retrospective data related to parity, age, calving data, reproductive performances, and conditions such as periparturient disorders, mastitis, and lameness were included in the present study.

3.3.2. Exclusion Criteria

The dairy farms that hadn't well recorded retrospective data related to parity, age, calving data, reproductive performances, and diseases such as periparturient disorders, mastitis, and lameness were excluded from the study.

3.4. Study Design

A cohort study was employed by using retrospective data from 2020 to 2022 G.C. to study the impact of per-parturient disorders, mastitis, and lameness on the reproductive performance of

dairy cows in selected districts of Wolaita Zone, Southern Ethiopia, from November, 2022 to April, 2023. In addition, a retrospective cross-sectional study was conducted to assess the prevalence of per-partum disorders, mastitis, and lameness. The prevalence was determined with respect to the number of risk factors such as age, parity, calving season, body condition of dairy cows, and location of the farm. The study districts and dairy farms were selected based on the number of farms and accessibility of the data. The names of dairy farms were collected from the district administrative office. In addition, the reproductive performance of normal cows was compared with that of diseased cows.

3.5. Sample Size Determination and Sampling Technique

Data were retrospectively collected from 40 dairy farms for 1326 cows on the impact of per-parturient disorders, mastitis, and lameness on the reproductive performance of dairy cows in selected districts of Wolaita Zone, southern Ethiopia. The study used two stage purposive sampling. Districts and dairy farms were represented as the primary and secondary sampling units, respectively. At each sampling stage, sampling units were purposefully selected based on criteria (Dohoo *et al.*, 2003). In Wolaita Zone, there are 16 districts. Among the 16 districts, three (Sodo, Sodo Zuryia, and Areka) were taken using purposive sampling based on the number of farms. 40 dairy farms were purposefully selected from three districts based on the accessibility of the data. Twenty, ten, and ten dairy farms were picked up from Sodo, Sodo Zuryia, and Areka districts, respectively.

3.6. Data Collection Methods

3.6.1. Retrospective data collection

According to the Wolaita livestock and fishery office (2022) (Appendix 3), 16 districts and 108 dairy farms were present in the Wolaita Zone. Through information, three districts (Sodo, Sodo Zuryia, and Areka) were selected based on the number of farms. Forty (40) dairy farms were selected based on the accessibility of data from selected districts. The retrospective data record sheet was created and utilised to gather data (Appendix 2). The livestock and fishery office

departments of selected districts were permitted to collect data from the dairy farms. As the researcher went to the farmers, the owners' willingness was then assessed. The study's purpose and its methodology were then discussed with farm managers and a data recorder. The farm manager and data recorder showed the researcher the last 3 years of recorded data from dairy farms.

Then, retrospective data was collected on the occurrence of per-parturient disorders, mastitis, and lameness as recorded on the data-generated book from the dairy farms. Accordingly, information about reproductive performances such as age at first service, age at first calving, number of services per conception, and calving-to-conception interval was collected. The age, calving season, parity, and body condition of dairy cows were generated based on the record book. On the basis of birth records, the study dairy cows were divided into three age groups: young (three to six years), adults (seven to nine years), and old (more than nine years). The parity was recorded and grouped into few (one to three calves), moderate (four to six calves), and high (seven and above calves). The calving season was recorded and classified into September to November, December to February, March to May, and June to August. All the cow-level information was registered by their ear tag number. The farm managers were given any information regarding retrospective data when missed information was presented in the data recording book.

3.7. Description and Definition of Variables

Dystocia: the cow's inability to remove newborns from its uterus through the birth canal (Mekonnen and Moges, 2016).

Retained placenta: a pathological condition characterized as the failure to evacuate fetal membranes within 24 hours following calving (Dervishi *et al.*, 2016).

Endometritis: a superficial inflammation of the endometrium without systemic signs (Wang *et al.*, 2018).

Hypocalcemia: metabolic disease when homeostatic systems fail to maintain normal blood calcium (Ca) concentrations during the start of lactation and parturition (Ma *et al.*, 2022).

Ketosis: A condition which characterized by relatively high concentrations of the ketone bodies acetoacetate, -hydroxybutyrate, and acetone, as well as a concomitantly low concentration of glucose in the blood due to result of insufficient dietary intake and excessive lactation (Madreseh and Dehghani, 2018).

Metritis: Inflammation of the wall of the uterus consisting of both the endometrial and the muscular layer (Negasee, 2020).

Mastitis: an inflammation of the mammary gland caused by bacterial infection, trauma, or injury to the udder (Gomes and Henriques, 2016).

Lameness: a deviation in gait to reduce pain (Viazzi *et al.*, 2013).

Age at first service (AFS): The number of days from birth to the date of animals at first service (Tadesse and Tegegne, 2018).

Age at first calving (AFC): The number of days from birth to the date of animals at first calving. In the study all cows that calved at least once were included (Atashi *et al.*, 2021)

Calving to conception or Days Open (DO): The number of days between parturition and conception (Temesgen *et al.*, 2022).

Number of services per conception (NSPC): The number of services required for successful conception (Cielava *et al.*, 2017).

3.8. Data Analysis

Retrospective data generated from dairy farms was entered, coded using a Microsoft Excel spreadsheet, and analysed using STATA 14.0. The prevalence of periparturient disorders, mastitis, and lameness was determined by the proportion of affected animals out of the total animal population determined by descriptive statistics. The logistic regression, reporting the odds ratio (OR), was used to evaluate the association of the prevalence of periparturient disorders, mastitis, and lameness with associated risk factors. A bar chart was used to determine the prevalence of periparturient disorders, mastitis, and lameness between calving seasons. The first-service conception rate was compared between diseased and normal animals by using the Chi-square test (χ^2). The reproductive performances, such as calving to conception interval, calving to first service interval, number of services per conception, age at first service, and age at first calving, were compared between normal and diseased dairy cows by using a t-test. Proportions

were compared using the mean and standard deviation. The results were considered statistically significant at a P-value less than 5% and a confidence interval of 95%.

3.9. Ethical Considerations

The ethical clearance was pursued from animal health ethical committee, College of Veterinary medicine and agriculture, Addis Ababa University. After receiving official letter of ethical clearance from Addis Ababa University, the researcher was communicated to farm manager and data recorder legally and smoothly. The purpose of the study was made clear and understandable for concerned bodies. Any communication with the concerned bodies were accomplished at their voluntarily consent. In addition, retrospective data was kept confidential.

4. RESULTS

4.1. Overall prevalence of periparturient disorders, lameness and mastitis in study area

The study included 1326 dairy cows, and it was revealed that (533/1326) 40.20 percent of dairy cows had at least one health disorder. This finding showed overall periparturient disorders, lameness, and mastitis. Endometritis, retained placenta, dystocia, and hypocalcemia were periparturient disorders found in the study area, with prevalence of 14.33%, 9.58%, 9.58%, and 8.60%, respectively. Moreover, mastitis and lameness were also among the disorders with the occurrence of 13.12% and 10.56%, respectively. Thus, endometritis was more common than other health disorders in dairy cows in the study area. The occurrence of mastitis was second only to endometritis. The prevalence of dystocia and retained placenta occurs equally frequently. The prevalence of hypocalcemia was less common than other health problems in the study area, as indicated in Table 3.

Table 3: The overall prevalence of periparturient disorders, lameness and mastitis

Health problems	Frequency Positive animals	Positive by percent
Endometritis	190	14.33
Retained placenta	127	9.58
Hypocalcemia	114	8.60
Dystocia	127	9.58
Mastitis	174	13.12
Lameness	140	10.56
Total	533	40.20

4.2. Association of Risk Factors with periparturient disorders in dairy cows

Respective to age, the prevalence of periparturient disorders was approximately 26% lower in adult animals than in young dairy cows, but there was no statistically significant difference (OR = 0.741, $p = 0.067$, CI = 0.54–1.0201). The prevalence of periparturient disorders was 1.87 times

higher in old animals than in young animals ($p = 0.00$, $CI = 1.363-2.56$), with a highly statistically significant difference (table 4).

Regarding parity, there was a highly statistically significant difference in the prevalence of periparturient disorders between parities ($p < 0.05$). The periparturient disorders were 1.41 and 2.36 times higher in dairy cows with 4-6 calved dairy cows ($P = 0.009$, $95\% CI = 1.089-1.824$) and dairy cows with > 7 calved dairy cows ($P = 0.002$, $CI = 1.386-4.048$) than in 1-3 calved dairy cows (table 4).

As shown in table 4, there was a significant relationship ($p < 0.05$) between the body condition of dairy cows and the prevalence of periparturient disorders, and the occurrence of these disorders was 4.13 times greater in obese dairy cows compared to those with good body condition (p value = 0.000 , $95\% CI = 2.303-7.396$).

Based on farm location analysis, farms found in Sodo district had a 24% lower prevalence of periparturient disorders than dairy farms found in Areka district ($OR = 0.76$, $p = 0.036$, $95\% CI = 0.58-0.982$). Furthermore, Sodo Zuryia had an approximately 36% lower prevalence of peripartum disorders than Areka dairy farms ($p = 0.005$, $OR = 0.643$, $95\% CI = 0.473-0.877$) (table 4).

Table 4: Logistic regression analysis on association of associated risk factors with periparturient disorders of dairy cows

Disorders	Risk factors		Total no of animals	No of positive animals	Odd ratio	P value	95% confidence interval
Parturient disorders	Age	Young	275	83	ref		
		Adult	581	141	0.741	0.067	0.54-1.020
		Old	470	210	1.87	0.00	1.363-2.56
	Body condition	Good	1,274	400	ref		
		Obse	52	34	4.13	0.000	2.303-7.396
	Parity	1-3 calves	420	114	ref		
		4-6 calves	842	290	1.41	0.009	1.089-1.824
		7 and above calves	64	30	2.37	0.002	1.386-4.048
	Location of farm	Areka	445	168	ref		
		Sodo	557	175	0.76	0.036	0.58-0.982
Sodo zuryia		324	91	0.643	0.005	0.473-0.877	

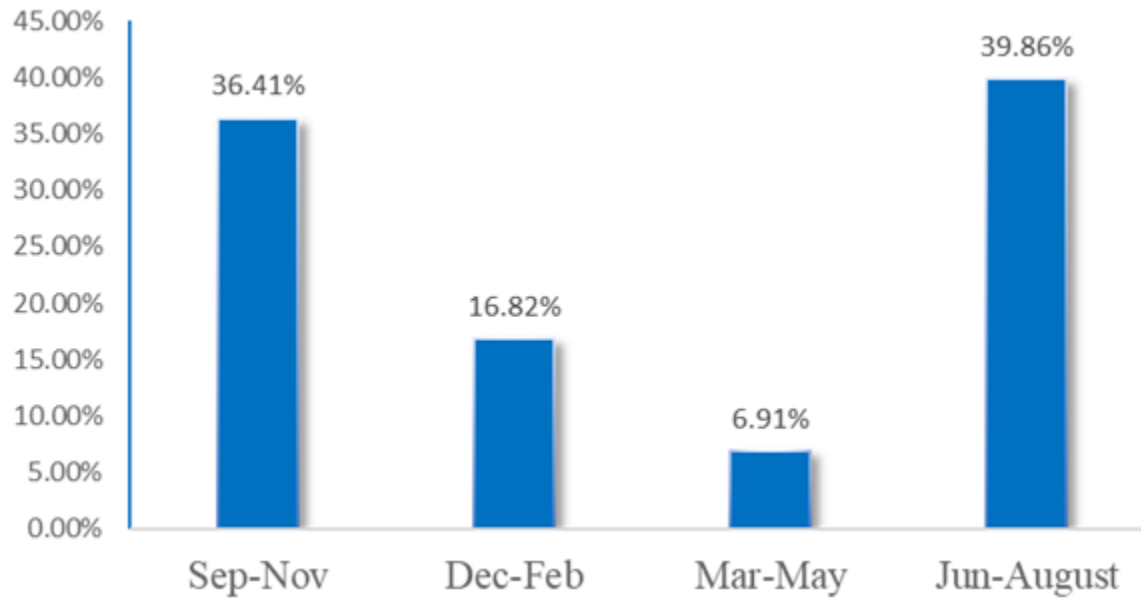


Figure 2: Graphical presentation of relationship on prevalence of periparturient disorders between calving seasons

Figure 2 shows that dairy cows that calved in June to August (39.86%) were more likely to have periparturient disorders than cows that calved in other calving seasons. Compared to other calving seasons, the results showed that periparturient disorders were second most likely to occur in September to November (36.41%). In addition, 16.82% of periparturient disorders occurred from December to February. Periparturient disorders were less common in the March to May months (6.91%) in the study area.

4.3. Association of Risk Factors with mastitis and lameness of dairy cows

According to a logistic regression analysis, older dairy cows were 3.6 times more likely to develop mastitis than younger dairy cows ($P = 0.00$, $CI = 2.15-6.024$). Although there was no statistically significant difference, the prevalence of mastitis was 1.44 times higher in adult dairy cows than in young ones ($P = 0.189$, $CI = 0.836-2.47$). The prevalence of mastitis was 2.84 times higher in animals with obese body conditions than in animals with good body conditions ($p\text{-value} = 0.001$, $CI = 1.5255-5.298$). Parity was a potential risk factor for the prevalence of mastitis ($P < 0.05$). Compared to dairy cows with 1-3 calves, the prevalence of mastitis was 1.83

times higher in cows that calved 4-6 calves ($P = 0.003$, $CI = 1.23-2.72$) and 4.64 times higher in ≥ 7 -calved dairy cows (p value = 0.000, $CI = 2.45-8.79$). Based on farm location analysis, the location of the farm had no significant statistical relationship with the prevalence of mastitis. However, compared to farms located in Areka district, the occurrence of mastitis was 1.323 and 1.034 times higher in farms found in Sodo district ($P = 0.139$, $CI = 0.913-1.92$) and farms found in Sodo Zuryia district, respectively (table 5).

Table 5: Logistic regression analysis on association of associated risk factors with mastitis and lameness of dairy cows

Disorders	Risk factors		No of total animals	No of positive animals	Odd ratio	P value	95% confidence interval
Mastitis	Age	Young	275	19	ref		
		Adult	581	56	1.44	0.189	0.836-2.47
		Old	470	99	3.6	0.00	2.15-6.024
	Body condition	Good	1,274	159	ref		
		obse	52	15	2.84	0.001	1.53 5.298
	Parity	1-3 calves	420	35	ref		
		4-6 calves	842	120	1.83	0.003	1.23-2.72
		7 and above calves	64	19	4.64	0.000	2.45- 8.79
	Location of farm	Areka	445	52	ref		
		sodo	557	83	1.323	0.139	0.913-1.92
Sodo zuryia		324	39	1.034	0.882	0.66-1.61	

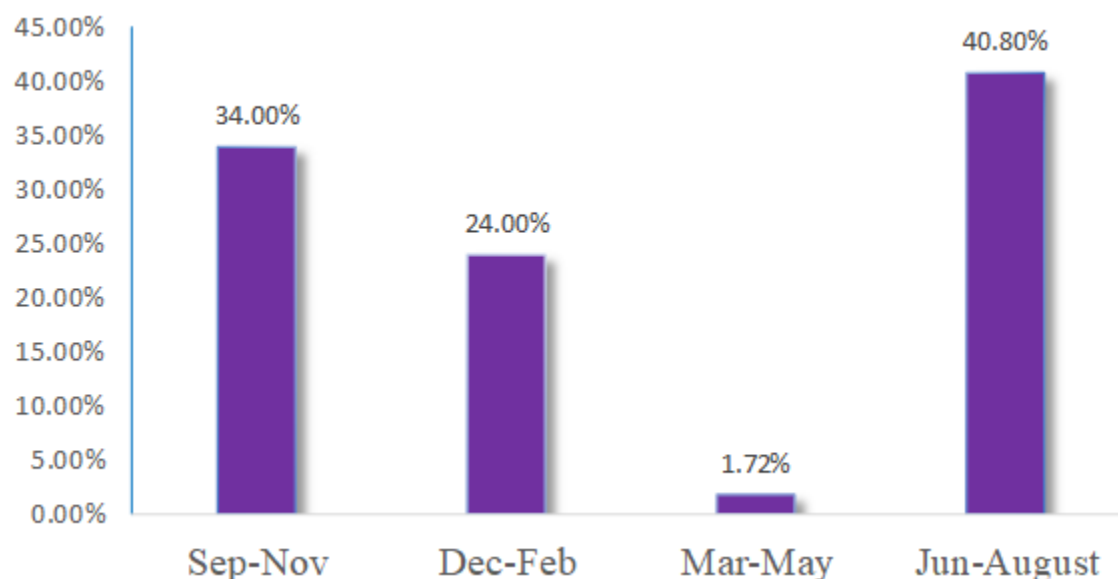


Figure 3: Graphical presentation on prevalence of mastitis between calving seasons

Figure 3 shows the June to August calving season (40.80%) had a greater prevalence of mastitis in dairy cows than another season of the year. Mastitis also occurred 34% of the season in September to November and 24% of the season in December to February. The calving season from March to May was the least likely of the three calving seasons for dairy cows to get mastitis.

Table 6 shows that there was no statistically significant difference between adult and young dairy cows in terms of the prevalence of lameness. In comparison to young animals, the prevalence of old animals was 2.6 times higher ($p = 0.000$, 95% CI = 1.535–4.40). The findings show that lameness was strongly related to parity and probable 2.94 times higher in 4-6 calved dairy cows than in 1-3 calved dairy cows ($p = 0.000$, 95% CI = 1.798–4.82). Moreover, the prevalence of lameness was 4.6 times higher in dairy cows with ≥ 7 calves than in 1-3 calved dairy cows ($p = 0.000$, 95% CI = 2.13–9.99). According to the analysis of body condition, there was no statistically significant relationship between the prevalence of lameness and the body condition of dairy cows ($p = 0.252$, 95% CI = 0.725–3.413), but cows with obese body conditions had 1.57 times higher odds of being lame than cows with good body conditions. Although the location of the farm had no significant statistical effect on the prevalence of lameness, its occurrence was

1.384 and 1.15 times higher in farms found in Sodo district and Sodo Zuryia district, respectively, compared to farms found in Areka district.

Table 6: Logistic regression analysis on association of associated risk factors and lameness of dairy cows

Health problem	Risk factors		Total no of animals	Number of positive animals	Odds ratio	P value	95% confidence interval
Lameness	Age	Young	275	19	ref		
		Adult	581	45	1.13	0.664	0.65-1.97
		Old	470	76	2.6	0.000	1.535-4.40
	Body condition	Good	1274	132	ref		
		Obse	52	8	1.57	0.252	0.725-3.4
	Parity	1-3 calves	420	20	ref		
		4-6 calves	842	108	2.94	0.000	1.798-4.82
		7 and above calves	64	12	4.6	0.000	2.13- 9.99
	Location of farm	Areka	445	40	ref		
Sodo		557	67	1.384	0.123	0.916- 2.093	
Sodo Zuryia		324	33	1.15	0.576	0.707-1.86	

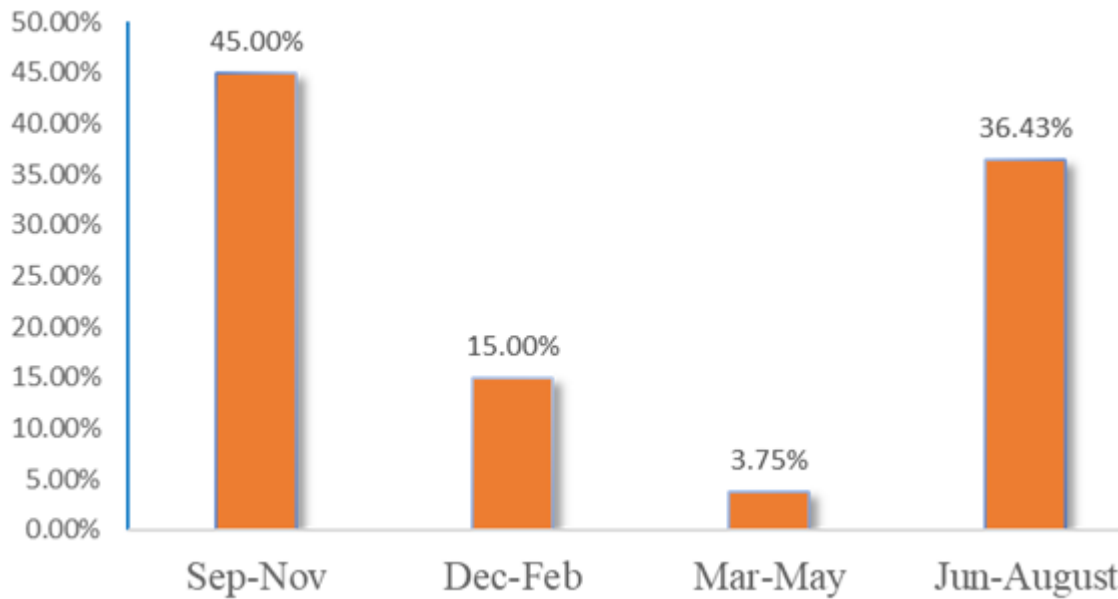


Figure 4: Graphical presentation on prevalence of lameness between calving seasons

Figure 4 demonstrates that lameness was more common in the months of September to November (45%) and lower in March to May (3.75%). The June to August calving season (36.43%) had the second-highest prevalence of lameness in the study area. 15% of dairy cows are affected by lameness from December to February.

4.4. Impact of Periparturient Disorders, Mastitis and Lameness on Reproductive Performance of Dairy Cows

4.4.1. Impact of periparturient disorders, mastitis and lameness on first service conception rate

As indicated in Table 7, the first-service conception rate had a statistical relationship with periparturient disorders, mastitis, and lameness ($P = 0.000$). Dairy cows with those disorders are less likely to become pregnant at first service. The dairy cows with and without periparturient disorders had 5.88% and 52.26% of the first service conception rate, respectively ($\chi^2 = 427.8235$, $P = 0.000$). Thus, periparturient disorders had impact on the first conception rate.

Regarding mastitis, 55.58% and 2.56% of FSCR were normal and diseased dairy cows, respectively. First-service pregnancy rates in lame and non-lame dairy cows were 2.34% and 55.81%, respectively (table 7).

Table 7: Impact of periparturient disorders, mastitis and lameness on first service conception rate

Disorders	Health status	Animals at first service	No of animals pregnant	First service conception rate	χ^2	P value
Periparturient disorders	Positive	434	78	5.88% (78/1326)	427.8235	0.000
	Negative	892	693	52.26% (693/1326)		
Mastitis	Positive	174	34	2.56% (34/1326)	122.6471	0.000
	Negative	1,152	737	55.58% (737/1326)		
Lameness	Positive	140	31	2.34% (31/1326)	83.3640	0.000
	Negative	1,186	740	55.81% (740/1326)		

4.4.2. Impact of periparturient disorders on reproductive performance

Table 8 showed that endometritis had an evident impact on the reproductive performance of the dairy cows in the study area. Endometritis had a significant impact on the calving-to-conception interval in dairy cows ($t = -10.9486$, $p = 0.0000$). Compared to normal dairy cows (99.45 ± 21.44 d, CI = 98.20–100.70), diseased dairy cows (117.75 ± 20.59 d, CI = 114.80–120.70) had a longer calving to conception interval.

Moreover, prolonged calving to the first service interval was seen in diseased cows (91.2 ± 13.28 d, CI = 89.3–93.10) rather than healthy cows (88.84 ± 12.27 d, CI = 88.13–89.56). This indicated that endometritis had impact on calving to the first service interval. Endometritis was significantly associated with NSPC ($P = 0.0000$) and required more services per conception in affected cows (2.19 ± 0.71 , CI = 2.093–2.297) than in healthy cows (1.44 ± 0.679 , CI = 1.40–1.48) ($t = 14.0010$, $P = 0.0000$) (table 8).

Table 8: Mean \pm SD for reproductive traits with absence or presence of endometritis

Trait	Health status	Mean \pmSD	95% confidence interval	t	P value
CCI	Negative	99.45 \pm 21.44	98.20-100.70	-10.9486	0.0000
	Positive	117.75 \pm 20.59	114.80- 120.70		
CFSI	Negative	88.84 \pm 12.27	88.13- 89.56	-2.4210	0.0156
	Positive	91.2 \pm 13.28	89.3-93.10		
NSPC	Negative	1.44 \pm 0.679	1.40-1.48	-14.0010	0.0000
	Positive	2.19 \pm 0.71	2.093-2.297		

According to Table 9, the findings showed that RP had a significant ($P < 0.05$) impact on the number of services per conception (NSPC), calving to the first service interval (CFSI), and calving to the conception interval (CCI). The time between calving to the first service was longer in the cows with retained placenta (93.22 \pm 12.86d, CI = 90.97-95.49) than in healthy cows (88.7 \pm 12.32d, CI = 88.05-89.45). Dairy cows with retained placenta (118.83 \pm 21.19d, CI = 115.1–122.56) had a significantly ($P = 0.0000$) higher than calving-to conception interval than normal dairy cows (100.30 \pm 21.623d, CI=99.076- 101.53). The mean number of services per conception in diseased dairy cows (2.15 \pm 0.735, CI= 2.02-2.28) was higher than in healthy cows (1.48 \pm 0.70, CI= 1.45-1.53), with a statistically significant difference.

Table 9: Mean \pm SD for reproductive traits with absence or presence of Retained placenta

Trait	Health status	Mean \pmSD	95% confidence interval	t	P value
CCI	Negative	100.30 \pm 21.623	99.076- 101.53	-9.1999	0.0000
	Positive	118.83 \pm 21.19	115.1- 122.56		
CFSI	Negative	88.7 \pm 12.32	88.05-89.45	-3.8755	0.0001
	Positive	93.22 \pm 12.86	90.97-95.49		
NSPC	Negative	1.48 \pm 0.70	1.45-1.53	-10.0301	0.0000
	Positive	2.15 \pm 0.735	2.02-2.28		

CCI= calving to conception interval, CFSI= calving to first service interval, NSPC=number of services per conception

Table 10 showed a significant relationship between hypocalcemia and reproductive performance, especially CCI, CFSI, and NSPC ($P < 0.05$). Dairy cows affected by hypocalcemia (117.48 ± 23.2 d, CI = 113.17-121.79) had prolonged calving to conception interval than healthy cows (100.63 ± 21.6 d, CI = 99.40-101.85) ($t = -7.9072$, $P = 0.0000$). There was a significant difference in the mean calving to first service interval between cows with hypocalcemia and normal cows ($t = -2.1000$, $P = 0.0359$). As a result, dairy cows with hypocalcemia (91.5 ± 13.92 d, CI = 88.94–94.10) had a higher average calving to first service interval than normal cows (88.96 ± 12.28 d, CI = 88.27–89.65). Regarding the number of services per conception, the mean NSPC between cows with hypocalcemia (2.17 ± 0.774 , CI = 2.023–2.31) and unaffected cows (1.49 ± 0.70 , CI = 1.45–1.53) differed statistically significantly ($t = 9.6989$, $P = 0.000$).

Table 10: Mean \pm SD for reproductive traits with absence or presence of hypocalcemia

Trait	Health status	Mean \pm SD	95% confidence interval	t	P value
CCI	Negative	100.63 \pm 21.6	99.40-101.85	-7.9072	0.0000
	Positive	117.48 \pm 23.2	113.17-121.79		
CFSI	Negative	88.96 \pm 12.28	88.27-89.65	-2.1000	0.0359
	Positive	91.5 \pm 13.92	88.94-94.10		
NSC	Negative	1.49 \pm 0.70	1.45-1.53	-9.6989	0.0000
	Positive	2.17 \pm 0.774	2.023-2.31		

CCI= calving to conception interval, CFSI= calving to first service interval, NSPC=number of services per conception

According to table 11, dystocia-affected cows (119.012 ± 20.73 d, 115.37-122.65) had a longer mean calving-to-conception interval than normal cows (100.28 ± 21.6 d, CI = 99.05-101.51). Between diseased and unaffected cows, there was a statistically significant difference in the interval from calving to conception ($P = 0.0000$). The mean calving-to-first service interval was longer for cows with dystocia than for unaffected cows (91.03d vs. 88.98d), but there was no statistically significant difference ($t = -1.7640$, $P = 0.078$). The results of this investigation indicate that dystocia has a statistically significant impact ($p < 0.05$) on the number of services per conception. Healthy dairy cows had a number of services per conception of 1.471 on average (SD = 0.69, CI = 1.432-1.51), whereas diseased cows had a number of services per conception of

2.31 on average (SD = 0.695, CI = 2.18-2.43). Thus, dystocia affected dairy cows required more services per conception than normal dairy cows (t value = -12.9668, P = 0.0000).

Table 11: Mean \pm SD for reproductive traits with absence or presence of dystocia

Trait	Health status	Mean \pm SD	95% confidence interval	t	P value
CCI	Negative	100.28 \pm 21.6	99.05-101.51	-9.3058	0.0000
	Positive	119.012 \pm 20.73	115.37-122.65		
CFSI	Negative	88.98 \pm 12.33	88.28- 89.67	-1.7640	0.0780
	Positive	91.03 \pm 13.32	88.69- 93.37		
NSPC	Negative	1.471 \pm 0.69	1.432-1.51	-12.9668	0.0000
	Positive	2.31 \pm 0.695	2.18- 2.43		

CCI= calving to conception interval, CFSI= calving to first service interval, NSPC=number of services per conception

4.4.3. Impact of Mastitis on reproductive performances

As shown in Table 12, there was a statistical relationship between mastitis and reproductive performance in dairy cows (P<0.05). The calving-to-conception interval in diseased cows (115.8 \pm 22.72d, CI = 112.38–119.18) was significantly longer (P <0.05) than in normal cows (100 \pm 21.4d, 98.766–101.25). Calving-to-first-service interval was longer in cows with mastitis (91.2 \pm 13.4d; CI: 89.20-93.22) than in normal cows (88.88 \pm 12.3 d, CI = 88.17–89.58) with statistically significant variation (t = -2.3147, P = 0.0208).

In affected dairy cows, the mean number of services per conception was 2.11 (SD = 0.7, CI = 2.003-2.22), but in healthy dairy cows, the mean number of services per conception was 1.467 (SD = 0.7, CI = 1.43-1.51) (t value = -11.2716, P = 0.0000). Overall, in the study area, mastitis and reproductive performance interacted strongly (table 12).

Table 12: Mean \pm SD for reproductive traits with absence and presence of mastitis

Trait	Health status	Mean \pm SD	95% confidence interval	t	P value
CCI	Negative	100 \pm 21.4	98.766-101.25	-8.9714	0.0000
	Positive	115.8 \pm 22.72	112.38-119.18		
CFSI	Negative	88.88 \pm 12.3	88.17- 89.58	-2.3147	0.0208
	Positive	91.2 \pm 13.4	89.20-93.22		
NSPC	Negative	1.467 \pm 0.7	1.42-1.50	-	0.0000
	Positive	2.11 \pm 0.7	2.003-2.22		

CCI= calving to conception interval, CFSI= calving to first service interval, NSPC=number of services per conception

4.4.4. Impact of lameness on reproductive performance

As shown in Table 13, the calving-to conception interval is statistically significant at the 0.05 significance level ($t = -7.1295$, $p = 0.0000$). In particular, the output shows that there is a mean difference in calving to conception interval between lame and non-lame cows. This indicated that CCI was longer in lame cows (114.52 \pm 23.37 d, CI = 110.62–118.43) than normal cows (100 \pm 21.7 d, CI = 99.37–101.84). The calving to the first service interval was higher in lame cows (92.5 \pm 14.96 d, CI = 90.06–95.06) than normal cows (88.78 \pm 12.05 d, CI = 88.09–89.47). with statistical mean difference ($t = -3.4084$, $P = 0.0007$). Lame dairy cows (2.014 \pm 0.69, CI = 1.89-2.13) required higher number of services per conception non-lame dairy cows (1.497 \pm 0.718, CI = 1.46-1.54) with a statistically significant mean difference.

The obtained results showed that lameness had statistically significant impact on the age at first calving of the diseased cows ($t = -2.7495$, $P = 0.0060$). Age at first calving was higher in lame cows (2.87 \pm 0.219 yrs., CI = 2.79–2.83) than in healthy cows (2.810.23 yrs., CI = 2.79–2.83). The average values of age at first service in lame and normal dairy cows were 1.91 \pm 0.176 and 1.88 \pm 0.174 yrs. respectively. However, in this study, there was no statistically significant mean

difference ($t = -1.7030$, $p = 0.088$) in age at first service between lame and normal dairy cows (table 13).

Table 13: Mean \pm SD for reproductive traits with absence or presence of lameness

Trait	Health status	Mean \pmSD	95% confidence interval	t	P value
CCI	Negative	100 \pm 21.7	99.37-101.84	-7.1295	0.0000
	Positive	114.52 \pm 23.37	110.62-118.43		
CFSI	Negative	88.78 \pm 12.05	88.09-89.47	-3.4084	0.0007
	Positive	92.5 \pm 14.96	90.06-95.06		
NSPC	Negative	1.497 \pm 0.718	1.46-1.54	-8.0921	0.0000
	Positive	2.014 \pm 0.69	1.89-2.13		
AFC	Negative	2.81 \pm 0.23	2.79-2.83	-2.7495	0.0060
	Positive	2.87 \pm 0.219	2.83- 2.91		
AFS	Negative	1.88 \pm 0.174	1.87-1.89	-1.7030	0.0888
	Positive	1.91 \pm 0.176	1.8-1.94		

CCI= calving to conception interval, CFSI= calving to first service interval, NSPC=number of services per conception, AFC= age at first calving, AFS=age at first service

5. DISCUSSION

5.1. Overall Prevalence of Periparturient Disorders, Lameness and Mastitis

Based on retrospective data, the current study found that 40.20% (533 out of 1326) of dairy cows in the study area had one or more disorders. This finding was consistent with the reports of Tigabneh *et al.* (2017), who found 39.8% in Northeast Ethiopia, and Tulu and Negera (2022), who found 37.8% in the Tole District of southwest Ethiopia. The present research finding was lower than the 55.3% (n = 57/103) reported by Dawit and Fesseha (2020) in Wolaita Sodo District and Misebo *et al.* (2018), who reported 52% in Boloso Sore, Wolaita Zone, Ethiopia. On the other hand, it exceeds the 30.12% founded by Abunna *et al.* (2018), which was reported in Bishoftu town, Ethiopia; Gizaw *et al.* (2011) figured that 31.76% (n = 128) in Central Ethiopia; the 18.5% found by Hunduma (2013) in the town of Assela; and the 24.8% reported by Molalegne and Shiv (2011) in Bedelle for disorders. Variation in magnitude could be due to differences in sample size, study setting, study year, diary management system, and agroecology.

5.2. Periparturient Disorders in Study Area

In this study, endometritis, hypocalcemia, retained placenta, and dystocia were found to be disorders identified in the study area. The prevalence of endometritis (14.33%) was comparable to the reports of Leblanc *et al.* (2000), who found that endometritis ranged from 14% to 42%. On the other hand, this study's finding was lower than Belachew and Fekadu (2009) in Debrezeit and Moges and Jebar (2012), which had a prevalence of 47.5% and 68.3%, respectively. In addition, it was higher than 2.5% in Jimma Town by Seid and Thomas (2019) in southwestern Ethiopia and 8.7% in central Ethiopia by Ebrahim (2003). This variance could be due to differences in management systems and magnitude of postpartum uterine infections such as brucellosis in different study area (Ayisheshim *et al.*, 2017).

The prevalence of dystocia in this study (9.58%) was consistent with the reports of Michael (2003) in small dairy cows in and around Awassa (9.7%). This current finding was lower than

that reported by Dawit and Fesseha (2020) in Wolaita Sodo District, Southern Ethiopia (12.6%), Beredu and Biruk (2019) in Asella town, Central Ethiopia, which was 15.5%. On the other hand, it was higher than Haile *et al.* (2014), who reported 5.9% in the urban and urban area of Hosanna, Southern Ethiopia, Gashaw *et al.* (2011) 3.8%, Hadush *et al.* (2013) 2.9%, Benti and Zewdie (2014) 3.4%, and Eshetu and Moges (2014) 3.3%. This variance in dystocia prevalence may be related to a number of variables, including differences in maternal nutritional status, age, parity, and size. Moreover, variation of breeds in different study areas can be another factor. For instance, small breeds of cows that are artificially inseminated with semen taken from larger bulls can contribute significantly to dystocia.

The current study revealed that the overall prevalence of retained placenta (9.58%) was comparable to the 10% estimated by Goff (2006). This study was lower than those of 19.2%, 17%, 14.7%, 17.8%, and 18.3% reported by Shiferaw *et al.* (2005) in the central highlands of Ethiopia; Gashaw *et al.* (2011) in Jimma town, south-west Ethiopia; Haile *et al.* (2010) in Addis Ababa Milk Shed; Gaafar *et al.* (2010); and Rahawy (2021), respectively. On the other hand, the current finding was higher than 5% in and around Gondar Town (Ayisheshim *et al.*, 2017); 8.64% in and around Bedelle, South West Ethiopia (Molalegne and Shiv, 2011); and 8.6% by Ayana and Gudeta (2015) in Bako. The varied prevalence of retained placenta mentioned by different authors might be attributed to various factors, such as environment, breed, age, heredity, nutrition, immunity, and hormonal status (Kamel *et al.*, 2022). In addition, the variation in the prevalence of RP may be attributed to variations in sample size.

The overall prevalence of hypocalcemia found in the current investigation was 8.60%, which aligns with the reported 8% in Zimbabwe by Chiwome *et al.* (2017). On the other hand, it was lower than the findings of Samuel *et al.* (2012), who found 30.2% in Gondar dairy farms, 27% by Akalu (2017) in Addis Ababa, 17.5% by Fasil (2016) in Hawassa dairy herds. Besides, current study result was lower than 23.3% in urban and 43.3% in peri-urban areas at Bishoftu (Leta, 2021), and higher than Adugna *et al.* (2019) 5.6% in North-Western Ethiopia. The variation in the occurrence of hypocalcemia in different studies might be attributed to differences in management system and the type of vegetation found in study areas.

5.3. Prevalence of Mastitis and Lameness in Study Area

The prevalence of mastitis (13.12%) was obtained in this study. This result was aligned with the meta-analysis report of Girma and Tamir (2022) in Ethiopia during 2005–2022 (12.59%). On the other hand, it was higher than Tesfanesh *et al.* (2018), who reported 9.46% in and around Wukro in the Tigray region of Ethiopia; Tesfaye (2016), who reported 6% in Debrezeit; Abraham (2017), who reported 5.1% in and around Wolaita Sodo. This present finding was lower than comparable to the studies by Abera *et al.* (2012), Workineh *et al.* (2002), Mekibib *et al.* (2010), Lakew *et al.* (2009), Sori *et al.* (2005), and Mungube *et al.* (2004), who reported 37.1% in Shashemene, 38.2% in Adami Tulu, 71.1% from Holeta, 64.6% from Assela, 52.8%, and 46.6% from the central highlands of Ethiopia, respectively. Getaneh and Gebremedhin's (2017) first meta-analysis of the prevalence of mastitis in dairy cattle in Ethiopia suggested that variations in the study period, the number of animals sampled, the breeds, the stages of lactation, and the parity number may be to blame for the variation in mastitis prevalence between studies. Besides, it might be attributed to differences in management practices (Tesfaheywet and Gerema 2017). Moreover, this variance in mastitis prevalence might be attributed to differences in environmental factors such as temperature and humidity in different study areas.

The overall prevalence of lameness in dairy cows during the study period was 10.56%. This study was comparable to that of Tyagi *et al.* (2017) in Karnal (10.66%). This result was lower than the 14.1% reported by Sheferaw *et al.* (2021) in selected farms in southern Ethiopia. Furthermore, the current finding was lower than previous reports from another country. Thus, it was relatively lower than that reported by Saikia *et al.* (1992) in Assam (13.98%) and Singh *et al.* (2011, 2015) at the same NDRI farm (38.24 and 65.54%). The lower prevalence of lameness in this study was due to the well-moving cattle on pasture and the small herd size (Tyagi *et al.*, 2017). The variation in prevalence of lameness between different studies conducted in different countries may be due to differences in management systems, herd size, study period, breeds, and cow productivity.

5.4. The association of Risk Factors with Periparturient Disorders, Lameness and Mastitis in Dairy Cows

The current study found a significant relationship between periparturient disorders and the body condition of dairy cows ($P < 0.05$). Animals with obese body conditions were 4.13 times more prone to periparturient disorders than those with good body conditions. This finding was inconsistent with the report of Tulu and Gebeyehu (2018) from the Kelem Wollega zone of Western Ethiopia, who documented that there is no statistically significant difference in the prevalence of periparturient disorders between body conditions. Moreover, this result was in disagreement with the finding of Alam *et al.* (2014), who reported that the lowest disease prevalence was in high BCS cows and the highest disease prevalence was in low BCS cows. This higher prevalence of periparturient disorders in obese than in well-conditioned dairy cows in the current study may be due to the fact that obese dairy cows mobilise more energy from body reserves, which tends to reduce dry matter intake and increase milk production; both factors contribute to the occurrence of periparturient disorders (Nogalski *et al.*, 2012). As well, this may be attributed to the fact that excess fat deposits may interfere with normal metabolic processes, which leads to increased stress levels, which may further increase the risk of periparturient disorders.

Regarding age, the prevalence of periparturient disorders was 1.87 times higher in old animals compared to young animals with statistically significant variation. This finding corroborates the findings of Gizaw *et al.* (2007) and Okumu (2006), who reported statistically significant variation in the occurrence of periparturient disorders between age groups of animals in and around Nazareth town, central Ethiopia, and in Kikuyu Division, Kiambu District, Kenya, respectively. This higher prevalence of periparturient disorders in older dairy cows than young ones in this study might be attributed to decreased immune function, increased stress, and a higher body condition score in older cows, which can increase the risk of periparturient disorders (Wang *et al.*, 2019). On the other hand, the prevalence of periparturient disorders was 26% lower in adults than in young animals (OR= 0.74, $P = 0.067$, CI=0.54-1.021), nevertheless, the difference was not statistically significant. This finding is in disagreement with previous reports (Degaris *et al.*, 2008; Kabir *et al.*, 2022), which stated that the occurrence of periparturient

disorders increases with cow age. This lower prevalence of peripartum disorders in adult dairy cows than in young ones in the present investigation might be attributed to the fact that adult animals have experienced hormonal, physiological, and physical changes that may help reduce the risk of periparturient disorders during pregnancy, parturition, and lactation (Gonzales, 2018).

In this study, the prevalence of periparturient disorders was significantly different between parities. Those cows with ≥ 7 calvings and 4-6 calvings were 2.37 and 1.4 times, respectively, more susceptible to periparturient disorders than dairy cows with 1-3 calvings. The present finding was consistent with Yohannes and Alemu (2019), who documented that there was significant variation between parities in terms of the prevalence of periparturient disorders in Asella town in central Ethiopia. On the other hand, the present finding was incomparable with the report of Ayana and Gudeta (2015) from Bako, who found that parity has no effect on the prevalence of periparturient disorders in dairy cows. This higher prevalence of periparturient disorders in ≥ 7 and 4-6 calved dairy cows than in 1-3 calved dairy cows in the current study might be attributed to higher metabolic demands in more parous cows due to increased milk production and wear on their bodies during multiple pregnancies, which may make them more vulnerable to health problems.

In an attempt to identify the effect of season on the occurrence of periparturient disorders, a higher (39.86%) prevalence of periparturient disorders was recorded in dairy cows calved from June to August than in those calved in other months of the year. This is consistent with a report by Lima *et al.* (2015), who found that dairy cows calving in the summer season were more often affected by periparturient disorders than cows calving in other seasons. This is in disagreement with the reports by Lema *et al.* (2003), Siyoum *et al.* (2016), and Gebeyehu (2018), who reported that cows were almost twice as likely (OR = 2.3) to have health problems in the spring season (March, April, and May) compared to other seasons. Differences between findings may be due to differences in environmental conditions, breeds, and management systems. Moreover, this higher prevalence of periparturient disorders in the current study in summer might be attributed to the increased environmental challenge to cows due to higher rainfall and associated humidity in this season, which predisposes them to the periparturient disorders. Besides, seasonal changes may

reflect changing exposure to infectious agents, a changing pattern of endocrine function, and different seasonal feeding regimes (Ghorbani and Asadi, 2004).

According to the current finding, the prevalence of periparturient disorders statistically varied between farm locations. In comparison to farms found in Areka districts, Sodo dairy farms had a 24% lower prevalence of peripartum disorders (OR = 0.76, $p = 0.036$, 95% CI = 0.58-0.982), while farms found in Sodo Zuryia had an approximately 36% lower prevalence of periparturient disorders ($p = 0.005$, OR = 0.643, 95% CI = 0.473-0.877). This result was allied to Weldegebriall (2015) reports from the Tigray Region. On the other hand, this outcome was at odds with that of Benti and Zewdie (2014), who found that districts had no discernible impact on the prevalence rate of periparturient disorders ($p > 0.05$). The variation between districts in this study might be brought on by variations in agroecology, management of animal husbandry, and extension services.

The current study result revealed that prevalence of mastitis had 3.6 and 1.44 times higher in old and adult animals respectively, than younger animals with statistically significant ($p=0.000$) variation between old and young, but not between adult and young dairy cows. This was agreed with the findings of Dego and Tareke (2003) in selected areas of southern Ethiopia; Abera *et al.*, (2013) in Adama town, Ethiopia, and Mungube *et al.* (2004) in central highland of Ethiopia found that the risk of mastitis increases significantly with the advancing age of the cows. Augmentation of mastitis prevalence with increasing age can be due to increasing ease of penetration of the teat duct by pathogens and previously accumulated pathogens (Radostits *et al.*, 2007). In addition, old animals may be at higher risk of mastitis due to factors such as reduced immune function, and effects of repeated lactations.

The prevalence of mastitis was 2.84 times higher in dairy cows with obese body condition than those with good body condition (p value = 0.001, CI= 1.5255-5.298). This finding was disagreed the reports of Tezera and Ali, (2021) in and around Assosa town, Benishangul- Gumuz Regional State, Western Ethiopia; Awale *et al.*, (2012); Girma (2010) who found that poor body conditioned dairy cows had higher prevalence of mastitis than good body conditioned ones. This higher prevalence of mastitis in obese dairy cows in present finding might be attributed to that

obese dairy cows tend to have a higher energy intake and may be overfed, which can lead to an increased risk of mastitis because excess energy intake can lead to changes in the composition of milk, making it more susceptible to bacterial infections (Richard *et al.*, 2020).

The current study found a strong statistical relationship between the prevalence of mastitis and the parity of dairy cows, with the risk of mastitis increasing with parity number. The prevalence of mastitis was 4.64 and 1.83 times higher in ≥ 7 and 4-6 calved dairy cows respectively, than 1-3 calved dairy cows. This result was in agreement with previous studies conducted in Ethiopia (Kebebew and Jorga, 2016; Getaneh and Gebremedhin, 2017; Girma and Tamir, 2022) who reported that parity has significant effect on prevalence of mastitis. This higher prevalence of mastitis in ≥ 7 and 4-6 calved dairy cows than 1-3 calved ones might be attributed to presence of better active mononuclear leukocyte function in few calved dairy cows than the more parous cows (Jha *et al.* 2010). As well, this could be due to the steady reduction in the body's immune system, and anatomical changes in the udder and teats in more parous cows which may all contribute to the rise in the prevalence rate in 4-6 and ≥ 7 calved dairy cows. Furthermore, it might be that cows calved ≥ 7 and 4-6 calves have a higher milk production, which can increase the risk of udder infections and longer lactation period, which can increase their exposure to mastitis-causing bacteria.

Based on analysis of farm location data, farm location had no statistically significant effect on the prevalence of mastitis. This finding was comparable to that of Jalil *et al.* (2022) who found that farm location showed no significant effect on prevalence of mastitis. This non-significant difference in mastitis prevalence between farm locations in the current study may be attributed to the breeds of dairy cows commonly raised in the study sites are similar and therefore equally susceptible to mastitis.

In the current investigation, body condition of dairy cows under study has no statistically significant effect on the prevalence of lameness. This finding was inconsistent with the reports of Randalln *et al.* (2015) and Green *et al.* (2014) who found that body condition was associated with an increased risk of lameness in dairy cows. This non-significant variation in the prevalence

of lameness between the body condition of dairy cows may be due to the fact that they are get similar veterinary services and well husbandry system.

The present study revealed that the prevalence of lameness was highest in September to November (45%) and lowest in March to May (3.75%). This finding was inconsistent with that of Foditsch *et al.* (2016), who reported that the occurrence of lameness is higher in summer, followed by winter, autumn and spring. This higher prevalence of lameness in the spring season in the current finding may be attributed to the transition from summer housing to spring grazing systems (Crossley *et al.*, 2021). This change in environment can be stressful for cows and can increase their risk of lameness.

The location of farm had no statistically significant effect on the prevalence of lameness. This current investigation was incomparable with finding of Sheferaw *et al.* (2021) and Rashad *et al.* (2022) who reported that location of farm had significant effect on prevalence of lameness in selected farms of southern Ethiopia and Alexandria, Egypt respectively. This insignificant difference of prevalence of lameness between location of farm might be attributed to similar in way of hoof cutting process and awareness of husbandry system in farms.

In present study, parity has shown statistically high significant effect on the prevalence of lameness in dairy cows under study. The likelihood of dairy cows with 4-6 and ≥ 7 parity was 2.94 and 4.6 times higher than those with 1-3 parity. This result was consistent with the finding of Sheferaw *et al.* (2021) who documented that the prevalence of lameness was highly related to the parity of dairy cows in selected farms of southern Ethiopia. This higher prevalence of lameness in dairy cows having ≥ 4 parity than in the 1-3 calving dairy cows in the current study may be the increased metabolic demands in high and moderate calving dairy cows, which may make them more susceptible to metabolic disorders. These disorders can contribute to the development of lameness by affecting the cow's ability to maintain proper body condition and support its weight (Gulinski, 2021).

Compared to young dairy cows, the prevalence of lameness was 2.6 times higher in old dairy cows. This finding was consistent with that of Henta (2018) who reported that lameness was

most prevalent in older animals in Wolaita Soddo and nearby Kebeles in Bossa Kacha and Offa Sere. This higher prevalence of lameness in older cows than young cows can be attributed to the fact that older cows may have weaker immune systems, making them more vulnerable to infectious diseases and other health problems such as arthritis and other joint problems that can contribute to the development of lameness. On the other hand, there was no statistically significant difference between adult and young dairy cows in terms of lameness prevalence. This result was comparable with the findings of Sulayeman and Fromsa (2012) who found that age was not statistically associated with the prevalence of lameness in and around Hawasa town in southern Ethiopia. This non-significant difference in prevalence of lameness between adult and young dairy cows in this study may be attributed to similar nutrition and management practices.

5.5. Impact of Parturient Disorders, Mastitis and Lameness on First Service Conception Rate

The current result showed that periparturient disorders, mastitis, and lameness had a significantly negative impact on the first-service pregnancy rate ($p = 0.000$). The first-service pregnancy rates in dairy cows with and without periparturient problems were 5.88% and 52.26%, respectively, with statistically significant variation. This is in agreement with dystocia (Kim *et al.*, 2016), and retained placenta were associated with a slight decrease in the FSC rate (4% to 10%) (Herradon *et al.*, 2004; Kim *et al.*, 2019). Similarly, this was consistent with Siddiqui *et al.* (2013) and Inchainri *et al.* (2010), who reported that cows with periparturient disorders had a lower probability of conception at first service than cows without such disorders. This negative impact of periparturient disorders on the first-service conception rate in the current study might be attributed to the fact that these disorders can lead to inflammation and uterine infection, which can delay the return to cyclicity and decrease the likelihood of successful breeding. This could be reason for affected cows were less likely to conceive at first service.

The first service conception rate was higher in normal cows (55.58%) than in mastitis-affected cows (2.56%). This finding disagreed with the report of Sadeghi *et al.* (2021) in the Northwest of Spain, who found that FSCR did not differ between the normal and mastitis groups (29.6% and 25.8%, respectively; $p = 0.134$). The negative impact of mastitis on FSCR in the current study

might be attributed to mammary gland infection, which causes immune responses, resulting in the abnormal secretion of cytokines and hormones and abnormal function of the reproductive system, such as the ovary, corpus luteum, and uterus. These factors contribute to a decrease in the first-service conception rate.

First-service conception rates in lame and non-lame dairy cows were 2.34% and 55.41%, respectively. This finding corroborates those of Archer *et al.* (2010) and Garvey (2022), who found that lameness can negatively impact FSCR. This low first-service conception rate in lame cows in the current study might be attributed to reduced mobility due to lameness, which diminishes the demonstration of estrus and makes them anestrous, leading to poor detection of estrus signs and improper timing of inseminations.

5.6. Impact of Endometritis on Reproductive Performances

The current result revealed that endometritis had a statistically significant adverse impact on the reproductive performance of dairy cows. During the study period, dairy cows suffering from endometritis had a significantly longer calving-to-conception interval than those without endometritis. This finding supports the reports of Tayebwa *et al.* (2015) in dairy cattle of Central Uganda, who stated that endometritis-affected cows have a longer calving-to-conception interval than normal cows. Secondly, endometritis had a potential impact on the calving-to-first service interval of dairy cows in the study area. This finding was comparable to that of Belachew (2007) in Debrezeyit, who reported that CFSI had a significantly higher mean difference between cows with endometritis and normal cows. Regarding the number of services per conception, it was significantly ($P = 0.0000$) higher in affected cows than normal cows. This current finding corroborates a large-scale study by Leblanc *et al.* (2000) in Canada; Plontzke *et al.* (2010) in Argentina found that cows affected with endometritis had an increased number of inseminations per conception than normal dairy cows. Besides, the present investigation was allied to the report of Nyabinwa (2021) in Gasabo District of Rwanda, who found that the positive cows had a longer calving to first service and required more services per conception. Similarly, it has also been reported that endometritis prolongs the interval from calving to first service and the calving to conception interval, increases NSPC (Raab *et al.*, 2003), and exerts a profoundly detrimental

impact on reproductive performance (Gilbert *et al.*, 2005). The depression of reproductive parameters in endometritis could be due to the toxic effects of diseases on uterine tissues, which affect reproductive performance (Dawod *et al.*, 2015). Furthermore, this declining reproductive performance in endometritis-affected cows in the current study may be associated with delayed uterine involution (Shrestha *et al.*, 2004; Chaudhari *et al.*, 2017), disruption of endometrial function, reduction of steroid concentrations in ovarian follicles (Green *et al.*, 2011), and ovarian dysfunction (Herath *et al.*, 2007).

5.7. Impact of Retained Placenta on Reproductive Performances

In this study, retained placenta had a significantly negative impact on the calving-to-conception interval, conception-to-first service, and number of services per conception. Thus, dairy cows affected by retained placenta had delayed CFSI and CCI as well as required a higher number of services per conception than normal cows. This finding was comparable with reports by Shiferaw *et al.* (2005) from the central highlands of Ethiopia. Besides, it was allied with Schindler *et al.* (1991); Gaafar *et al.* (2010); Rahawy (2021); and Kamel *et al.* (2022), who found that dairy cows affected by retained placenta had a longer calving to first service and an increased number of services per conception than normal dairy cows. Conversely, other authors documented that retained placenta has no effect on calving to first service or calving to conception interval (Bonneville *et al.*, 2011; Kaneko and Kawakami, 2008). This negative impact of retained placenta on CCI, CFSI, and NSPC in the current study might be attributed to cows that experience RP being at increased risk of chronic endometritis and pyometra, which in turn leads to a decreased conception rate and increased calving to conception interval. This might be attributed to RP can cause a delay in uterine involution and create a conducive environment for bacterial growth and infection (Qu *et al.*, 2014; Peltoniemi *et al.*, 2015).

5.8. Impact of Dystocia on Reproductive Performances

In this investigation, dystocia had a significantly impact on the calving-to-conception interval ($P < 0.05$). This result was in line with the finding of Birmachu and Hunde (2021) from Arsi Negele, Oromia Regional State, Ethiopia, who reported that dairy cows that encountered dystocia had a

prolonged calving-to-conception interval. Those cows affected by dystocia had a significantly ($P < 0.05$) higher number of services per conception as compared to normal cows (2.31 vs. 1.471). The current result was consistent with reports by Ghavi (2016), Gaafar *et al.* (2011), and Maturana *et al.* (2007), who found that the effect of dystocia had a statistically significant adverse effect on the number of services per conception. This higher number of services per conception in cows affected by dystocia might be due to the lower conception rate associated with dystocia. This demonstrates that dystocia has an impact on reproductive performance, as documented by Bonneville *et al.* (2011). This adverse effect of dystocia on CCI and NSPC in the current study might be attributed to the fact that cows experiencing dystocia are at increased risk of uterine infections and retained fetal membranes (Ghavi and Ardalan, 2011). These complications can lead to decreased conception rates, which in turn increase NSPC and CCI. In addition, dystocia can cause tears, lacerations, and other injuries to the reproductive tract, which lower the cows' conception abilities.

5.9. Impact of Hypocalcemia on Reproductive Performances

The result of the current investigation revealed that hypocalcemia had a significant impact on the calving to conception interval, calving to the first service, and the number of services per conception. This result corroborates the findings of Lobago *et al.* (2006) in Selale, Central Ethiopia; Birmachu and Hunde (2021); Samuel *et al.* (2012); and Caixeta *et al.* (2017), who reported that hypocalcemia negatively affected reproductive performance due to causing significantly prolonged the CFSI, increased both the calving-to-conception interval and the number of services per conception.

This negative impact of hypocalcemia on CFSI, CCI, and NSPC in the current study might be due to delayed uterus involution caused by uterine prolapse in cases of hypocalcemia. The delayed involution of the uterus had a negative effect on the return of reproductive organ function during the voluntary waiting period (Oetzel, 2010). This is because low calcium levels can cause muscle weakness and poor uterine contractions, which can make it difficult for the cow to expel the placenta after calving and increase the risk of uterine infections. Besides,

hypocalcemia can affect the cow's immune system, making cows more susceptible to infections that can further impact reproductive performance.

5.10. Impact of Mastitis on Reproductive Performances

The results of the current study demonstrated that mastitis had a statistically significant impact on the reproductive performance of dairy cows. Those dairy cows affected by mastitis had a longer calving to first service (91.2 ± 13.4 d vs. 88.88 ± 12.3 d), calving to conception interval (115.8 ± 22.72 d vs. 100 ± 21.4 d), and number of services per conception (2.11 vs. 1.467) than normal cows. The current outcome is in agreement with the findings of Asmare and Kassa (2017), who reported mastitis had the potential to undermine fertility through declining reproductive performance in Sodo town and its surroundings, Wolaita zone, Ethiopia. Besides, the result of the present study was aligned with the findings of Kumar *et al.* (2017) and Ahmadzadeh *et al.* (2009), who reported that the adverse effects of mastitis on reproduction are mostly due to prolonged CFSI and CCI. Similarly, mastitis-affected cows required a higher number of services per conception than normal cows (Gunay and Gunay, 2008), which aligns with the present finding. This negative impact of mastitis in the current investigation could be due to the activation of inflammatory immunological responses in the udder, which might cause aberrant estrous cycle durations, anovulation at estrus, and unsuccessful fertilization (Huszenicza *et al.*, 2005; Pinzon and Ruegg, 2011).

According to Hansen *et al.* (2004), the activation of inflammatory pathways disrupts reproductive function at the hypothalamic-pituitary axis, ovary, oocyte, and embryo (Kumar *et al.*, 2017). The diseased mammary gland releases a number of bioactive chemicals like prostaglandin F₂ into the bloodstream, which have the potential to affect reproductive organs such as the ovary, hypothalamus, and endometrium (Herath *et al.* 2007). In addition, it might be attributed to mastitis, which causes decreased ovarian function and disrupts hormonal balance due to its systematic effect. This can result in delayed ovulation, irregular estrus cycles, and decreased fertility. Moreover, cows with chronic or severe mastitis may experience pain and discomfort, which can lead to decreased feed intake and compromise their reproductive performance.

5.11. Impact of Lameness on Reproductive Performances

The present investigation revealed that lameness had a significant impact on the reproductive performance of dairy cows. Thus, lame cows had a prolonged calving to first service interval, a delayed calving to conception interval, required a high number of services per conception, and a longer age at first calving than non-lame cows. However, lameness had no significant impact on age at first service. This finding corroborates the report of Bekuma *et al.* (2018), who documented that lameness had an adverse impact on the reproductive performance of dairy cows in Ethiopia. Similarly, it was consistent with the finding of Mellado *et al.* (2018), who reported that lame cows increased the odds of requiring multiple services per conception and prolonged the calving-to-conception interval. This might be attributed to the fact that lame cows have a decreased chance to show correct time of estrus, mate, and conceive (Tsousis *et al.*, 2022), which in turn cause reduced reproductive performance.

In addition, the negative impact of lameness on the reproductive performance of dairy cows in the current study might be attributed to the following reasons: The first reason is that lameness can lead to increased stress and inflammation in the cow's body, irregular estrus cycles, and decreased fertility because the hypothalamus-pituitary-ovarian axis's functionality is greatly impacted. This could be related to negative energy balance, pain, hormonal insufficiency, delayed cyclicity (Garbarino *et al.*, 2004), increased incidence of ovarian cysts, and reduced ovulation (Morris *et al.*, 2009). Secondly, lameness can lead to decreased feed intake and weight loss, which can further impact reproductive performance because cows need adequate nutrition to support reproductive processes such as ovulation and embryo development. Finally, lame cows may have difficulty mounting, which can lead to decreased conception rates and increased calving intervals because lame cows may not show heat behaviors or may have difficulty standing to mount, making it harder for them to become pregnant.

6. CONCLUSION AND RECOMMENDATIONS

The important points in dairy farms are a smaller number of services per conception, a shorter calving-to-conception interval, a short calving-to-first service. However, periparturient disorders, mastitis, and lameness are the key problems that negatively impact dairy cows' potential to reproduce. Body condition, age, and parity, as well as calving season, are associated risk factors that were linked to the occurrence of parturient disorders, mastitis, and lameness in the present study. The location of the farm is a potential risk factor that is associated with the prevalence of periparturient disorders but not with the occurrence of mastitis and lameness. The first-service conception rate was higher in normal cows than in diseased cows. Besides, findings revealed that periparturient disorders, mastitis, and lameness had an impact on the calving-to-conception interval, calving-to-first service, and number of services per conception. Lameness had a significant negative effect on age at first calving. However, dystocia and lameness had no statistically significant effect on the calving-to-first-service interval or age at first service, respectively. This indicated that the parturient disorders of mastitis and lameness had a great negative impact on reproductive performance.

Based on above conclusion, the following recommendations are forwarded:

- ❖ Good feeding system should be applied around the transition period, and concentrate feed should be reduced in the last trimester of pregnancy in over conditioned dairy cows in order to decrease the occurrence of dystocia.
- ❖ Take care of hygienic practices in dairy cows, especially those calved during the rainy season to reduce occurrence of periparturient disorders and mastitis in June to August.
- ❖ Awareness of good udder health and foot care should be created.
- ❖ The regular monitoring of dairy cows around transition period should be applied.
- ❖ Early detection and immediate treatment of periparturient disorders, mastitis and lameness in dairy cows are very important.
- ❖ Good care of heat detection and correct time of insemination need to be implemented.
- ❖ Further detailed studies on impact of parturient disorders, mastitis and lameness on reproductive performance in the area should be performed.

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8. APPENDICES

Appendix 1: Body condition scoring system

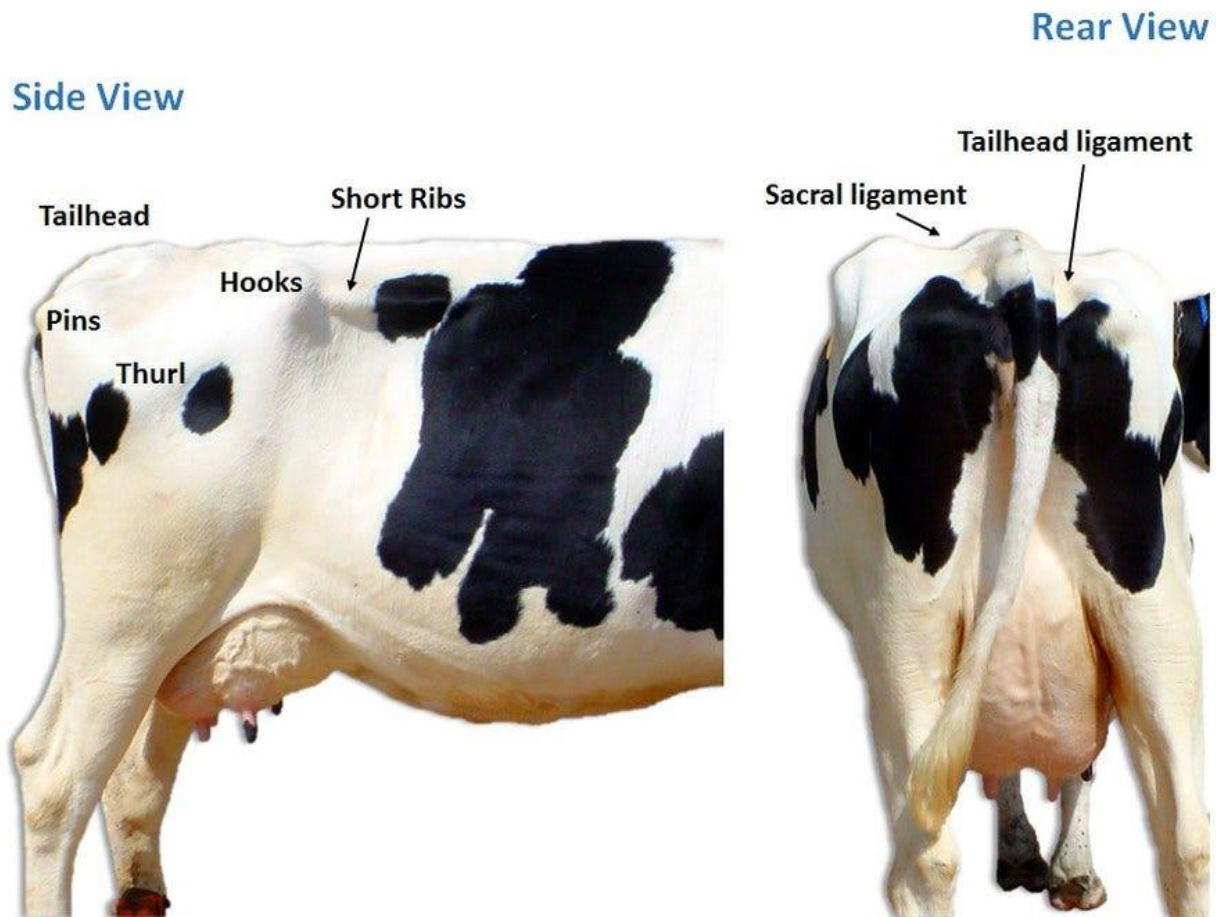


Figure 5: Anatomical regions used for determining BCS

Score of 1 (very poor body condition)

- ❖ Each short rib is covered in a thin layer of flesh.
- ❖ The chine, loin, and rump bones are particularly noticeable.
- ❖ With a very thin layer of tissue covering them and significant depressions between the bones, hook and pin bones protrude prominently.
- ❖ Deep hollow under tail and around tail head (between pin bones).

- ❖ Sharp protrusion of bone structure; prominent ligaments and vulva.

Body condition score 2 (poor body condition)

- ❖ Individual short ribs are discernible but not overt.
- ❖ The ends of the ribs feel sharp to the touch but have a thicker covering of flesh.
- ❖ Short ribs don't have the same pronounced "overhanging shelf" effect.
- ❖ The individual bones in the chine, loin, and rump regions can be easily felt, but they are not visually distinct
- ❖ Although the depression between the hook and pin bones is noticeable, it is not less severe
- ❖ The area between the pin bone and the area below the tail head is slightly depressed, but the skeletal structure has some flesh covering.

Body condition scoring 3 (good body condition)

- ❖ Short rib ends can be felt by lightly pressing on them.
- ❖ The short ribs seem smooth, and the effect of the overhanging ledge is less obvious.
- ❖ The backbone appears as a rounded ridge; to feel individual bones, firmly applied pressure is required.
- ❖ The hook and pin bones are smooth and rounded.
- ❖ The region surrounding the tail head and between the pin bones seems smooth and devoid of any deposits of fat.

Body condition score 4 (fat)

- ❖ Individual short ribs are distinguishable only by firm palpation.
- ❖ Short ribs lack the overhanging shelf look and seem flat or rounded instead.
- ❖ In the chine region, the backbone forms a smooth, rounded ridge.
- ❖ The rump and loin areas look flat.
- ❖ The spread between the hooks is flat and rounded.

- ❖ The tail and pin bones' area are rounded and shows signs of fat deposition

Body condition Score of 5 (obese)

- ❖ The subcutaneous fat deposit is quite noticeable, but the bony features of the backbone, short ribs, and hook and pin bones are not visible.
- ❖ The tail seems to be buried in fat.

Appendix 2: Retrospective Data Record Format

Record sheet for retrospective study on the impact of per parturient disorders, mastitis and lameness on reproductive performance of cross bred dairy cows in selected sites of Wolaita Zone, Southern Ethiopia.

SNo	Cow no	Calving season	FSP	age	Body condition	parity	Calving data	Endometritis	Dystocia	RFM	MF	Ketosis	Mastitis	lameness	1 st AI date	2 nd AI date	3 rd AI date	Conception date	AFS	NSC	AFC	
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						

Appendix 3: Farm data collection from Wolaita Zone Livestock and fishery resource department



Appendix 4: Data collection from Wolaita Sodo Jersey and Multiplication (Dalga)



Appendix 5: Data collection from Exodus farm College



Appendix 6: Farm Data record book from different farms

