Arq. Bras. Med. Vet. Zootec., v.77, n.1, e13328, 2025
http://dx.doi.org/10.1590/1678-4162-13328
Original Article - Veterinary Medicine

Postpartum diseases and their effects on reproduction in dairy cows

[*Doenças do pós-parto e seus efeitos na reprodução de vacas leiteiras*]

J.F. Rocha[1], S.R.B. Couto[2], N.M.P.M. Caparelli[2*1], J.P.N. Andrade[3], C.G. Jayme[1], M.R.B. Mello[2]

[1]Instituto Federal Sudeste de Minas Gerais, Campus Rio Pomba, Rio Pomba, MG, Brasil
[2]Universidade Federal Rural do Rio de Janeiro, Niterói, RJ, Brasil
[3]West Texas A&M University, Canyon, USA

ABSTRACT

This study evaluated the effects of postpartum diseases and body condition score (BCS) on the reproductive performance of dairy herds. Cows were monitored during the postpartum to diagnose diseases and changes in BCS. The cows were divided into those with no disease and those with one or more diseases. The incidence of diseases, pregnancy rate (PR) at the first postpartum service, number of days open, percentage of pregnant cows at 150d, and gestational loss were analyzed. No difference was observed between healthy and diseased cows in the PR at the first service or for days open. Diseased cows showed greater gestational loss and the percentage of pregnant cows at 150d postpartum was higher among healthy cows. Cows with a BCS ≥ 3.0 at prepartum had a lower PR at the first service and shorter days open. In conclusion, dairy herds affected by diseases during postpartum show impaired reproductive efficiency.

Keywords: dairy cattle, postpartum diseases, transition period, pregnancy rate.

RESUMO

O presente estudo avaliou os efeitos de doenças do pós-parto e do escore de condição corporal (ECC) sobre a performance reprodutiva de rebanhos leiteiros. As vacas foram monitoradas durante o pós-parto para diagnosticar doenças e mudanças no ECC. Elas foram divididas entre aquelas sem doença e as com uma ou mais doenças. A incidência de doenças, a taxa de concepção (TC) no primeiro serviço pós-parto, a taxa de serviço, o percentual de vacas prenhas aos 150d e a perda gestacional foram analisados. Não foram observadas diferenças entre vacas saudáveis e doentes com relação à TC ou à taxa de serviço. Vacas com doença apresentaram maior perda gestacional, e a porcentagem de vacas prenhas aos 150 dias foi maior entre vacas saudáveis. Vacas com ECC ≥ 3,0 no pré-parto tiveram menor TC no primeiro serviço e menor taxa de serviço. Em conclusão, rebanhos leiteiros acometidos por doenças no pós-parto apresentam eficiência reprodutiva prejudicada.

Palavras-chave: gado leiteiro, doenças do pós-parto, período de transição, taxa de prenhez.

[1]*Corresponding author: nmonneratvet@gmail.com
Submitted: June 10, 2024. Accepted: August 10, 2024.

INTRODUCTION

In dairy farms, reproductive efficiency is one of the major factors interfering with the economic success of the farm. Owing to increasingly frequent issues with heat detection and a decrease in pregnancy rates (PRs), the calving interval (CI) has been increasingly prolonged. Therefore, to achieve high reproductive and productive performance, CI must be reduced, which can be achieved using reproductive techniques such as Timed Artificial Insemination (TAI). This tool has been proven to be efficient in this context, allowing dairy cows to become pregnant as soon as possible after a voluntary waiting period (VWP).

Diseases that affect dairy cows in the postpartum period can cause severe economic and productive losses as well as affect reproduction. Therefore, the primary diseases that occur during this period must be evaluated, their impact on reproduction must be analyzed, and decisions should be made to improve reproductive and productive efficiency, to improve the efficiency and profitability of dairy farms.

Peripartum disorders in dairy cows negatively affect productivity and reproductive performance (Goto et al., 2019). In addition, most animals have at least one clinical disease (metritis, mastitis, digestive problems, respiratory problems, or lameness) during the first three weeks of lactation (Ribeiro and Carvalho, 2017; Monteiro et al., 2021).

A fundamental step in starting a program that aims to improve the reproductive performance of dairy cattle is identifying the primary factors that compromise animal fertility. Several studies in different countries and milk production systems have identified risk factors associated with poor reproductive performance in cattle, such as dystocia, retained placenta, uterine and mammary gland infections, and metabolic diseases (Lee et al., 2018; Ernstberger et al., 2019; Gonçalves et al., 2019; Montiel-Olguín et al., 2019; Okawa et al., 2019).

In dairy cattle, inadequate management during the transition period intensifies the negative energy balance, increases postpartum body condition loss, decreases milk production, increases morbidity, delays uterine recovery, and reduces the potential reproductive performance of cows (Goto et al., 2019). Therefore, adequate management during the transition period and the use of TAI can improve productivity during the postpartum period and the reproductive performance of dairy cows. Therefore, the hypothesis tested in the present study was that the occurrence of diseases in the first 60d postpartum decreases the reproductive performance of dairy cows up to 150d after parturition. The objective of this study was to evaluate the occurrence of postpartum diseases and body conditions and their effects on the reproductive performance of dairy cows.

MATERIALS AND METHODS

The parturition of 187 crossbred dairy cows and heifers (genetic composition ranging from 3/4 Holstein × 1/4 Gir to 7/8 Holstein × 1/8 Gir) was monitored between May 2021 and June 2022 on three commercial properties, two of which are located in the state of Minas Gerais (22º16’30’’S, 44º03’56’’W) and one in the south of the State of Rio de Janeiro (21º47’15’’S, 42º56’22’’W). Of these properties, one had an intensive production system (compost barn), and the other had semi-intensive and semi-extensive systems, with average milk production of 20– 30kg/cow/d and 10–16kg/cow/d, respectively. All animals received bulk supplementation based on corn silage in addition to a balanced concentrate based on milk production, with

water and mineral salt offered ad libitum. Regarding the sanitary program, in the three properties that participated in the study, the control of brucellosis, tuberculosis, and foot-and-mouth disease was performed according to the norms of the official programs regulated by the Ministério da Agricultura Pecuária e Abastecimento. In addition, other vaccines were used in the herd, such as the anti-rabies and clostridiosis vaccines, in addition to deworming and ectoparasite control.

In the present study, the following postpartum diseases were considered: retained placenta (RP), uterine infection (UI), clinical mastitis (CM), clinical hypocalcemia (CH), and foot disorders (FD). To evaluate and diagnose these postpartum diseases, the cows were monitored during the first 60 postpartum d (PPD), with follow-up by the veterinarian every 28d. Immediately after parturition, females were observed for the total elimination of fetal membranes in the first 24h after the expulsion of the fetus (Kelton et al., 1998). Cows who did not shed blood were diagnosed with RP. UI was diagnosed based on the following clinical signs: a distended uterus on rectal palpation; the presence of vaginal discharge, ranging from serosanguinous to mucopurulent, fetid; fever; apathy; and/or anorexia. A postpartum gynecological evaluation was performed in all animals within the frequency of visits every 28d through rectal palpation and using transrectal ultrasound (SonoScape®, DM10V, linear transducer; 7.5MHz). To diagnose CM, the presence of lumps in the black bottom mug test was considered a definitive criterion, and management was performed at each milking. CH was diagnosed based on the following clinical signs: excitement, tetany, muscle tremors of the head and limbs, reluctance to feed, prolonged sternal recumbency, drowsy appearance, head turning to the flank, dry snout, cold extremities, lowered body temperature, and weak pulse. FD was evaluated based on the locomotion score (LS) proposed by Sprecher et al. (1997), in which females were classified from 1 to 5, with 1 indicating perfect locomotion and 5 indicating difficulty lifting the limb and walking. The animal that presented an LS above 2 was considered to have FD because its locomotion capacity was impaired.

The animals were evaluated by the same technician using a scale from 1 to 5, with intervals of 0.25 (Ferguson et al., 1994). Five BCS evaluations were performed for each animal: BCS1, BCS2, BCS3, BCS4, and BCS5. The first body condition assessment (BCS1) was performed 60d before the expected date of parturition in the seventh month of pregnancy (when the animals entered the prepartum period). Other evaluations were made at an interval of 28d until 60 PPD was completed.

The reproductive management adopted for the three properties that participated in this study involved the use of a Natural Breed (NB), conventional AI, and TAI. From day 30 of the VWP, the females detected in the heat were subjected to NB or AI. Females that did not receive service up to 40d postpartum were evaluated and subjected to two different reproductive strategies: i) administration of a dose of prostaglandin (500µg of cloprostenol sodium) in animals that presented with corpus luteum (CL); ii) ovulation synchronization and TAI in cyclic or anestrous animals. Pregnancy was diagnosed 40d after insemination using transrectal ultrasonography (SonoScape®, DM10V, linear transducer; 7.5MHz). Confirmation of pregnancy was based on the visualization of the embryonic vesicle in the presence of a viable embryo (presence of heartbeat). Gestational loss (GL) was assessed by gynecological examination after a suspected miscarriage. Therefore, animals with confirmed pregnancies after 40d were reassessed at different stages of pregnancy,

and if the pregnancy was not confirmed, they were counted as animals that had lost their pregnancy.

For data analysis, the females were separated into two groups: healthy cows that did not develop any disease over 60PPD and cows affected by one or more diseases among those previously described. The binomial variables–PR at first service (number of pregnant cows / total cows inseminated or mated), percentage of pregnancy at 150d (number of cows pregnant after 150d postpartum / total cows inseminated or mated), and GL (number of nonpregnant cows with a confirmed pregnancy diagnosis after 40d / total pregnant cows)–were analyzed with the Statistical Analysis System (SAS) (Version 9.4; SAS Institute) using the PROC GLIMMIX procedure. The number of lactations and farms were included as covariates. Continuous variables were analyzed using the SAS MIXED procedure. The possible negative effects of one or more diseases on the reproductive parameters of the analyzed cows were hypothetically considered as tails in the statistical tests. Statistical significance was set at 5% and trended when the P value was >5% and <10%.

This study was approved by the Committee on Ethics in the Use of Animals (CEUA) of the Instituto Federal de Educação, Ciência e Tecnologia do Sudeste MG (protocol nº 04/2021).

RESULTS AND DISCUSSION

Of the 187 cows evaluated in the present study, 126 (67.4%) were not affected by disease during the first 60d after calving, and 61 (32.6%) had one or more cases of disease among those evaluated. The percentages of healthy cows, cows with only one disease, and cows with two or more diseases during the postpartum period are shown in Tab. 1. The percentage of healthy cows in property "C" (85.2%) was significantly higher (P = 0.04) than in properties "A" and "B" (60.5% and 61.7%, respectively). Regarding the proportion of cows presenting only one disease in the postpartum period, property "C" tended to be lower (P = 0.08) in relation to the other properties. Regarding the percentage of cows presenting two or more diseases in the postpartum period, property "C" had a significantly lower number (P = 0.045) compared to properties "A" and "B" (Table 1).

Table 1. Mean milk production, percentage of healthy cows, and percentage of cows with one or more diseases in the first 60d of the postpartum period in different dairy farms

Parameters	Dairy Farms			
	A	B	C	
Production system	Intensive	Semi-intensive	Semi-extensive	P-Value
Average milk production (kg/cow/d)	27.2	19.0	13.8	NE
Healthy cows (%)	60.5	61.7	85.2	0.004
One postpartum disease (%)	24.7	25.5	13.0	0.08
Two or more postpartum diseases (%)	14.8	12.8	1.8	0.045

NE = Not evaluated.

Regarding the effect of postpartum diseases on reproduction (Table 2), the results are presented with reference to the PR in the 1st service, the days open (DO), the percentage of pregnant cows at 150d postpartum, and gestational loss of healthy

cows or cows affected by one or more diseases.

Table 2. Effect of the occurrence of postpartum diseases on pregnancy rate in the first postpartum AI, days open, percentage of pregnant cows at 150d postpartum, and gestational loss in crossbred dairy cows

Reproductive parameters	Healthy	One or more diseases	P value
Pregnancy rate in the first service (%)	35.5	29.3	0.2
Days open (days ± standard error)	67.8 ± 2.54	73.4 ± 4.21	0.1
Pregnancy rate at 150d (%)	60.8	47.5	0.04
Gestational loss between 40 and 90d (%)	2.75	10.4	0.03

AI = Artificial Insemination.

No significant difference in PR was observed between healthy cows and those with one or more diseases in the first postpartum AI (P = 0.2) and DO (P = 0.1). However, diseased cows had a higher gestational loss (P = 0.03) than healthy cows (10.4% vs. 2.8%), and the percentage of pregnant cows at 150d postpartum was significantly higher (P = 0.04) in healthy cows (60.8% vs. 47.5%). These results confirmed the hypothesis that the occurrence of diseases in the first 60d postpartum decreases the reproductive performance of dairy cows.

No statistical difference (P>0.05) was observed between the average BCS of healthy and diseased cows evaluated at five different times during the transition period. Because of the similarity observed between the average BCS of healthy and diseased cows at the five different evaluation times, a new analysis was conducted, in which the BCS of the cows when they entered the precalving period (BCS1), or 60d before the expected calving date, was considered. Thus, all animals were divided into two groups: BCS1 ≥ 3.0 and BCS1 < 3.0, regardless of whether they had the disease within 60d postpartum.

The values representing the PR in the first postpartum service, the DO, percentage of pregnancy 150d postpartum, and gestational loss of cows with BCS ≥ or < 3.0 are presented in Table 3.

Cows with BCS ≥ 3.0 prepartum had a lower PR in the first postpartum AI (28.8% vs. 42.2%; P = 0.04) and shorter DO (67.0 vs. 74.6 d; P = 0.01). However, no significant difference was observed between these two groups in terms of the percentage of pregnancies at 150d (P = 0.34) and gestational loss (P = 0.22).

Thus, Table 4 presents values referring to the PR in the 1st postpartum service, DO, percentage of pregnancy 150d postpartum, and gestational loss of cows that lost, maintained, or gained BCS during the transition period.

No statistically significant differences (P > 0.05) were observed between PRs, DO, and gestational loss among cows that lost, maintained, or gained BCS. In contrast, the PR observed at 150d postpartum was significantly higher in cows that gained BCS during the transition period (P = 0.05).

Table 3. Effect of prepartum BCS on pregnancy rate in the first postpartum AI, days open, percentage of pregnant cows at 150d postpartum, and gestational loss in crossbred dairy cows

Reproductive parameters	BCS ≥ 3.0	BCS < 3.0	P value
Pregnancy rate in the first service (%)	28.8	42.2	0.04
Days open (days ± standard error)	67.0 ± 2.8	74.6 ± 3.4	0.01
Pregnancy rate at 150d (%)	57.6	54.5	0.34
Gestational loss between 40 and 90d (%)	8.8	3.7	0.22

BCS = Body condition score; AI = Artificial Insemination.

Table 4. Effect of BCS dynamics in the transition period on pregnancy rate in the first postpartum AI, days open, percentage of pregnant cows at 150d postpartum, and gestational loss in crossbred dairy cows.

Reproductive parameters	BCS loss	BCS maintenance	BCS gain	P Value
Pregnancy rate in the first AI (%)	32.2	31.1	38.8	0.32
Days open (days ± standard error)	73.7 ± 4.3	65.1 ± 2.6	71.3 ± 4.8	0.16
Pregnancy rate at 150d (%)	53.2[b]	50.7[b]	69.4[a]	0.05
Gestational loss between 30 and 90d (%)	15.8	4.3	0.0	0.25

BCS = Body condition score; AI = Artificial Insemination.
[a,b] Means followed by the same lowercase letter in a row do not differ significantly (P>0.05).

The results for the incidence of diseases in the different properties may be related to the different average milk production and the production system among the properties that participated in the study since properties "A" and "B" had a higher average milk production (27.2 and 19kg/cow/d, respectively) than property "C" (13.8 kg/cow/d). Other studies have evaluated the prevalence of postpartum diseases in dairy herds (Ribeiro et al., 2013; Carvalho et al., 2019; Daros et al., 2022). In a study conducted in Florida (USA), Ribeiro et al. (2013) reported that 37.5% of 957 cows from two commercial properties had some type of postpartum disease.

Carvalho et al. (2019) performed a retrospective study in which they evaluated data from 2,335 Holstein cows and observed a prevalence of 45.9% for at least one disease within the first 21d postpartum. In this manner, the percentage of dairy cows presenting one or more diseases in the postpartum period was similar between the different studies (37.5%, 39.5%, and 45.9%), and this value was also near to that observed in the present experiment (32.6%).

Regarding the occurrence of diseases in the postpartum period and their impact on reproduction, the findings of the present study in relation to PR in the first postpartum service and DO differ from those of other studies, demonstrating a negative effect of postpartum diseases on the reproductive efficiency of dairy cattle (Maizon et al., 2004; Ribeiro et al., 2013; Carvalho et al., 2019; Goto et al., 2019; Monteiro et al., 2021).

In a retrospective study evaluating 7,500 lactating cows, Carvalho et al. (2019) reported a lower PR in cows that experienced health problems in the first 21d postpartum. Ribeiro et al. (2013) concluded in their study involving 957 pluriparous females that diseases in the transition period delayed the resumption of postpartum cyclicity, decreased the PR, and increased the risk of gestational loss. In another retrospective study conducted in New Zealand with 2,652 cows, McDougall (2001) reported that females with a retained placenta or dystocia had lower postpartum PRs and longer days open. It is possible that the number of animals evaluated in the present study may constitute a basis for the divergence between the statistical analyses of different studies and for the confirmation of the first hypothesis.

In the present study, the number of days open for healthy cows was similar (P = 0.1) to that for cows with one or more

diseases. Ribeiro et al. (2013) reported a delay in the resumption of cyclicity in Holstein cows presenting with clinical and subclinical diseases during the first 30d postpartum. They observed that, at 49d postpartum, the percentage of cows that were cycling (presence of a CL in one of the ovaries) was significantly higher (95.6%) in the group of healthy animals than in the group of cows affected by clinical and subclinical diseases (83.5%).

In another study conducted in dairy herds in New Zealand, McDougall (2001) observed that cows that had assisted births or retained placentas required more time to become pregnant than control cows (healthy and without assistance at birth).

It is possible that the use of TAI in this experiment attenuated the negative effects of postpartum diseases on reproduction, causing diseased and healthy cows to have similar days open. This is because, in the reproductive management of the three properties that participated in this study, cows that were not detected in natural heat up to 40d postpartum were subjected to synchronization of ovulation for TAI.

In addition, cows affected by one or more diseases were promptly treated and carefully followed up in the postpartum period; thus, monitoring and treatment may also have influenced healthy and affected animals to have similar DO.

Regarding the analyzes used to evaluate the BCS on the reproductive parameters, a shorter DO presented by cows that entered the prepartum period with BCS $\geq$ 3.0 was expected since López-Gatius et al. (2003) reported that animals with high BCS at calving showed a significant reduction in the number of open days (5.8 or 11.7d) compared to animals with intermediate or low body condition, respectively. The BCS change is an indirect measure of energy balance. Energy balance before calving can affect production and health during the next lactation period. Cows may suffer a loss of BCS before calving due to a negative energy balance and may, therefore, be more subject to postpartum diseases as well as compromised reproductive performance.

Chebel et al. (2018) studied the association between weight loss in dairy cows during the dry period and postpartum reproductive performance. These authors reported that a loss of score was associated with a reduction in PR in the first two postpartum inseminations, corroborating the findings of the present study. The lower PR in the first postpartum AI ($P = 0.04$) observed in the present study in cows with BCS $\geq$ 3.0 is possibly related to the greater loss of score they likely had in relation to cows with BCS < 3.0.

In a study conducted in New York, researchers demonstrated that the loss of BCS during the dry period in Holstein cows was associated with an increased risk of dystocia, culling, and reproductive failure (Gearhart et al., 1990). Sheehy et al. (2017) demonstrated that during the prepartum period, cows that lost BCS during the last 15d of gestation tended to have higher concentrations of non-esterified fatty acids and lower insulin concentrations than cows that maintained BCS.

Thus, cows that enter the prepartum period with BCS $\geq$ 3.0 will likely have greater score losses in the transition period and, consequently, will present alterations in the concentrations of metabolites and hormones, as described by Sheehy et al. (2017), and this could lead to impaired reproductive performance.

CONCLUSIONS

Under the conditions of this experiment, it can be concluded that: Properties with a semi-extensive farming system have a higher proportion of healthy

cows, but also have lower rates of animals with two or more diseases in the postpartum period. Animals that present more than one disease in the postpartum period have greater pregnancy loss, a lower pregnancy rate at 150 days postpartum, but the days open and pregnancy at the first AI is not affected. The body condition score in the transition period is not affected by the incidence of postpartum diseases. Cows with BCS $\geq$ 3.0 pre-partum have a lower pregnancy rate at the first postpartum AI and fewer days open, however, the pregnancy rate at 150 days and pregnancy loss are not affected. In short, dairy cows that present diseases in the first 60 days after birth have compromised reproductive efficiency.

ACKNOWLEDGMENTS

To Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Financing code #001), and Conselho Nacional de Desenvolvimento Científico (CNPq - #302998/2020-9) for financial support. To Editage (www.editage.com) for English language editing.

REFERENCES

1. CARVALHO, M.R.; PEÑAGARICANO, F.; SANTOS, J.E.P. et al. Long-term effects of postpartum clinical disease on milk production, reproduction, and culling of dairy cows. **J. Dairy Sci.**, v.102, p.11701-11717, 2019.

2. CHEBEL, R.C.; MENDONÇA, L.G.D.; BARUSELLI, P.S. Association between body condition score change during the dry period and postpartum health and performance. **J. Dairy Sci.**, v.101, p.4595-4614, 2018.

3. DAROS, R.R.; WEARY, D.M.; VON KEYSERLINGK, M.A.G. Invited review: risk factors for transition period disease in intensive grazing and housed dairy cattle. **J. Dairy Sci.**, v.105, p.4734–4748, 2022.

4. DA SILVA, Emanuel Isaque Cordeiro. **Anatomia e Fisiologia do Sistema Reprodutivo dos Animais Domésticos**. Emanuel Isaque Cordeiro da Silva, 2020.

5. DA SILVA, E.I.C.; FONTAIN, E.C.S. Comparative evaluation of the reproductive capacity of male goats in feedlot. **Revista Ciencia Agraria**, v. 3, n. 2, p. 7-24, 2024.

6. DA SILVA, Emanuel Isaque Cordeiro. **Fertilidade em Vacas Leiteiras: Fisiologia e Manejo**. 2022. Disponível em: https://philpapers.org/archive/DASFEV.pdf. Acesso em: 14 jan. 2024.

7. DA SILVA, Emanuel Isaque Cordeiro. Fisiologia Clínica do Ciclo Estral de Vacas Leiteiras: Desenvolvimento Folicular, Corpo Lúteo e Etapas do Estro. 2020.

8. DA SILVA, Emanuel Isaque Cordeiro. Fisiologia da Reprodução Animal: Ovulação, Controle e Sincronização do Cio. 2020.

9. DA SILVA, Emanuel Isaque Cordeiro. **Fisiologia do ciclo estral dos animais domésticos**. Emanuel Isaque Cordeiro da Silva, 2021.

10. DA SILVA, Emanuel Isaque Cordeiro. **Fisiologia da Reprodução de Bovinos Leiteiros: Aspectos Básicos e Clínicos**. Emanuel Isaque Cordeiro da Silva, 2022.

11. DA SILVA, Emanuel Isaque Cordeiro. **Manejo Reprodutivo e Índices Zootécnicos em Gado de Leite**. 2023.

12. DA SILVA, Emanuel Isaque Cordeiro. **Nutrição Sobre a Reprodução e Fertilidade dos Bovinos**. Emanuel Isaque Cordeiro da Silva, 2021.

13. DA SILVA, E. I. C. **Reprodução de novilhas leiteiras**. Departamento de Reprodução Animal – DRA, Instituto Agronômico de Pernambuco – IPA. Recife, 2022.

14. ERNSTBERGER, M.; OEHL, H.; HAESSIG, M. et al. Predicting the probability of conception in dairy cows with clinical endometritis based on a combination of anamnestic information and examination results. **Theriogenology**, v.138, p.127- 136, 2019.

15. FERGUSON, J.D.; GALLIGAN, D.T.; THOMSEN, N. Principal Descriptors of body condition score in Holstein cows. **J. Dairy Sci.**, v.77, p.2695-2703, 1994.

16. GEARHART, M.A.; CURTIS, C.R.; ERB, H.N. et al. Relationship of changes in condition score to cow health in Holsteins. J. Dairy Sci., v.73, p.3132- 3140, 1990.

17. GONÇALVES, R.S.; GUAGNINI, F.S.; STORCK, D.J. et al. Risk factors associated to retained placenta in Holstein cows. **Acta Sci. Vet.**, v.47, p.6, 2019.

18. GOTO, A.; TAKAHARA, K.; SUGIURA, T. et al. Association of postpartum diseases occurring within 60 days after calving with productivity and reproductive performance in dairy cows in Fukuoka: a cow-level, retrospective cohort study. **J. Vet. Med. Sci.**, v.81, p.1055-1062, 2019.

19. KELTON, D.F.; LISSEMORE, K.D.; MARTIN, R.E. Recommendations for recording and calculating the incidence of selected clinical diseases of dairy cattle. **J. Dairy Sci.**, v.81, p.2502- 2509, 1998.

20. LEE, S.C.; JEONG, J.K.; CHOI, I.S. et al. Cytological endometritis in dairy cows: diagnostic threshold, risk factors, and impact on reproductive performance. **J. Vet. Sci.**, v.19, p.301, 2018.

21. LÓPEZ-GATIUS, F.; YÁNIZ, J.; MADRILESHELM, D. Effects of body condition score and score change on the reproductive performance of dairy cows: a meta-analysis. **Theriogenology**, v.59, p.801-812, 2003.

22. MAIZON, D.O.; OLTENACU, P.A.; GRÖHN, Y.T. et al. Effects of diseases on reproductive performance in Swedish red and white dairy cattle. **Prev. Vet. Med.**, v.66, p.113-26, 2004.

23. MCDOUGALL, S. Effects of periparturient diseases and conditions on the reproductive performance of New Zealand dairy cows. **N. Z. Vet.**, v.49, p.60-67, 2001.

24. MONTEIRO, P.L.J.; GONZALES, B.; DRUM, J.N. et al. Prevalence and risk factors related to anovular phenotypes in dairy cows. **J. Dairy Sci.**, v.104, p.2369-2383, 2021.

25. MONTIEL-OLGUÍN, L.J.; ESTRADA-CORTÉS, E.; ESPINOSA-MARTÍNEZ, M.A. et al. Risk factors associated with reproductive performance in small-scale dairy farms in Mexico. **Trop. Anim. Health Prod.**, v.51, p.229-236, 2019.

26. OKAWA, H.; GOTO, A.; WIJAYAGUNAWARDANE, M.M.P. et al. Risk factors associated with reproductive performance in Japanese dairy cows: vaginal discharge with flecks of pus or calving abnormality extend time to pregnancy. **J. Vet. Med. Sci.**, v.81, p.95-99, 2019.

27. RIBEIRO, E.S.; CARVALHO, M.R. Impact and mechanisms of inflammatory diseases on embryonic development and fertility in cattle. **Anim Reprod.**, v.14, p.589-600, 2017.

28. RIBEIRO, E.S.; LIMA, F.S.; GRECO, L.F. et al. Prevalence of periparturient diseases and effects on fertility of seasonally calving grazing dairy cows supplemented with concentrates. **J. Dairy Sci.**, v.96, p.5682-5697, 2013.

29. SHEEHY, M.R.; FAHEY, A.G.; AUNGIER, S.P.M. et al. A comparison of serum metabolic and production profiles of dairy cows that maintained or lost body condition 15 days before calving. **J. Dairy Sci.**, v.100, p.536-547, 2017.

30. SPRECHER, D.J.; HOSTETLER, D.E.; KANEENE, J.B. A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. **Theriogenology**, v.47, p.1179-1187, 1997.