



Association of NEDAP Neck and Leg Tags Monitoring Behaviors as Indicators for the Diagnosis of Health Disorder During the Transition Period in Buffaloes



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Abstract

THIS study aimed to evaluate the effects of various health disorders on feeding, rumination, and lying behaviors in buffaloes using NEDAP leg and neck tags. A total of 30 buffaloes were equipped with these monitoring devices 30 days prior to their expected calving dates. Four health disorders were observed among the enrolled buffaloes: lameness (n=3), mastitis (n=7), dystocia (n=5), and dystocia accompanied by metritis (n=2). Behavioral data related to feeding, rumination, and lying were collected from 11 days before to 11 days after calving. The results demonstrated a significant reduction ($P<0.0001$) in feeding and rumination behaviors in buffaloes affected by lameness, mastitis, and dystocia, compared to healthy individuals. Additionally, lying time increased significantly ($P<0.01$) in buffaloes with lameness and mastitis, indicating discomfort or restlessness due to leg pain and udder inflammation, respectively. In cases of dystocia, lying behavior peaked on the day of calving ($P<0.01$), likely due to labor-related discomfort, followed by a gradual decline postpartum. Buffaloes experiencing metritis following dystocia exhibited the most pronounced behavioral disruptions between days +3 and +7 postpartum compared to healthy controls. In conclusion, the study highlights that feeding, rumination, and lying behaviors are significantly influenced by various health disorders. Furthermore, the use of NEDAP technology proved highly effective in monitoring these behavioral changes, offering valuable insights for improving health management in buffaloes at the farm level.

Keywords: Buffaloes, NEDAP neck and leg tags, Health disorders, behavioral variables.

Introduction

The improving of dairy animal farms is mainly dependent upon good management, proper nutrition and early disease diagnosis. The period 3 weeks before and 3 weeks after calving is called transition period [1]. The calving is very challenging event in dairy animals due to endocrine hormonal, metabolic and immune changes. The decreased daily DM intake (DMI) and slow variability of DMI during transition period leads to negative energy balance than early milk production [2]. The previous literature showed that due to decreased DMI, may result in metritis, metabolic diseases, lameness, hypocalcemia, and mastitis during early lactation [3]. The negative energy balance leads to dystocia and

may result to still born [3]. Therefore, regular monitoring parameters in dairy animals decreases the risk of diseases and improves herd health.

The deviation in gait due to severe pain or leg injuries or hoof discomfort and any other diseases, this condition in dairy is called lameness [4]. Lameness is the major health issue in modern dairy farms. The high prevalence of this issue due to housing management, body condition score (BCS) of animals and energy balance [3]. Mastitis is also one of the major and important health problem in high lactating dairy cows and buffaloes. Mastitis is the inflammatory condition of udder and caused by many infectious and non-infectious factors [5]. Rumination activity is the most important and indicative behavior

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not only for rumen condition but for overall health status of dairy animals [6]. In previous review, Soriani et al. [7] reported that rumination behavior may be the important activity to evaluate the metabolic condition of animals during prepartum and postpartum because changes in feeding behavior during these times. Similarly lying behavior is important activity for the detection of lameness, ketosis and other condition during calving [8]. Therefore, monitoring these behaviors is very important and mandatory for the detection of various diseases.

The automated monitoring technologies in modern dairy farms are now well adopted and used for monitoring effective health status. Various studies were presented on the monitoring behaviors through automated sensors, such as, Kramer et al. [9] used automated devices to measure walking activity during lameness condition in dairy cows, calving time was predicted by using of sensor based on feeding, rumination and lying variables. Some studies diagnosed the mastitis condition in cows based on these variables [10]. The rumination time was measured by using long distance collars during prepartum and postpartum in cows [11]. In this regard, we hypothesizes that the behavioral variables are affected during various health disorders in buffaloes. However, all previous studies had carried out in dairy cattle, but unfortunately no studies are reported to monitor the behavioral changes and detection of various health disorders in buffaloes. Therefore, we designed the first study, to measure the changes in feeding, rumination and lying behaviors through NEDAP leg and neck tags during various diseased conditions in dairy buffaloes.

Material and methods

Animals and farm management

This experiment was conducted on Dairy Animals Training and Research Center, B Block, Ravi Campus-Pattoki, University of Veterinary and Animal Sciences, Lahore, Pakistan. The study was performed from September 2020 to November 2021. All experimental producers were approved by animal research ethical committee of University of Veterinary and Animals Sciences, Lahore, Pakistan. Initially, thirty (n=30) multiparous Nili Ravi buffaloes at 30 days before the expected date of calving were selected in this study. The selected animals were separated in prepartum pens, which was well ventilated and straw bedding (20±2 buffaloes/pen). The animals were fed a green fodder with additional supplementation of concentrate. The feeds were offered twice a day during prepartum and post-partum period. The feeds were formulated to meet or exceed the requirement of lactating buffaloes and fresh water was available to all buffaloes.

The buffaloes diagnosed with severe disease conditions were separated houses, referred to as a hospital group (10 ± 3 buffaloes). The healthy buffaloes were separated and housed in free stall pens with rubber mats bedded with sawdust.

Experimental procedures

Health monitoring

The study was conducted to monitor the impact of various health disorders on feeding, rumination, and lying behaviors in buffaloes. A total of 30 prepartum buffaloes were selected from Dairy Animals Training and Research Center, based on their expected calving dates, and were equipped with NEDAP leg and neck tags 30 days before calving to record behavioral data continuously. Buffaloes were included if they were clinically healthy at the start of the study and excluded if they had any pre-existing conditions. The health status of the buffaloes was initially assessed daily by farm staff and then confirmed by veterinarians from the University of Veterinary and Animal Sciences, Lahore. Throughout the observation period, four types of health disorders were diagnosed: lameness (n=3), mastitis (n=7), dystocia (n=5), and dystocia with metritis (n=2).

Calving event and postpartum care

Farm staff monitored prepartum buffaloes every 2 hours, starting 3 days before the expected calving date, until the onset of labor. When signs of calving were observed, all calving-related events, including cases of dystocia or other complications, were recorded and managed according to the farm's standard protocols. Postpartum, the buffaloes were transferred to the hospital facility within 0 to 4 days, depending on their health status. Healthy buffaloes were moved from the hospital barn to the lactating animal shed after 4 days after treatment. All postpartum buffaloes were regularly monitored for any signs of disease throughout the study period.

Mastitis

The presence of clumps in the milk, swollen, hard or hot udder, and pain with watery or reddish color serous secretion from the udder is defined as mastitis condition. This condition was confirmed through somatic cells count and surf fill mastitis test. After confirmation of mastitis, its treatment was done as routine standard procedure.

Lameness

The abnormal gait, the presence of an arched back or leg, and signs of severe pain in the leg during walking or standing were diagnosed as lameness. After diagnosis of lameness, treatment with

analgesics and supportive therapy as routinely adopted in the farm.

Automated behaviors measurement

The NEDAP leg and head collar tags were attached on hind limb and left side of neck, respectively, on enrolled buffalos. These devices were attached from -30 days before the calving to 30 days after calving in buffaloes either with normal birth (control) or dystocia or still born calving or lame or positive mastitis. The neck tag monitored feeding and rumination behaviors, while the leg tag monitored lying behavior parameters.

Statistical Analysis

The excel data sheets were organized and all statistical analyses were applied by using SAS version 9.4. The data of mastitis vs. normal healthy (control) buffaloes, lame vs. not lame buffaloes, and buffaloes that calved with normal birth vs. dystocia or still born were compared on each sampling day by T-test. Effects were deemed significant when $P \leq 0.05$.

Results

Association of lameness with behavioral variables

The results showed that the feeding behaviors (bouts and time/d) was suddenly dropped in lame buffaloes as compared to not lame (healthy) on day 0 (onset of lameness) (11.3 ± 1.9 bouts/d and 120.5 ± 14 min/d; $P < 0.0001$), respectively. Moreover, the feeding behaviors was significantly lower in lame than in not-lame buffaloes at 1-5 day interval, but the differences were lowered between lame and not lame animals during this interval, which indicated that lame buffaloes recovered slowly after treatment, as shown in Figure 1. The rumination behaviors (bouts and time) were 10.5 ± 1.6 bouts/d ($P < 0.001$) and 270 ± 16 min/d ($P < 0.01$), respectively, on day 0 in lame buffaloes as compared to ??? and ??? in not-lame animals. However, after treatment, rumination behaviors were tended to be normal ($P > 0.05$) on day 5 after treatment, as shown in Figure 1. Also, the lying bouts and time increased on 0 day 32.5 ± 2.6 bouts/d, ($P < 0.01$) and 480.9 ± 20 min/d ($P < 0.05$), respectively, in lame buffaloes as compared to healthy, as shown in Fig. 1.

Association between mastitis and behaviors

The association between feeding behaviors and mastitis is shown in Fig. 2. The feeding bouts during 0-3 d interval and feeding time during 0-5 d interval were significantly decreased in buffaloes with mastitis than in healthy ones. Similarly, rumination behaviors (bouts and time) were significantly lower as the mastitis diagnosed up to 5 days (0-5 day) compared with healthy animals. In animals with

mastitis, the lying bouts (0-1 d) and time (0-3 d) were significantly increased as compared to healthy animals. The results showed that all behavioral variables were recovered to be normal after 3-7 days of treatment.

Association between dystocia and behavioral variables

The feeding and rumination behaviors were significantly decreased at 0-3 day in buffaloes with dystocia compared with the normal calving. However, feeding behaviors were normalized after 5 days of the calf expulsion, as shown in Fig. 3. The lying bouts (0-5 d) and time (0-1 d) were higher ($P < 0.05$) in animals with dystocia than in those with normal calving, as shown in Fig. 3.

Effect of Dystocia with metritis on behavioral variables

The effect of dystocia with metritis on behavioral variables is shown in Fig. 4. The feeding bouts (1-7 d) and time (3-7 d) were significantly ($P < 0.05$) decreased after the expulsion of calf in metritis buffaloes as compared to healthy buffaloes. The rumination time and bouts were lower ($P < 0.05$) at 3-9 days in buffaloes with metritis than in healthy animals. The lying time was increased ($P < 0.05$) at 3-7 days in metritis as compared to healthy buffaloes, but lying bouts was not affected significantly by metritis.

Discussion

Health issues are very common in dairy animal herds, which includes mastitis, metritis, lameness, dystocia, digestive disorders and still born etc. these health issues put deleterious effect on milk production and reproductive performance [12]. Therefore, the timely diagnosis of these health disorders is very necessary for the improvement of production and reproduction in dairy animals. Various studies [13, ???, ???] have reported to solve the diagnosis issue through automated monitoring devices, but unfortunately all these studies were conducted on dairy cattle and no such type of study was reported on buffaloes. Therefore, we design this study to establish the behavioral standards for various health disorders in dairy buffaloes.

Results of the current study showed that automated monitoring behaviors (feeding and rumination) in lame buffaloes were significantly lower on day of diagnosis (day 0) than in healthy buffaloes, after that it again increased to normalized after treatment. Our findings are in consistent with previous reports showing that feeding duration decreases in lame cattle than in healthy ones [14]. The reason of consistency in findings of this study with previous studies may be due to pain or

discomfort during lameness [15]. In feeding behaviors, the cattle and buffaloes redistribute their weight on the legs, for this reason lame animals spent more time in lying than standing or other activities may be due to reduced discomfortable [16]. Norring *et al.* [17] observed that feeding activity was associated with feeding time *i.e.* morning, afternoon and night feeding. The findings of current study showed that, rumination behaviors were decreased in lame buffaloes, being is consistent with previous results of Van *et al.* [18], who found lowered rumination time in lame dairy cattle. The rumination behaviors in lame were also affected by animal conditions, including management protocol and response to treatment [19]. Barkema *et al.* [20] found that due to severe pain during lameness, therefore feed intake decreases and rumination behavior were affected. The results of current study showed that lying time and bouts were increased on the day of diagnosis of lameness. These findings of this study is in agreement with previous studies of Mattachini *et al.* [15], who observed that lying behavioral variables were increased in lame animals due to severe pain when stand or walk the animals.

Feeding time was also affected by other diseases like hoof lesion, mastitis *etc.* Similarly, the feeding and rumination behaviors in the current study were decreased at 0-5 days interval in buffaloes with mastitis. In literature, similar results indicated that mastitis caused deleterious effect on feeding and rumination behaviors in Holstein cows [21]. Another scientist [6] used noseband sensor for measuring feeding and eating behaviors in dairy cattle. They found that mastitis either clinical or subclinical impact on feeding behavior. The decrease in feeding time in both buffaloes and cattle may be due to toxins of pathogens, which affect the digestive physiology [22]. In comparable with our results, Paudyal *et al.* [5] found that feeding time increased, while drinking and rumination time decreased in clinical mastitis cows.

In literature various researchers reported that feeding behavior disturbed during the onset of calving in dairy and beef animals [5]. Moreover, Proudfoot *et al.* [23] found that feeding behavior was seriously affected by dystocia occurred during calving in Holstein cattle. These findings support our findings that feeding time had marked decrease in buffaloes with dystocia. The reduction in feeding time during calving or dystocia may be due to severe labor pain or release of parturition hormones [24]. The findings of current study indicated a reduction in rumination bouts and time was at 0-3 day interval in buffaloes with dystocia during calving and after the expulsion of the fetus, but the rumination behaviors had become normal after 5 days of treatment. These

results supported by previous literatures [5], who reported that rumination behaviors was seriously affected by dystocia during calving. The rumination was also affected by season in which dystocia present, *i.e.* It was reported that rumination time had 231.1 min/d in cool season, while 110.9 min/d in hot season in dairy cattle with dystocia or still born [25]. The rumination behaviors were stable after calving, which showed that rumination behaviors significantly association with pripartum and postpartum status in dystocia animals [26]. The decreased in rumination behaviors in the present study or other studies may be due to uterine disease post calving after dystocia or a reduction in the feed intake related to stresses due to dystocia [27] or ketosis either subclinical or clinical after dystocia [28]. Rumination time was also affected by particle size of feed stuff or total mixed ration (TMR), feed ingredients, environmental condition, and early lactation in dairy animals [28]. In the current study, lying time and bouts were slightly increased as calving time approaches in dystocia animals and then decreased after deliver the fetus. Paudyal *et al.* [25] found similar observations in cattle with dystocia during calving. The similarity in results of current study and previous reports may be due to similar physiology of bovine and buffalo, and the increase of lying time at parturition may be due to labor pain, ketosis or other uterine diseases.

In the present study, automated monitoring behaviors were slightly affected by metritis after dystocia in buffaloes. Pastell *et al.* [29] observed that behaviors are affected in metritis problem either normal calving or dystocia. The decrease in behaviors may be due to stress or release of inflammation mediators, which affect the feeding and rumination behaviors [1]. Another possible reason is that, during parturition the acute stressors on nociception and adrenocortical responses developed which affect the feeding behaviors in animals. The results are in consistence with previous author [5] who reported that uterine diseases link with still born calving in cattle.

Conclusion

In conclusion, the results showed that feeding, rumination, and lying behaviors were significantly altered in buffaloes affected by various health disorders, including lameness, mastitis, and dystocia. The reductions in feeding and rumination time, along with increased lying behavior in diseased buffaloes, indicating that these behavioral changes can serve as early indicators of health problems. These findings have significant implications for disease detection and management at the farm level. The ability to

continuously monitor behavioral patterns using NEDAP technology allows for early identification of animals at risk, enabling immediate veterinary intervention and reducing the severity of health complications. Furthermore, the study supports the validation of NEDAP monitoring systems as a reliable tool for automated health surveillance, improving overall herd management efficiency and welfare. Future research should focus on refining the sensitivity and specificity of these monitoring systems to further improve their effectiveness in detecting subclinical disease conditions.

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Data Availability

Available on request.

Declarations

Ethical approval: This study was conducted according to the standards of the Ethics Committee for Animal Experimentation of the Committee on Animal Use and Care, University of Veterinary and Animal Sciences, Lahore Pakistan

Conflict of interest: None to be declared.

Consent to participate: Not applicable.

Consent to Publish: Not applicable.

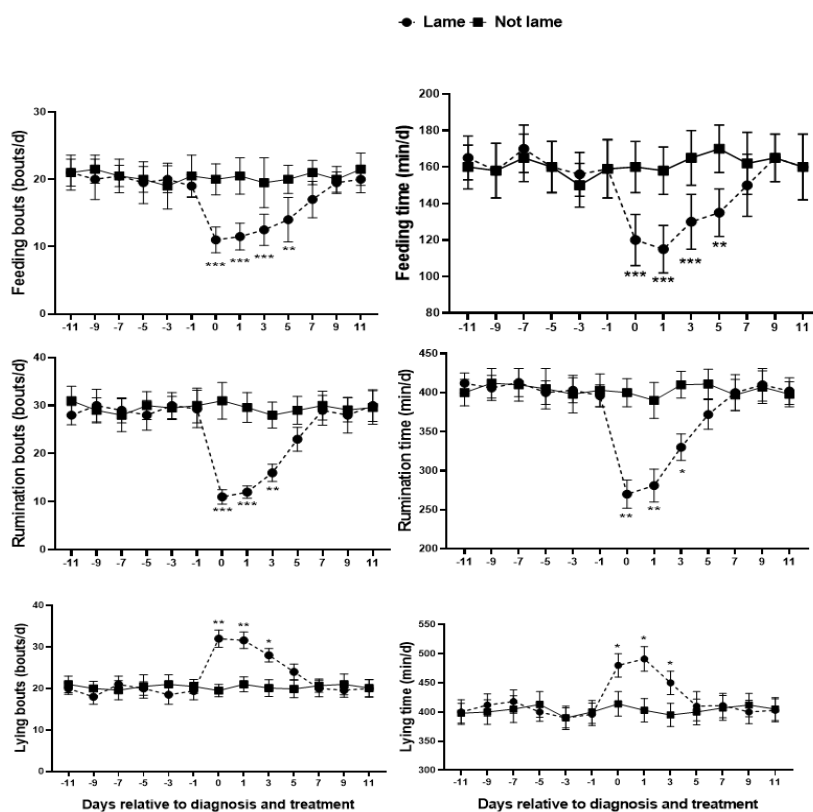


Fig.1. Effect of lameness on bouts and time of feeding, rumination,, and, lying in buffaloes on days -11, -9, -7, -5, -3, -1, 0, 1, 3, 5, 7, 9, and 11 days relative to diagnosis and treatments.

*** Significant differences at $P < 0.001$, ** Significant differences at $P < 0.01$ and * Significant differences at $P < 0.05$.

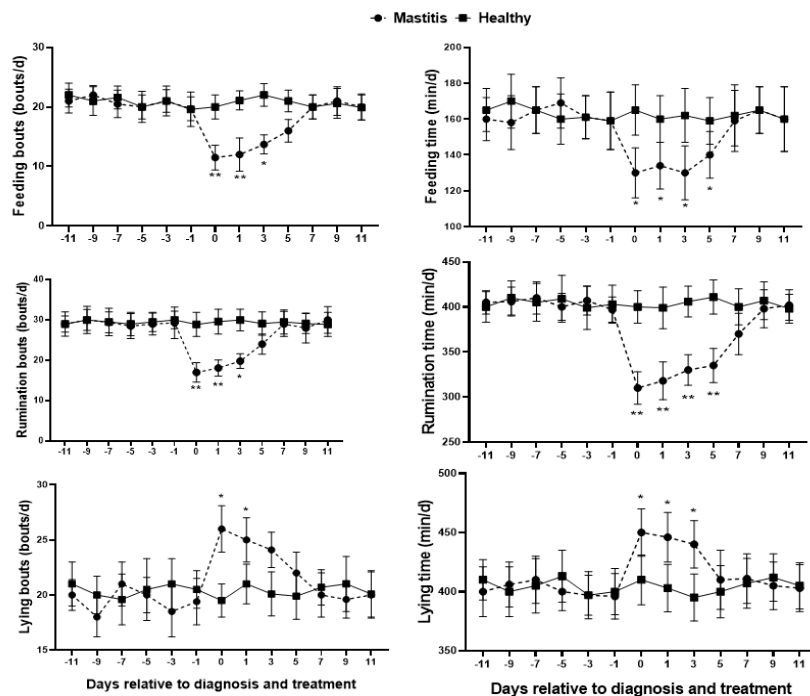


Fig. 2. Effect of mastitis on bouts and time of feeding, rumination,, and, lying in buffaloes on days -11, -9, -7, -5, -3, -1, 0, 1, 3, 5, 7, 9, and 11 days relative to diagnosis and treatments.

** Significant differences at $P < 0.01$ and * Significant differences at $P < 0.05$.

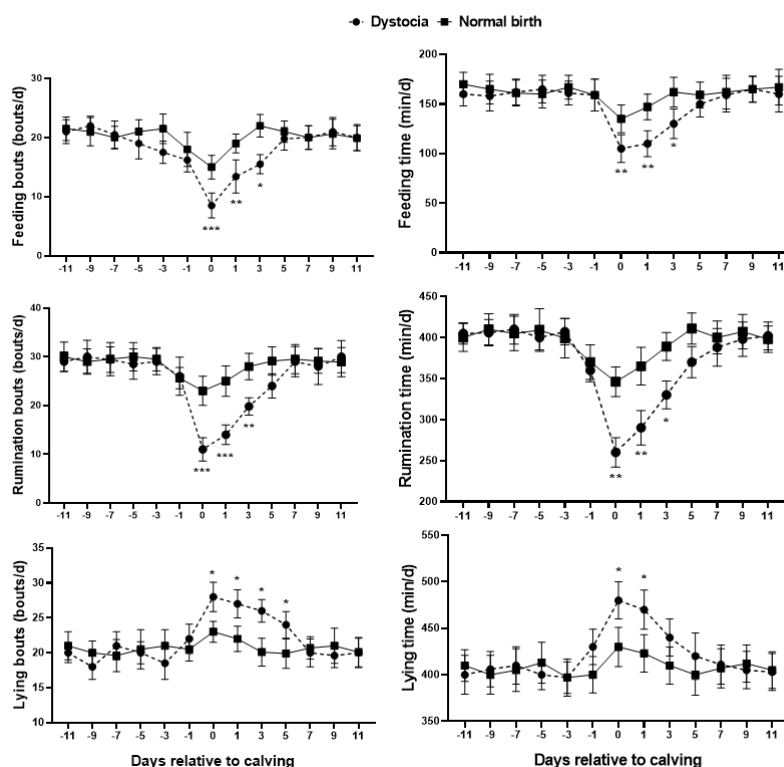


Fig. 3. Effect of dystocia on bouts and time of feeding, rumination, and, lying in buffaloes on days -11, -9, -7, -5, -3, -1, 0, 1, 3, 5, 7, 9, and 11 days relative to diagnosis and treatments.

*** Significant differences at $P < 0.001$, ** Significant differences at $P < 0.01$ and * Significant differences at $P < 0.05$.

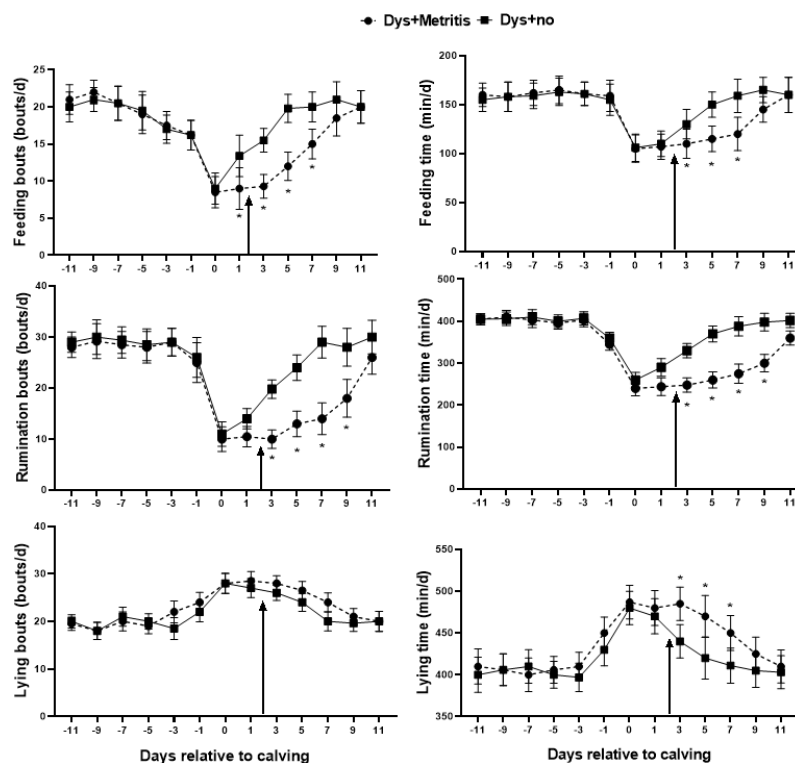


Fig. 4. Effect of dystocia and metritis on bouts and time of feeding, rumination, and, lying in buffaloes on days -11, -9, -7, -5, -3, -1, 0, 1, 3, 5, 7, 9, and 11 days relative to diagnosis and treatments.

*** Significant differences at * Significant differences at $P < 0.05$. Arrow indicated diagnosis of metritis and treatment.

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