ISSN: 2456-2912
VET 2021; 6(2): 15-22
© 2021 VET
www.veterinarypaper.com
Received: 15-01-2021
Accepted: 19-02-2021

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Postpartum clinical diseases of dairy cows managed on smallholder production system in Gasabo district, Rwanda

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DOI: https://doi.org/10.22271/veterinary.2021.v6.i2a.329

Abstract
The objective of the present retrospective cross-sectional study was to estimate the prevalence of postpartum clinical diseases (PPCDs) of dairy cows reared under existing management conditions of smallholder zero-grazing farming in Gasabo district, Rwanda. The data of PPCDs were collected retrospectively from 250 cows which calved for the period from 01 November 2019 to 29 February 2020. PPCDs were diagnosed from the hour of calving until 40 days postpartum by animal health service providers and/or farmers. Uterine diseases (UD) included clinical endometritis, retained placenta, and uterine prolapse. Non-uterine diseases (NUD) included clinical ketosis, clinical mastitis, left displaced abomasum, and milk fever. Calving problems (CP) included dystocia, stillbirth, and twin calving. Overall, 21.6% [95% confidence interval (CI): 16.9-27.1] of the cows were diagnosed with UD, 28.4% (95% CI: 23.2-34.3) with NUD, and 70.4% (95% CI: 64.7-75.7) with CP. For individual PPCD, dystocia (66.4%, 95% CI = 60.3-71.9), clinical mastitis (27.6%, 95% CI = 22.4-33.5), and retained placenta (19.2%, 95% CI = 14.8-24.5) were the most frequently observed in the sampled cows. These results provide evidence of the high prevalence of PPCDs in zero-grazed cows on smallholder farms in the study area. This is indicative of a general herd health issue, warranting that extension service needs to increase capacity building among farmers about control and prevention of PPCDs in their dairy cows.

Keywords: postpartum diseases, uterine diseases, non-uterine diseases, calving problems, smallholder farms, Rwanda

Introduction

Postpartum diseases in dairy cows occur after a decrease in dry matter intake associated with the immune deficit [1, 2]. This is because, during the transition from pregnancy state to lactation state, a dairy cow experiences several changes that include increased energy and calcium demands for lactogenesis and lactopoiesis, substantial immune suppression, a decline in dry matter intake and nutrient imbalance, and contaminated environment [1, 3, 4].

Despite physiological controls and adjustments to cope with the changes in metabolism caused by milk production [5], these changes increase the risk of postpartum diseases that are an important cause of poor reproductive performance and reduced milk yield [6–8], which consequently impair profitability and sustainability of dairy herds [6, 9]. These health diseases referred to as postpartum diseases complex consist of diseases that affect the mammary gland and the uterine tract, and metabolic disorders [2, 10]. In their studies, [2, 11, 12] reported that up to 30.0% of dairy cows develop some type of clinical disease in their first 60 days postpartum. These diseases have been classified into three groups: (i) uterine diseases (UD) (i.e. endometritis, retained placenta, and uterine prolapse); (ii) non-uterine diseases (NUD) (i.e. clinical mastitis, left displaced abomasum, and milk fever); and (iii) calving problems (CP) (i.e. dystocia and stillbirth) [2, 8, 12].

Most studies [8, 9, 11, 12] on postpartum diseases in dairy cows have been based on intensively managed commercial large dairy herds in developed countries and reported large variability in prevalence rates of postpartum clinical diseases (PPCDs), for instance, 22.1 to 63.3% for UD [8, 12], 20.6 to 23.0% for NUD [8, 12], and 8.5 to 21.2% for CP [2, 9]. However, few studies on postpartum diseases in Sub-Saharan Africa have been conducted on commercial and smallholder dairy farms, examples being Ethiopia [13] and Kenya [14]. These studies reported the prevalence of individual postpartum clinical disease (PPCD): 8.8 to 13.6% for dystocia, 28.2 to 40.4% for retained placenta, 11.2 to 15.8% for milk fever, 6.3 to 31.6 for metritis, 3.9 to 5.3% for uterine prolapse, 9.7% for mastitis, 0.5% for ketosis, and 5.8% for stillbirth, which suggest a high prevalence of PPCDs in dairy cows. The large variation in prevalence rates suggests that some herds experience substantial economic loss from these PPCDs, depending on the management practices to control and prevent the PPCDs [4]. This implies that improving dairy herds management practices and monitoring the health status of postpartum dairy cows are fundamental for obtaining adequate welfare and health, and optimal production and reproductive performance in dairy cows.

Despite the high prevalence of PPCDs previously reported by different studies, empirical evidence in zero-grazed dairy cows in Rwanda is non-existent to inform targeted management interventions. Since these PPCDs accounts for up to 8.0% of all the diseases affecting dairy cows as has been reported in large dairy herds [14], they could have an economic impact on smallholder zero-grazed dairy herds. Yet this dairy farming system holds the majority (92.0%) of the cattle population and supplies the bulk of the milk for the domestic market in Rwanda [15]. Thus, suboptimal production due to the PPCDs could have effects on national milk production. It was hypothesized that PPCDs are prevalent in smallholder zero-grazed dairy cows in Gasabo district, Rwanda. Therefore, this study is one of the first in Rwanda conducted to estimate the prevalence of PPCDs in dairy cows managed on existing management conditions of smallholder farms.

Materials and Methods

Study area

This study was conducted in smallholder zero-grazed dairy farms located in Gasabo district, Rwanda (1°52'S, 30°06'E), at an altitude of 1800-meter above sea level, with an annual mean temperature of 22°C and bimodal rainfall pattern that averages 1000 mm annually. The total cattle population in the study area is estimated at 12 414 of which 52.0% are dairy crossbreeds, 29.0% are indigenous cattle, and 19.0% are pure dairy breeds [16]. These cows are kept in a zero-grazing system, which is prevalent in Gasabo district compared to other districts. This dairy farming system is characterized by prevalent muddy conditions, low hygienic standards, weak and inconsistent herd health management plan, and a high-risk exposure to bacterial disease [17]. These conditions present risks for prevalent postpartum diseases [18, 3].

Study design and data collection

The study applied a retrospective cross-sectional design involving a total of 195 smallholder dairy herds selected through snowball sampling procedures. Animal health service providers identified the initial farmers in the sampling process. To be eligible, dairy farmers had to fit predefined study criteria: (i) having cows within their first 40 days postpartum, (ii) giving informed consent for the visits and interviews, (iii) farmers authorizing that animal health service provider assisting the cow (if any) be contacted to verify and/or complete the calving related information, and (iv) physical accessibility of the herd. Herds enrolled were visited once during the study period.

The minimum sample size of dairy cows was determined by using the formula stated by [19] as follows:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where
n = sample size
Z = z-score value at 95% confidence level
P = Expected prevalence of PPCDs
d = precision level required for a 95% confidence interval.

From the literature, the prevalence of PPCDs varies from 8.5% to 63.3% [8, 9]. Based on these prevalence estimates, the median value estimate of 35.9% was used to compute the needed minimum sample size. Therefore, with Z set to 1.96, P to 35.9%, and d to 0.06 in the formula, the minimum sample size was 246 dairy cows.

For each recruited farmer, an explanation of the objective of the study was presented, and informed consent was sought before the start of the study on their herd. The sample dairy herds granted access to an enrolment of 250 dairy cows which calved between 01 November 2019 and 29 February 2020. Breeds included were dairy breeds (predominantly crossbreeds: 57.6% and pure breeds: 27.2%) and indigenous local breeds (15.2%). The management system was a zero-grazing system in which cattle are permanently housed indoors and fed on a cut-and-curry feeding system.

In the current study, a PPCD was defined as a disease that manifested itself clinically in a dairy cow within the first 40 days postpartum and recognized by a farmer and/or animal health service providers without the need for laboratory confirmation [20]. Therefore, farmers and animal health service providers were asked to enumerate the PPCDs that they observed (if any) clinically in a dairy cow from the hour of calving until 40 days postpartum. The PPCDs data were collected retrospectively from the animal health service providers' records, herd records and/or farmer recall through an interview using a pre-tested structured questionnaire. All PPCDs were coded as 1, 0 dichotomous variables, with "1" indicating that the PPCD was present or occurred, and "0" if the cow did not show signs of that PPCD.

Furthermore, in an attempt to make appropriate on-farm diagnoses and normalize the diagnostic process of PPCD, the researchers explained to the farmers and animal health service providers the standardized diagnostic definitions of PPCDs that are not obvious before starting data collection (Table 1). In this study, cows were grouped into three groups of PPCDs: (i) uterine diseases (UD), (ii) non-uterine diseases (NUD), and (iii) calving problems (CP) groups. The grouping criterion was that the cow was diagnosed with a single or more than one PPCD. Therefore, cows were considered to have UD if they were diagnosed with clinical endometritis, retained placenta, or uterine prolapse; whereas cows were regarded to have NUD if they were diagnosed with clinical ketosis, clinical mastitis, left displaced abomasum, or milk fever. Finally, cows were classified to have CP if they had either dystocia, stillbirth, or twin calving. Because cows could develop multiple PPCDs, many of those that had CP also develop UD or NUD and vice versa.

Table 1: Definitions used for postpartum diseases considered in this study

Postpartum clinical diseases	Definition	Reference
Clinical endometritis[1]	A case where a cow had visible mucopurulent or purulent discharge at the time of oestrus and white or whitish-yellow mucopurulent vaginal discharge comes out when the animal lies down on the perineum, tail, and vulva.	[21, 22]
Clinical ketosis[2]	Is a case related to observing clinical signs that include: reduced feed intake, abnormal licking, excess salivation, decreased milk production, nervousness, odor of acetone on the breath, and sternal recumbency.	[23, 24]
Clinical mastitis[2]	Is an inflammatory response to infection-causing visible abnormal milk (e.g., color changes, fibrin clots, reduced milk yield) and changes (swelling, heat, pain, redness, or harness) in one or more quarters	[25, 26]
Dystocia[3]	Assisted calving either by the farmers who normally pull the foetus or by the animal health service providers who may pull the foetus or apply caesarean section or foetotomy.	[27]
Left displaced abomasum[2]	The presence of a reduction in the intensity of rumen movements and a fluid-gas interface when struck sharply with a finger on the left side of the abdominal cavity.	[28]
Milk fever[2]	A case related to observing clinical signs that include: nervousness, cold skin, off-feed behavior, cows becomes too weak to stand and eventually becomes comatose over a matter of time and favorable to calcium boroglunate therapy.	[29, 30]
Retained placenta[1]	Failure to expel foetal membranes for more than 12 h after calving.	[31]
Stillbirth[3]	Delivery of a dead single calf, or death of the calf in the first 12 h after calving.	[32]
Uterine prolapse[1]	Uterus slips down into or protrudes out of the vagina following calving.	[33]
Twin calving[3]	Calving of two calves.	[34]

[1]Uterine diseases, [2]Non-uterine diseases, [3]Calving problems.

The general information about the sample cows was also recorded using a pre-tested structured questionnaire: breed of cow, parity, body condition score, breeding service, cowshed flooring type, and herd size. The breeds of the cows were identified based on phenotype [35], history from farmers and the available records. The local breed was Ankole longhorn, and crossbreeds were Ankole longhorn crossed with Jersey, Friesian, Sahiwal, and Brown Swiss. The parity of the cow was classified as primiparous (one calving) and multiparous (more than one calving). The body condition score (BCS) was evaluated as described by [36] and finally, two categories were used: poor (BCS<3) and good (BCS≥3) body condition. The cowshed flooring type was classified into concrete and earthen. The breeding service was either artificial insemination or breeding bull. The herd size was grouped as small (1 to 3 cows) and medium (≥4 cows).

Data management and statistical analysis

The collected data were entered and stored in the Microsoft office excel 2016 program and analyzed using SPSS version 20.0 for Windows package software [37]. Descriptive statistics were generated using frequency procedures and cross-tabulation. The association of different variables with the occurrence of the PPCD was determined by Chi-square statistic. The prevalence of PPCDs was calculated by dividing the number of cases by the number of all cows enrolled.

Hypothesis testing was also with the Non-parametric Kruskal-Wallis H test for whether the occurrence of PPCD differs by cow's breed (indigenous cattle, dairy pure and crossbreeds). PPCD where there were overall differences based on findings with the use of the Kruskal-Wallis test were subsequently evaluated using a Mann-Whitney U test to explore pairwise comparisons. Ninety-five percent confidence interval (95% CI) for each PPCD prevalence estimate were computed by using the EpiTools software [38]. In all analyses, a probability level of $p<0.05$ was considered significant.

Results

Description of study cows

Data analyses were based on a total of 250 dairy cows from 195 different smallholder dairy farms. In this study, 34.4% were primiparous and 65.6% multiparous dairy cows. Feeding was inadequate as 84.0% of the cows were scored poor body condition score and few (16.0%) were scored good body condition. The majority (80.0%) of the cows were kept in a zero-grazing housing units with an earthen floor and few (20.0%) in units with concrete floors. Mating was predominantly bull service (52.4%) compared to artificial insemination service (47.6%).

Prevalence of postpartum clinical diseases

Overall, of the 250 cows sampled, 207 (82.8%) suffered at least one PPCD from calving until 40 days postpartum. Uterine diseases (UD) affected 21.6% (95% CI: 16.9-27.1), non-uterine diseases (NUD) affected 28.4% (95% CI: 23.2-34.3), and calving problems (CP) affected 70.4% (95% CI: 64.7-75.7) (Table 2). The most prevalent UD was retained placenta, followed by clinical endometritis, then uterine prolapse. The most prevalent NUD was clinical mastitis with only a small proportion of cows (0.4%) diagnosed with clinical ketosis. Cases of the left displaced abomasum were not observed. Of the CP evaluated, dystocia was the most prevalent, occurring in 66.4% (95% CI: 60.3-71.9) of the cows at calving. The results of the study indicated that dystocia (66.4%, 95% CI = 60.3-71.9), clinical mastitis (27.6%, 95% CI = 22.4-33.5), and retained placenta (19.2%, 95% CI = 14.8-24.5) were found to be the major PPCD more frequently observed in the sampled cows.

Table 2: Prevalence of postpartum clinical diseases of dairy cows (n = 250) encountered during the study period

Postpartum clinical diseases	Number of affected cows	Percentage (%)	95% confidence interval
Uterine diseases	54	21.6	16.9-27.1
Clinical endometritis	11	4.4	2.5-7.7
Retained placenta	48	19.2	14.8-24.5
Uterine prolapse	4	1.6	0.6-4.0
Non-uterine diseases	71	28.4	23.2-34.3
Clinical ketosis	1	0.4	0.0-2.2
Clinical mastitis	69	27.6	22.4-33.5
Left displaced abomasum	0	0.0	0
Milk fever	6	2.4	1.1-5.1
Calving problems	176	70.4	64.7-75.7
Twin calving	4	1.6	0.6-4.0
Stillbirth	27	10.8	7.5-15.3
Dystocia	166	66.4	60.3-71.9

Table 3 shows the prevalence of the UD, NUD, CP, and individual PPCD according to the breed of cow, body condition score, breeding services, floor type, herd size, and season of calving. Of all variables considered in this study, breed of cow, BCS, breeding services, and parity of cow did not influence (p>0.05) prevalence for UD and NUD. In contrast, the prevalence of CP was relatively high compared to those of UD and NUD, but did not differ (p>0.05) among all variables considered in this study.

The breed of the cow did not influence (p>0.05) prevalence for UD, NUD, and CP. Nevertheless, the prevalence of some individual PPCD differed with the breed. Dairy pure breeds had a greater (p<0.05) prevalence of UP than crossbreeds and indigenous cattle. On the other hand, indigenous cattle breeds had a lower (p<0.05) prevalence of clinical mastitis than dairy pure breeds and dairy crossbreeds. Moreover, neither BCS, breeding services, nor parity of cow influenced the occurrence of UD, NUD, and CP. However, the prevalence of some individual PPCD differed with BCS, parity of cow and breeding services. Cows in good body condition had a greater (p<0.05) prevalence of clinical ketosis than those in poor body condition. Cows artificially serviced had a high (p<0.05) prevalence of twin calving than bull served cows. Further, primiparous cows had significantly higher (p<0.05) prevalence of a stillbirth than multiparous cows. Cowshed flooring type influenced prevalence for UD but did not influence prevalence for NUD and CP. Cows kept in cowshed with earthen floor had greater (p<0.05) prevalence of retained placenta (22.5%) than cows kept in cowshed with concrete floor (6.0%). Herd size and season of calving influenced the prevalence of NUD. More clinical mastitis cases occurred in the rainy season (38.3%) than in the dry season (22.5%, p<0.05). Furthermore, clinical mastitis cases occurred more frequently in cows kept in small herd size (37.3%) compared to cows kept in medium herd size (17.7%).

Table 3: Prevalence of three groups of postpartum clinical diseases in dairy cows with different variables

Variables	n	Uterine diseases,% (n)				Non-uterine diseases,% (n)				Calving problems,% (n)			
		CE	RP	UP	Overall	CK	CM	MF	Overall	TC	ST	DYS	Overall
Breed of cow													
Local breeds	38	5.3 (2)	26.3 (10)	0.0 (0)	26.3 (10)	0.0 (0)	13.2^{b} (5)	1.4 (2)	13.2 (5)	0.0 (0)	10.5 (4)	55.3 (21)	60.5 (23)
Crossbreds	144	2.1 (3)	14.6 (21)	0.0 (0)	16.0 (23)	0.0 (0)	32.6^{a} (47)	2.9 (2)	34.0 (49)	2.8 (4)	11.1 (16)	66.0 (95)	70.1 (101)
Pure breeds	68	8.8 (6)	25.0 (17)	5.9 (4)	30.9 (21)	1.5 (1)	25.0^{a} (17)	5.3 (2)	25.0 (17)	0.0 (0)	10.3 (7)	73.5 (50)	76.5 (52)
χ^2 statistic		5.068^{ns}	4.693^{ns}	10.88*	6.652^{ns}	2.87^{ns}	6.026*	2.043^{ns}	6.971^{ns}	2.992^{ns}	0.035^{ns}	3.674^{ns}	2.985^{ns}
BCS													
Good	40	5.0 (2)	10.0 (4)	2.5 (1)	10.0 (4)	2.5 (1)	35.0 (14)	2.5 (1)	35.0 (14)	2.5 (1)	10.0 (4)	65.0 (26)	70.5 (148)
Poor	210	4.3 (9)	21.0 (44)	1.4 (3)	23.8 (50)	0.0 (0)	26.2 (55)	2.4 (5)	27.1 (57)	1.4 (3)	11.0 (23)	66.7 (140)	70.0 (28)
χ^2 statistic		0.041^{ns}	2.598^{ns}	0.245^{ns}	3.784^{ns}	5.271*	1.305^{ns}	0.002^{ns}	1.020^{ns}	0.245^{ns}	0.032^{ns}	0.042^{ns}	0.004^{ns}
Breeding services													
AI	119	3.4 (4)	16.8 (20)	0.0 (0)	19.3 (23)	0.8 (1)	23.5 (28)	1.7 (2)	24.4 (29)	3.4 (4)	12.6 (15)	63.9 (76)	69.7 (83)
Breeding bull	131	5.3 (7)	21.4 (28)	3.1 (4)	23.7 (31)	0.0 (0)	31.3 (41)	3.1 (4)	32.1 (42)	0.0 (0)	9.2 (12)	68.7 (90)	71.0 (93)
χ^2 statistic		0.582^{ns}	0.838^{ns}	3.693^{ns}	0.692^{ns}	1.193^{ns}	1.883^{ns}	0.502^{ns}	1.814^{ns}	4.475*	0.768^{ns}	0.654^{ns}	0.046^{ns}
Parity of cow													
Primiparous	86	3.5 (3)	24.4 (21)	2.3 (2)	26.7 (23)	1.2 (1)	33.7 (29)	3.5 (3)	34.9 (30)	2.3 (2)	17.4 (15)	64.0 (55)	70.9 (61)
Multiparous	164	4.9 (8)	16.5 (27)	1.2 (2)	18.9 (31)	0.0 (0)	24.4 (40)	1.8 (3)	25.0 (41)	1.2 (2)	7.3 (12)	67.7 (111)	70.1 (115)
χ^2 statistic		0.259^{ns}	2.301^{ns}	0.438^{ns}	2.049^{ns}	1.915^{ns}	2.458^{ns}	0.663^{ns}	2.710^{ns}	0.438^{ns}	6.003*	0.352^{ns}	0.018^{ns}
Floor type													
Concrete	50	0.0 (0)	6.0 (3)	0.0 (0)	6.0 (3)	0.0 (0)	20.0 (10)	2.0 (1)	20.0 (10)	4.0 (2)	12.0 (6)	74.0 (37)	76.0 (38)
Earthen	200	5.5 (11)	22.5 (45)	2.0 (4)	25.5 (51)	0.5 (1)	29.5 (59)	2.5 (5)	30.5 (61)	1.0 (2)	10.5 (21)	64.5 (129)	69.0 (138)
χ^2 statistic		2.877^{ns}	7.020*	1.016^{ns}	8.982*	0.251^{ns}	1.807^{ns}	0.043^{ns}	2.710^{ns}	2.287^{ns}	0.093^{ns}	1.618^{ns}	0.941^{ns}
Herd size													
Small	126	3.2 (4)	17.5 (22)	0.0 (0)	18.3 (23)	0.8 (1)	37.3 (47)	2.4 (3)	38.1 (48)	0.8 (1)	11.1 (14)	65.1 (82)	69.8 (88)
Medium	124	5.6 (7)	21.0 (26)	3.2 (4)	25.0 (31)	0.0 (0)	17.7 (22)	2.4 (3)	18.5 (23)	2.4 (3)	10.5 (13)	67.7 (84)	71.0 (88)
χ^2 statistic		0.907^{ns}	0.496^{ns}	4.131*	1.679^{ns}	0.988^{ns}	11.965*	0.000^{ns}	11.743*	1.049^{ns}	0.026^{ns}	0.199^{ns}	0.038^{ns}
Season of calving													
Rainy	81	0.0 (0)	12.3 (10)	0.0 (0)	11.1 (9)	0.0 (0)	38.3 (31)	0.0 (0)	38.3 (31)	3.7 (3)	13.6 (11)	66.7 (54)	70.4 (57)

Dry	169	6.5 (11)	22.5 (38)	2.4 (4)	26.6 (45)	0.6 (1)	22.5 (38)	3.6 (6)	23.7 (40)	0.6 (1)	9.5 (16)	66.3 (112)	70.4 (119)
x^2 statistic		5.515*	3.629^{ns}	1.948^{ns}	7.784*	0.481^{ns}	6.829*	2.946^{ns}	5.742*	3.366^{ns}	0.961^{ns}	0.004^{ns}	0.000^{ns}

*^{ns}not significant (p>0.05), *statistically significant (p<0.05), x^2 = chi-square, a and b = percentage within the same column followed by different letters are statistically different (p<0.05), CE = clinical endometritis, RP = retained placenta, UP = uterine prolapse, CK = clinical ketosis, CM = clinical mastitis, MF = milk fever, TC = twin calving, ST= stillbirth, DYS = dystocia, AI = artificial insemination, BCS = body condition score.

Discussion

This retrospective study presents compelling evidence for the prevalence of postpartum clinical diseases (PPCDs) of dairy cows managed on a smallholder production system in Gasabo district, Rwanda. The study revealed that out of 250 dairy cows enrolled, 207 were affected by PPCDs with an overall prevalence rate of 82.8%. This is an indication of a high prevalence of PPCDs in smallholder dairy herds. This prevalence was higher than some previously reported rates ranging from 18.3% to 56.0% [4, 10, 39]. The differences in the findings could be related to different PPCDs definitions, production system, sample size, breed of cow, herd management conditions and skills of farmers for controlling and preventing PPCDs that might be appeared in the different study sites [40]. Prevalence may also depend on the quality of herd health records. In the current study, all cases of PPCDs were obtained from the animal health service providers' records, herd records and/or farmer recall, which could have influenced our findings. A similar observation has been reported in dairy herds of Chile [4].

This study is one of the first to estimate the prevalence of PPCDs that were grouped into three health categories: uterine diseases (UD), non-uterine diseases (NUD), and calving problems (CP). The prevalence of UD (21.6%), in the present study, was in agreement with the 22.1% reported in north-central Florida, the United States of America, by [12]. In contrast, this prevalence was lower than the rate (63.3%) reported by [8] in Brazilian postpartum dairy cows. The prevalence of NUD observed in this study (28.4%) was similar to that observed in Florida [12], but the prevalence was higher than the previously reported rate in Brazil (20.6%) [8]. In this study, the prevalence of CP was higher than some previously reported in Brazil (8.7) [8] and in Florida (8.5%) [9]. Overall, the high prevalence of UD, NUD, and CP in the sampled cows is most likely attributed to the little attention paid by farmers to these diseases due to lack of awareness on the economic losses from these diseases and lack of management practices for controlling and preventing the PPCDs on dairy herds.

Differences in variation in the prevalence of UD, NUD, and CP in these studies could be explained by the different definition criteria for these diseases, different characteristic of the cows, or varied environment and herd health control conditions. For instance, in the study of [8], UD grouped retained placenta, metritis, clinical and subclinical endometritis; NUD was a combination of mastitis, displaced abomasum, pneumonia, and lameness. In contrast, in the current study, standardized case definitions were used, and UD grouped clinical endometritis, retained placenta, and uterine prolapse; whereas NUD grouped clinical ketosis, clinical mastitis, left displaced abomasum, and milk fever.

Analysis of the prevalence of PPCDs revealed that some variables like herd size, floor type and season of calving had statistically significant association on the occurrence rate of UD and NUD. A higher (25.5%) prevalence rate of UD was obtained in cows kept in the cowshed with the earthen floor than those kept in the cowshed with concrete floor (6.0%). Similarly, cows calved in the rainy season had a high prevalence of UD (26.6%) compared to those calved in the dry season (11.1%). These findings are likely the consequences of an earthen floor that increases the risk of bedding materials to become quickly heavily soiled particularly during the rainy season. Therefore, cows calved in less hygienic conditions and were crowded together in a small housing unit. These conditions could expose the cows to microorganisms at calving which are more comfortable in these dirty and wet environments [41, 42]. These microorganisms may ascend the reproductive tract and increase the potential of UD to develop [43, 3], and thus, farmers are advised to maintain good hygiene in the cowshed to reduce uterine contamination.

A greater prevalence of NUD (38.1%) was observed in cows kept in small herd size than those kept in medium herd size (18.5%). Additionally, the high prevalence of NUD (38.3%) was obtained in cows calved in the rainy season as compared to those calved in the dry season (23.7%). These findings could be explained by the fact that in small herd size, cows are crowded together without adequate spacing. As a result, cows calved in poor hygienic environments. In such conditions, cows are exposed to environmental pathogens especially for mastitis as it was observed highly prevalent (27.6%) among diseases that constitute NUD. Therefore, frequent cleaning and a comfortable cow lying area may help to minimize infection pressure around the cow in the transition period.

For individual PPCDs, retained placenta, dystocia and clinical mastitis were more frequently observed in the study area. The prevalence rate of retained placenta found in this study (19.2%) was similar to that reported in Ethiopia by [40], but the prevalence was higher than some previously reported rates (8.8-13.2%) [4, 8, 12] and lower than the rate (28.2%) reported in Kenya [14]. The variation in the prevalence of retained placenta may be attributed to the difference in feeding practices and general herd management conditions. Cows in the study area were poorer fed as evidenced by body condition score as a proxy of feeding practices. The high proportion (84.0%) of the sampled dairy cows had poor body condition. Also, [44] reported that stress, late or premature calving, dystocia, twin calving, mineral, vitamin and protein deficiencies are considered as major causes of retained placenta. Therefore, to prevent retained placenta, farmers should ensure an adequate balanced diet in the transition period, as well as hygiene during the calving and post-calving period.

The prevalence of dystocia (66.4%) in this study was higher than that previously reported for large confinement dairy herds (5.6-41.7%) [40, 45]. The difference could be attributed to the different case definitions of dystocia [46]. Another probable reason for high dystocia cases observed in this study could be related to the zero-grazing farming, imbalanced nutritional conditions and lack of exercise areas in a cowshed. In the sample farms, cows are kept in small zero-grazing housing unit without exercise areas. This condition may predispose pregnant cows to dystocia due to insufficient exercise. The current finding is consistent with the observation of [47] in Denmark, who found that cows kept on pasture had a lower risk of dystocia relative to cows in zero-grazing herds. This is because cows that graze or having exercise areas in cowshed their uterine muscle tonicity could be increased during calving and thereby making calving easier [46–48].

Finally, imbalanced nutritional conditions observed in the study cows as evidenced by a high proportion of cows in poor body condition may predispose them to dystocia because underfed cows especially in calcium and phosphorus are more likely to experience infrequent and weak uterine contractions during calving thus a high risk of dystocia [49, 50]. This demonstrates that improvement in management practices such as improving feeding practices, constructing standard zero-grazing unit having exercise area, and providing exercise to pregnant cows during three weeks before calving using family residential compounds are required to minimize the risk of dystocia [3, 51].

The present study reported the prevalence of clinical mastitis of 27.6%. These findings were similar to those reported by [52] in Ethiopia and [52] in Canada. However, they were higher than some previously reported rates (3.4-18.1%) [12, 24]. The differences could be attributed to the breed of cow, cow characteristics, environment and herd health conditions. The high prevalence of clinical mastitis observed in this study could be linked to poor hygiene in a cowshed in which cows were kept in wet and muddy conditions which favor the proliferation and transmission of mastitis-causing agents [53, 54]. This is indicative of inadequate control and prevention measures of mastitis in the study farms. Furthermore, the breed of cow was significantly associated with the occurrence of clinical mastitis. A high prevalence (32.6%) was observed in dairy crossbreeds than the dairy pure breeds (25.0%) and indigenous local breeds (13.2%). The findings of the current study could be associated with the lower degree of adaptation of improved breeds to tropical conditions of high temperature and humidity, inadequate feeding practices, and poor hygienic conditions [55, [56], making them more susceptible to disease than indigenous cattle breeds. Therefore, good hygiene and raising awareness of a mastitis control plan among farmers should be incorporated into herd management practices to effectively improve udder health and milk production of zero-grazed dairy cows in Rwanda.

Conclusion

The current study revealed the high prevalence rate of postpartum clinical diseases in the study area. Dystocia, clinical mastitis and retained placenta were the most important postpartum clinical diseases of dairy cows. These postpartum clinical diseases can lead to huge economic losses through reduced milk production, increasing veterinary costs and poor reproductive performance, which reduce herd profitability and sustainability. Therefore, farmers' awareness and control and preventive measures for postpartum clinical diseases should be a priority in the national herd healthy strategy.

Acknowledgement

The authors acknowledge full support from Animal Resources Officers, enumerators, and farmers for their time and participation.

References

1. Hammon DS, Evjen IM, Dhiman TR, Goff JP, Walters JL. Neutrophil function and energy status in Holstein cows with uterine health disorders. Vet Immunol Immunopathol 2006;113(1-2):21-29. doi:10.1016/j.vetimm.2006.03.022
2. Baez JMP, A. Risk Factors and Economic Impact of Postpartumn Diseases in Dairy Cows. Published online 2019. https://ufdc.ufl.edu/UFE0055729/00001. 22 May 2020.
3. Nyabinwa P, Olivier Basole K, Claire d'Andre H, Bockline Omedo B. Risk factors associated with endometritis in zero-grazed dairy cows on smallholder farms in Rwanda. Prev Vet Med 2021;188:1-11. doi:10.1016/j.prevetmed.2020.105252
4. Sepúlveda-Varas P, Weary DM, Noro M, Von Keyserlingk MAG. Transition diseases in grazing dairy cows are related to serum cholesterol and other analytes. PLoS One. 2015;10(3):1-13. doi:10.1371/journal.pone.0122317
5. Santos JE, Bisinotto RS, Ribeiro ES *et al*. Applying nutrition and physiology to improve reproduction in dairy cattle. Soc Reprod Fertil Suppl 2010;67:387-403. doi:10.7313/upo9781907284991.030
6. Nyabinwa P, Kashongwe OB, Hirwa CDA, Bebe BO. Effects of endometritis on reproductive performance of zero-grazed dairy cows on smallholder farms in Rwanda. Anim Reprod Sci 2020;221:106584. doi:10.1016/j.anireprosci.2020.106584
7. Nyabinwa P, Kashongwe OB, Hirwa CDA, Bebe BO. Influence of endometritis on milk yield of zero-grazed dairy cows on smallholder farms in Rwanda. Vet Anim Sci 2020;10:100149. doi:10.1016/j.vas.2020.100149
8. Edelhoff INF, Pereira MHC, Bromfield JJ, Vasconcelos JLM, Santos JEP. Inflammatory diseases in dairy cows: Risk factors and associations with pregnancy after embryo transfer. J Dairy Sci 2020;103(12):11970-11987. doi:10.3168/jds.2020-19070
9. Ribeiro ES, Lima FS, Greco LF *et al*. Prevalence of periparturient diseases and effects on fertility of seasonally calving grazing dairy cows supplemented with concentrates. J Dairy Sci. 2013;96(9):5682-5697. doi:10.3168/jds.2012-6335
10. Rinell E, Heringstad B. The effects of crossbreeding with Norwegian Red dairy cattle on common postpartum diseases, fertility and body condition score. *Animal*. 2018;12(12):2619-2626. doi:10.1017/S175173111800037X
11. Vergara CF, Döpfer D, Cook NB *et al*. Risk factors for postpartum problems in dairy cows: Explanatory and predictive modeling. J Dairy Sci 2014;97(7):4127-4140. doi:10.3168/jds.2012-6440
12. Ribeiro ES, Gomes G, Greco LF *et al*. Carryover effect of postpartum inflammatory diseases on developmental biology and fertility in lactating dairy cows. J Dairy Sci 2016;99(3):2201-2220. doi:10.3168/jds.2015-10337
13. Getenet A, Berhanu M, Desie S. Major postpartum problems of dairy cows managed in small and medium scale production systems in Wolaita Sodo, Ethiopia. African J Agric Res 2014;9(36):2775-2780. doi:10.5897/ajar2013.7946
14. Abuom T, Njenga M, Wabacha J, Tsuma V, Gitau G. Incidence and risk factors of periparturient conditions in smallholder dairy cattle herds in Kikuyu Division of Kiambu District, Kenya. Ethiop Vet J 2012, 16(2) doi:10.4314/evj.v16i2.8
15. IFAD. Rwanda Dairy Development Project. Detailed Design Report 2016.
16. NISR. National Institute of Statistics of Rwanda. Statistical Yearbook Statistical Year Book. (SYB2016),

2016. https://www.statistics.gov.rw/publication/statistical-yearbook-2016. 12 June, 2020.
17. Ndahetuye JB, Persson Y, Nyman AK, Tukei M, Ongol MP, Båge R. Aetiology and prevalence of subclinical mastitis in dairy herds in peri-urban areas of Kigali in Rwanda. Trop Anim Health Prod. 2019;51(7):2037-2044. doi:10.1007/s11250-019-01905-2
18. Dutta LJ, Nath KC, Deka BC *et al*. Management conditions and their relationship with infertility in crossbred cows under field conditions. Biol Rhythm Res 2019;00(00):1-7. doi:10.1080/09291016.2019.1608727
19. Dohoo I, Martin W, Stryhn H. Veterinary Epidemiologic Research. AVC Inc., University of Prince Edward Island, 550 University Avenue, Charlottetown, Prince Edward Island, Canada, CIA 2003, 4P3.
20. Kelton DF, Lissemore KD, Martin RE. Recommendations for Recording and Calculating the Incidence of Selected Clinical Diseases of Dairy Cattle. J Dairy Sci 1998;81(9):2502-2509. doi:10.3168/jds.S0022-0302(98)70142-0
21. Kumar P. Applied Veterinary Gynaecology and Obstetrics,2009. https://www.researchgate.net/publication/295223082_Applied_Veterinary_Gynaecology_and_Obstetrics_Ed. 11 February 2020.
22. Abdullah FFJ, Chung ELT, Abba Y *et al*. Management of Clinical Case of Endometritis in a Cow : A Case Report Management of Clinical Case of Endometritis in a Cow : A Case Report. J Vet Adv. 2015;5(4):887-890. doi:10.5455/jva.20150425121148
23. Biswal S, Nayak DC, Sardar KK. Prevalence of ketosis in dairy cows in milk shed areas of Odisha state Vet World. 2016;9(11):1242-1247. doi:10.14202/vetworld.2016.1242-1247
24. Brunner N, Groeger S, Canelas Raposo J, Bruckmaier RM, Gross JJ. Prevalence of subclinical ketosis and production diseases in dairy cows in Central and South America, Africa, Asia, Australia, New Zealand, and Eastern Europe. Transl Anim Sci. 2019;3(1):102-112. doi:10.1093/tas/txy102
25. Fox LK. Prevalence, incidence and risk factors of heifer mastitis. Vet Microbiol. 2009;134(1, 2):82-88. doi:10.1016/j.vetmic.2008.09.005
26. Erskine RJ. Mastitis in Cattle. Vet J 1934;90(8):343-344. doi:10.1016/s0372-5545(17)38508-5
27. Funnell BJ, Hilton WM. Management and Prevention of Dystocia. Vet Clin North Am - Food Anim Pract 2016;32(2):511-522. doi:10.1016/j.cvfa.2016.01.016
28. Toni F, Vincenti L, Ricci A, Schukken YH. Postpartum uterine diseases and their impacts on conception and days open in dairy herds in Italy. Theriogenology 2015;84(7):1206-1214. doi:10.1016/j.theriogenology.2015.06.022
29. Abdela N, Fikadu W, Tegegne D, Ahmed WM. Milk Fever and its Economic Consequences in Dairy Cows: A Review. Glob Vet. 2016;16(5):441-452. doi:10.5829/idosi.gv.2016.16.05.103137
30. Melendez P, Bartolome J, Roeschmann C *et al*. The association of prepartum urine pH, plasma total calcium concentration at calving and postpartum diseases in Holstein dairy cattle. Animal 2020;(xxxx):100148. doi:10.1016/j.animal.2020.100148
31. Patel PV, Parmar S. Retention of Fetal Membranes and its Clinical Perspective in Bovines Retention of Fetal Membranes and its Clinical Perspective in Bovines. Sch J Agric Vet Sci Sch 2016;3(2):111-116.
32. Mahnani A, Sadeghi-Sefidmazgi A, Keshavarzi H. Performance and financial consequences of stillbirth in Holstein dairy cattle. Animal 2017;12(3):617-623. doi:10.1017/S1751731117002026
33. Carluccio A, de Amicis I, Probo M, Giangaspero B, Veronesi MC. Prevalence, survival and subsequent fertility of dairy and beef cows with uterine prolapse. Acta Vet Hung 2020;68(1):91-94. doi:10.1556/004.2020.00017
34. Correa MT, Erb HSJ. Path Analysis for Seven Postpartum Disorders of Holstein Cows. J Dairy Res. 1993;76:1305-1312.
35. Hirwa CDA, Kugonza DR, Murekezi T *et al*. Management and phenotypic features of indigenous cattle in Rwanda. Int J Livest Prod. 2017;8(7):95-112. doi:10.5897/IJLP2017.0362
36. Edmonson AJ, Lean IJ, Weaver LD, Farver T, Webster G. A Body Condition Scoring Chart for Holstein Dairy Cows. J Dairy Sci 1989;72(1):68-78. doi:10.3168/jds.S0022-0302(89)79081-0
37. SPSS. Statistical Package for the Social Sciences. Version 22.0 for Windows. Published online 2013. https://www.spss-tutorials.com/spss-what-is-it/. 23 October, 2020.
38. Aus Vet Animal Health Services. Calculate confidence limits for a sample proportion. Published 2015. https://epitools.ausvet.com.au/ciproportion?page=CIProportion
39. Dinka H. Journal of Veterinary Medicine and Animal Health Major reproductive disorders of dairy cows in and around Asella town, Central Ethiopia 2013;5(4):113-117. doi:10.5897/JVMAH2013.0197
40. Sahlu BW, A. Assessment of Major Reproductive Problems of Dairy Cattle in Selected Sites of Central Zone of Tigrai Region, Northern Ethiopia. Published online 2015. doi:10.1126/science.1157215
41. Moges N, Jebar A. Prevalence of Subclinical Endometritis and its effect on Pregnancy in Crossbred Dairy Cows in Gondar. J Reprod Infertil 2012;3(2):26-31. doi:10.5829/idosi.jri.2012.3.2.65164
42. Cheong SH, Nydam DV, Galvão KN, Crosier BM, Gilbert RO. Cow-level and herd-level risk factors for subclinical endometritis in lactating Holstein cows. J Dairy Sci 2011;94(2):762-770. doi:10.3168/jds.2010-3439
43. Lee SC, Jeong JK, Choi IS *et al*. Cytological endometritis in dairy cows: Diagnostic threshold, risk factors, and impact on reproductive performance. J Vet Sci. 2018;19(2):301-308. doi:10.4142/jvs.2018.19.2.301
44. Beagley JC, Whitman KJ, Baptiste KE, Scherzer J. Physiology and treatment of retained fetal membranes in cattle. J Vet Intern Med. 2010;24(2):261-268. doi:10.1111/j.1939-1676.2010.0473.x
45. Amicis I De, Veronesi MC, Robbe D, Gloria A, Carluccio A. Prevalence, causes, resolution and consequences of bovine dystocia in Italy Ippolito. Theriogenology. Published online 2017. doi:10.1016/j.theriogenology.2017.11.001
46. Mee JF. Prevalence and risk factors for dystocia in dairy cattle: A review. Vet J 2008;176(1):93-101. doi:10.1016/j.tvjl.2007.12.032
47. Bruun J, Ersbøll AK, Alban L. Risk factors for metritis in Danish dairy cows. Prev Vet Med 2002;54:179-190.

48. Han W, Hiew M. Prediction of parturition and dystocia in holstein- friesian cattle, and cesarean section in dystocic beef cattle 2014. https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1347&context=open_access_dissertations. 12 November, 2020.
49. Moellers J, Moellers J, Dvm BS. Nutritional Causes of Infertility in Dairy Cows Nutritional Causes of Infertility in Dairy Cows. Vet J. 1988;50(2).
50. Balamurugan B, Ramamoorthy M, Ravi Shankar Kumar Mandal JK, Gopalakrishnan G, Kavya KM, Kharayat CG, Katiyar R. Mineral an Important Nutrient for Efficient Reproductive Mineral an Important Nutrient for Efficient. Int J Sci Environ Technol. 2017;6(1):694-701.
51. Onyango J. Cow postpartum uterine infection: A review of risk factors, prevention and the overall impact. Vet Res 2014;2(2):18-32.
52. Mekibib B, Furgasa M, Abunna F, Megersa B, Regassa A. Bovine mastitis: Prevalence, risk factors and major pathogens in dairy farms of holeta town, central Ethiopia. Vet World. 2010;3(9):397-403. doi:10.5455/vetworld.2010.397-403
53. Cobirka M, Tancin V, Slama P. Epidemiology and classification of mastitis. Animals 2020;10(12):1-17. doi:10.3390/ani10122212
54. Bujok J, Pecka-kielb E. Maintaining Optimal Mammary Gland Health and Prevention of Mastitis. Front Vet Sci. 2021;8:1-17. doi:10.3389/fvets.2021.607311
55. Hernández-Castellano LE, Nally JE, Lindahl J *et al*. Dairy science and health in the tropics: challenges and opportunities for the next decades. Trop Anim Health Prod 2019;51(5):1009-1017. doi:10.1007/s11250-019-01866-6.
56. Pal A, Chakravarty AK. Disease resistance for different livestock species. Genet Breed Dis Resist Livest. Published online 2020, 271-296. doi:10.1016/b978-0-12-816406-8.00019-x