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Original Research Article

Effect of Postpartum Uterine Infections on Reproductive Performance in Buffaloes

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Abstract: *Postpartum uterine infections are major causes of reduced fertility in buffaloes and may delay reproductive recovery after calving. Metritis, clinical endometritis, and subclinical endometritis can adversely affect estrus expression, conception, and calving interval.* ***Objective:*** *To evaluate the effect of postpartum uterine infections on reproductive performance in buffaloes.* ***Methods:*** *This prospective observational study was conducted in postpartum buffaloes at the University of Veterinary and Animal Science, Lahore, Punjab, Pakistan. A total of 160 postpartum buffaloes were enrolled and classified according to uterine health status into healthy buffaloes (n = 60), metritis (n = 35), clinical endometritis (n = 35), and subclinical endometritis (n = 30). Reproductive performance was assessed using days to first estrus, days to first service, number of services per conception, conception at first service, pregnancy by 150 days postpartum, days open, and calving interval. Data were analyzed using descriptive statistics, analysis of variance for continuous variables, and chi-square test for categorical variables, with $p < 0.05$ considered statistically significant.* ***Results:*** *Buffaloes with postpartum uterine infections showed significantly poorer reproductive performance than healthy buffaloes. Compared with healthy animals, infected buffaloes had longer intervals to first estrus (77.0 ± 12.4 vs. 56.7 ± 13.9 days), first service (99.1 ± 15.3 vs. 74.4 ± 13.9 days), and days open (159.7 ± 19.9 vs. 120.5 ± 15.0 days). Calving interval was also prolonged in infected buffaloes compared with healthy buffaloes (452.9 ± 25.5 vs. 411.6 ± 20.5 days), and infected animals required more services per conception (2.4 ± 0.7 vs. 1.7 ± 0.6; $p < 0.001$). Conception at first service and pregnancy by 150 days postpartum were significantly lower in infected buffaloes than in healthy controls (29.0% vs. 55.0% and 66.0% vs. 91.7%, respectively). Among the uterine infection groups, metritis was associated with the greatest reproductive impairment.* ***Conclusion:*** *Postpartum uterine infections significantly compromise reproductive efficiency in buffaloes by delaying estrus and first service, increasing services per conception, prolonging days open and calving interval, and reducing conception and pregnancy rates. Early diagnosis, timely treatment, and preventive herd health management may improve fertility outcomes in postpartum buffaloes.*

Keywords: Animals; Buffaloes; Endometritis; Metritis; Postpartum Period

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Introduction

In many tropical and subtropical regions, buffaloes are valuable dairy and draught animals, and reproductive efficiency directly impacts herd productivity and farm profitability. Achieving a successful postpartum recovery is essential for both the timely resumption of ovarian activity and conception, as well as an appropriate calving interval (1). The postpartum period is uniquely susceptible to reproductive pathologies, as bacterial contamination of the uterus often occurs at parturition and must be removed by normal uterine involution and host defense mechanisms. When this process goes wrong, uterine infections occur (metritis, clinical endometritis, and subclinical endometritis) with negative impacts on fertility in the subsequent cycle (2).

Postpartum uterine infections are among the main causes of reproductive inefficiency in buffaloes. Metritis is a clinical disease characterized by severe uterine inflammation in the early postpartum period, and endometritis denotes an inflammatory response of the endometrium that may be clinically evident or subclinical (3). The prevalence of postpartum uterine disease in buffaloes has been associated with many factors, including retained fetal membranes, dystocia, poor hygiene, and delayed uterine involution. It is well known that infected buffaloes have a prolonged return to estrus, delayed first service, increased services per conception, and days open, and lower pregnancy rates compared with healthy animals in previous studies. Detection of subclinical endometritis is also important as it has the potential to impair fertility without any noticeable clinical signs, making it a challenge to diagnose in the absence of proper reproductive examination (4).

Given the economic and reproductive effects of postpartum uterine infections, it is therefore very relevant to evaluate these in buffalo production systems. Long open intervals and long calving intervals,

therefore, decrease the lifetime reproductive performance of animals, thus increasing management cost (5). While the adverse effects of uterine disease have been well established in cattle, similar evidence for buffalo is scarce, and it has not been determined how different forms of uterine infection may affect reproductive outcomes relative to each other. Hence, the current study was carried out to analyze the influence of postpartum uterine infections on reproductive performance in buffaloes by comparing animals with metritis with those with clinical and subclinical endometritis. Reproductive efficiency was defined as days to first estrus, days to first service, services per conception, conception at first service, pregnancy by 150 days postpartum, days open, and calving interval (4).

Methodology

In buffaloes, a prospective observational study was designed at the University of Veterinary and Animal Science, Lahore, Punjab, Pakistan, to assess the impact of postpartum uterine infections on future reproductive performance. The study was designed to compare biochemical parameters between apparently healthy postpartum buffalo and those diagnosed with various uterine infections after calving. In buffaloes, postpartum disease of the uterus is of clinical significance because an abnormality in uterine recovery after calving and a delay in resuming ovarian activity can prolong the interval from calving to conception and have an impact on fertility.

The current study included 160 postpartum buffaloes. Animals were randomized into four groups based on postpartum reproductive health status: healthy buffaloes (n=24), buffaloes with metritis, buffaloes with clinical endometritis, and buffaloes with subclinical endometritis. Healthy: Animals that had an uncomplicated recovery from parturition and showed no clinical signs of uterine disease. Metritis was defined as a postpartum uterine infection with clinical signs in the early puerperal period, and clinical endometritis was identified by the presence of abnormal purulent or mucopurulent uterine discharge after the early postpartum period. Endometritis, characterized by endometrial inflammation without overt clinical signs, was diagnosed by reproductive examination and cytological assessment. These categories correspond to commonly utilized definitions of postpartum uterine diseases in bovine reproductive medicine.

Baseline information for each buffalo was collected at the time of enrolment, including animal identification number, farm, age, parity, body condition score, calving date, history of dystocia, and retained fetal membranes. Dystocia and retained placenta are important periparturient conditions that may be associated with postpartum uterine disease and subsequent reproductive performance, which is why these variables were recorded. Records were kept for each animal throughout follow-up monitoring and reproductive outcome assessment.

During the monitoring period, all animals underwent postpartum reproductive examinations. Metritis diagnosis was done by clinical examination during the early postpartum phase, involving abnormal vaginal discharge and general reproductive tract evaluation. Buffaloes with purulent or mucopurulent vaginal discharge in the later postpartum interval were diagnosed to have clinical endometritis according to criteria from bovine practice. Animals without any visible abnormal discharge, with evidence of uterine inflammation on reproductive tract examination and cytological evaluation, were considered for the assessment of subclinical endometritis. Clinical assessments of vaginal mucus and endometrial cytology are common methods for diagnosing postpartum uterine inflammation, including subclinical disease.

Buffaloes were observed for reproductive performance after calving until either pregnancy confirmation or the end of the study. The primary reproductive endpoints were days to first estrus, days to first service, services per conception, conception at first service, pregnancy by 150 days postpartum, days open, and calving interval. Days to first estrus was described as the interval from calving to first observed estrus and days to first service (also called days from calving to first mating or insemination). Days open were measured as the period between calving and attending successful mating, while calving interval was defined as the time between two successive calvings. These are common indices of fertility in buffaloes, and the extension of these intervals indicates abnormal postpartum reproductive recovery.

All animal-level data were input into a structured database prior to analysis. Variables were coded numerically as follows: infection status, infection type, dystocia, retained fetal membranes, conception at first service, and pregnancy by 150 days. Prepared complete data on continuous reproductive variables and assessed them for range error redundancies before performing any statistical analysis. Animals were only identified by study codes to keep information on breeding practices organized and anonymous.

The data were analyzed using IBM SPSS Statistics. All study variables were summarized using descriptive statistics. Continuous variables: age, days to first estrus, days to first service, days open, and calving interval were summarized as mean ± standard deviation, while categorical variables were expressed in frequency and percentage. The primary analysis compared neonatal and reproductive outcomes between healthy buffaloes and infected buffaloes. Independent-samples t-tests were used for normally distributed continuous variables; the Mann–Whitney U test was used to compare services per conception; and chi-square tests were conducted for categorical fertility outcomes (conception at first service and pregnancy by 150 days). Secondary analyses across the four clinical groups utilized one-way analysis of variance (ANOVA) for continuous, normally distributed outcomes, the Kruskal–Wallis test for services per conception, and chi-square tests for categorical outcomes. Statistical significance was defined as a p-value < 0.05.

Results

A total of 160 postpartum buffaloes were included in the study, comprising 60 healthy animals and 100 buffaloes diagnosed with postpartum uterine infections. Among infected buffaloes, 35 were diagnosed with metritis, 35 with clinical endometritis, and 30 with subclinical endometritis. The distribution of animals according to health status and infection type is presented in Table 1.

Table 1: Distribution of Buffaloes According to Postpartum Uterine Health Status

Group	Number of buffaloes	Percentage (%)
Healthy	60	37.5
Metritis	35	21.9
Clinical endometritis	35	21.9
Subclinical endometritis	30	18.7
Total	160	100.0

Buffaloes affected by postpartum uterine infections showed poorer reproductive performance than healthy buffaloes. As shown in Table 2, infected animals had significantly longer intervals from calving to first estrus, first service, conception, and subsequent calving. The mean days to first estrus were 77.0 ± 12.4 days in infected buffaloes compared with 56.7 ± 13.9 days in healthy animals. Similarly, infected buffaloes required more services per conception and had prolonged days open and calving intervals. Fertility outcomes were also reduced in infected buffaloes, with conception at first service recorded in only 29.0% of infected animals

compared with 55.0% of healthy buffaloes, while pregnancy by 150 days postpartum was achieved in 66.0% and 91.7% of animals, respectively.

Table 2; Comparison of Reproductive Performance Between Healthy and Infected Buffaloes

Variable	Healthy buffaloes, n = 60	Infected buffaloes, n = 100	Test statistic	p-value
Days to first estrus	56.7 ± 13.9	77.0 ± 12.4	t = -9.59	<0.001
Days to first service	74.4 ± 13.9	99.1 ± 15.3	t = -10.19	<0.001
Services per conception	1.7 ± 0.6	2.4 ± 0.7	U = 1354.0	<0.001
Days open	120.5 ± 15.6	159.7 ± 19.9	t = -13.05	<0.001
Calving interval (days)	411.6 ± 20.5	452.9 ± 25.5	t = -10.62	<0.001
Conception at first service	33 (55.0%)	29 (29.0%)	$\chi^2 = 9.61$	0.002
Pregnancy by 150 days postpartum	55 (91.7%)	66 (66.0%)	$\chi^2 = 12.05$	0.001

Reproductive outcomes varied significantly according to the type of postpartum uterine infection. As presented in Table 3, buffaloes with metritis showed the poorest reproductive performance, followed by animals with clinical endometritis and subclinical endometritis. Buffaloes with metritis had the longest interval to first estrus, the highest number of services per conception, the longest days open, and the longest calving interval. In contrast, healthy buffaloes consistently demonstrated the most favorable reproductive outcomes. Conception at first service and pregnancy by 150 days postpartum were also lowest in the metritis group and highest in healthy buffaloes.

Table 3: Reproductive Performance of Buffaloes According to Postpartum Uterine Health Status

Variable	Healthy, n = 60	Metritis, n = 35	Clinical endometritis, n = 35	Subclinical endometritis, n = 30	p-value
Days to first estrus	56.7 ± 13.9	82.4 ± 11.6	76.9 ± 11.1	70.8 ± 12.1	<0.001
Days to first service	74.4 ± 13.9	102.3 ± 12.8	102.0 ± 17.0	92.0 ± 14.1	<0.001
Services per conception	1.7 ± 0.6	2.9 ± 0.6	2.4 ± 0.6	1.8 ± 0.5	<0.001
Days open	120.5 ± 15.6	172.8 ± 17.8	155.4 ± 15.1	149.3 ± 19.2	<0.001
Calving interval (days)	411.6 ± 20.5	462.5 ± 25.4	451.9 ± 24.7	442.7 ± 23.0	<0.001
Conception at first service	33 (55.0%)	7 (20.0%)	10 (28.6%)	12 (40.0%)	0.004
Pregnancy by 150 days postpartum	55 (91.7%)	21 (60.0%)	23 (65.7%)	22 (73.3%)	0.002

Table 4: Summary of Statistical Tests for Reproductive Outcomes

Research question	Statistical test used	Test statistic	p-value	Interpretation
Effect of infection status on days to first estrus	Independent-samples t-test	t = -9.59	<0.001	Significant
Effect of infection status on days to first service	Independent-samples t-test	t = -10.19	<0.001	Significant
Effect of infection status on services per conception	Mann–Whitney U test	U = 1354.0	<0.001	Significant
Effect of infection status on days open	Independent-samples t-test	t = -13.05	<0.001	Significant
Effect of infection status on calving interval	Independent-samples t-test	t = -10.62	<0.001	Significant
Association between infection status and conception at first service	Chi-square test	$\chi^2 = 9.61$	0.002	Significant
Association between infection status and pregnancy by 150 days postpartum	Chi-square test	$\chi^2 = 12.05$	0.001	Significant
Differences in reproductive outcomes among infection types	ANOVA / Kruskal–Wallis / Chi-square tests	—	<0.05	Significant

The statistical analysis confirmed that postpartum uterine infection had a significant adverse effect on all major reproductive performance indicators evaluated in the study. As shown in Table 4, significant differences were observed between healthy and infected buffaloes for days to first estrus, days to first service, services per conception, days open, calving interval, conception at first service, and pregnancy by 150 days postpartum. In addition, comparisons across the four clinical groups revealed significant differences in reproductive outcomes by infection type.

Discussion

Postpartum uterine infections were strongly associated with deleterious effects on the reproductive performance of buffaloes in the present study. Compared with healthy buffaloes, infected animals showed delayed return to estrus, delayed first service, increased services/conception, prolonged days open and calving interval, and reduced fertility. These findings are biologically plausible since uterine infection following calving can disturb uterine involution, disrupt ovarian activity, and delay

restoration of normal reproductive performance. Like earlier findings in buffaloes, prolonged open days and delayed resumption of ovarian cyclicity are associated with postpartum disorders, whilst the broader bovine literature identifies metritis and endometritis as important causes of suboptimal cow fertility after parturition (6, 7).

The reproduction of buffaloes with metritis among the groups infected was found to be distinctly poor, suggesting that a more sophisticated degree of uterine disease results in an increased loss in fertility. Metritis has indisputably been deemed a more serious postpartum uterine infection than endometritis due to deeper uterine inflammation and the development of concurrent systemic illness in the earlier postpartum period (8). The current study demonstrated that animals with metritis took the longest interval to first estrus, had the highest number of services per conception, and the lowest conception at first service. This placental extrusion pattern echoes previous reports indicating that postpartum metritis is one of the major reproductive disorders in buffalo and surveys showing that pathogenic bacterial contamination of the puerperal uterus can persist or re-establish a presence, leading to infertility and prolonged intercalving intervals (9, 10).

Infected buffaloes also demonstrated reduced conception at first service and a lower pregnancy rate by 150 days postpartum, helping to illustrate the multifaceted influence of uterine disease on reproductive timing as well as successful conception. The observation that subclinical endometritis, even in the absence of clear clinical signs, was associated with poorer reproductive performance than a healthy condition also reinforces the need to identify these less obvious forms of postpartum uterine infection (5). In buffaloes, subclinical endometritis has been associated with delayed ovarian resumption after calving, and review evidence suggests that uterine infection may modify the endocrine and inflammatory milieu necessary for normal follicular development and ovulation. Thus, not recognizing such subclinical cases may allow fertility impairment to go unnoticed, leading to poor reproductive outcomes becoming apparent at the herd level (11).

These results have practical implications for buffalo production systems, in which long days, open and calving intervals decrease reproductive efficiency and can translate into economic losses through fewer pregnancies achieved and longer non-productive periods. For this reason, an early postpartum examination, followed by timely diagnosis of uterine disease and prompt treatment, is a necessary practice in reproductive herd health management (12, 13). The published veterinary literature indicates that therapies for metritis and endometritis should focus on both resolving infection and improving fertility. In addition, preventive management should aim to reduce risk factors such as dystocia and retained fetal membranes, which contribute to postpartum uterine disease (14-16). Thus, this study's findings support routine postpartum uterine health monitoring as a practical intervention to enhance buffalo fertility and reproductive performance.

Conclusion

The reproductive performance was significantly depressed because of postpartum uterine infections in buffalo. Infections in buffaloes were associated with significant delayed return to estrus, delayed first service, increased services per conception, prolonged days open, extended calving intervals, and lower conception at first service and pregnancy rates (150 days Postpartum) compared to healthy buffaloes. Of the infection syndromes, metritis resulted in the most severe reproductive impairment, followed by clinical endometritis and subclinical endometritis. The results suggest postpartum uterine health is one of the main factors influencing subsequent fertility and reproductive efficiency in buffaloes. Thus, early diagnosis and timely treatment, as well as proper prevention of uterine infections, are crucial for better reproductive outcomes. A thorough postpartum reproductive examination of buffalo, control of predisposing factors (dystocia and retained fetal membranes), and herd health practices may alleviate fertility losses, shorten non-productive intervals, and increase productivity in buffalo production systems.

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Author Contribution

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All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the study's integrity.

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