Transition period rumination time and its association with milk production in New Zealand dairy cows

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Maximising the seasonal performance of dairy cows is dependent on a positive transition into lactation. By utilising daily rumination time (RT), made available through automated monitoring devices (AMD), farmers may gain insights into peripartum management practises which impact cow dry matter intake (DMI), health and milk production.

The transition period, defined as the three weeks prepartum to three weeks postpartum is typically characterised by a decline in DMI prior to parturition, a negative energy balance (NEB), depression of immune function, and a decline in serum calcium and glucose at the onset of lactation. After which a rapid increase in DMI is observed from 0–21 days in milk (DIM) (Grant *et al.* 1995).

Rumination, the process by which previously swallowed ingesta is regurgitated, remasticated and swallowed, is modified by the passage of feed particles into the omasum, due to particle size; and the rate of particle size reduction, due to density and digestibility of the ingesta. Collectively these factors alter the physically effective neutral detergent fibre (peNDF) properties of the diet (Mertens 1997; Beauchemin, 2018).

During the prepartum period, RT is maintained until within 24 hours of parturition at which time a drop occurs to a nadir at or around parturition Figure 1. In healthy cows, RT increases rapidly in the postpartum period, stabilising by 5–8 DIM, while RT recovery in diseased cows is often delayed till 14–15DIM (Stevenson *et al.* 2020; Fadul *et al.* 2022). While delayed recovery of RT postpartum indicates disease, prepartum RT may indicate rumen function, impacting NEB and disease postpartum (Calamari *et al.* 2014; Soriani *et al.* 2012).

The association between transition period RT and milk production has not been assessed in pasture-based systems, however correlation between RT and milk yield (MY) have been reported as moderate (r = 0.37–0.69) between postpartum RT and MY (Soriani *et al.* 2012; Calamari *et al.* 2014; Liboreiro *et al.* 2015; Kaufman *et al.* 2018). Therefore, the objective of this study was to create linear mixed effect models to investigate the association between RT peripartum with seasonal herd-test-predicted milk solids (kgMS), and first 30 DIM cumulative milk yield (MY30).

Data was collected in retrospect from cows (n=6421) of twelve New Zealand dairy herds utilising individual cow milk meters (SenseHub™ Milk Sensor, MSD Animal Health) and behavior monitoring neck tags (SenseHub™ Monitoring Neck Tag, MSD Animal Health). Farms were well distributed across New Zealand, with four farms having >1000 cows and five farms <450 cows. Cows were categorised by parity into parity 1 (P1, n=1438), parity 2 (P2, n=1211) and parity 3+ (P3+, n=3772). The cow breeds were Friesian (F, n=2382), Jersey (J, n=436), Kiwi Cross (X , n=2983) and other (n=620).

For each cow, a lactation curve was obtained using a Wilmink equation and AUC values for the first 30DIM used to derive MY30 (Wilmink 1987). Predicted KgMS values were extracted from MINDA where two herd-test values were present. Variables were created for the arithmetic mean RT of weeks relative to partition date, including week one prepartum (PrP), week one postpartum (1PoP) and week two postpartum (2PoP). Disease

cases were obtained from farm records and assessed for model inclusion when disease diagnosis preceded the models RT measure. Weekly RT and milk production for parity categories are shown in Table 1.

Three-way interactions between weekly mean RT, parity and breed resulted in separate models for each parity category being created. Weekly RT variables were also considered in separate models rather than repeated measures. This resulted in 18 models describing RT for three weeks peripartum, three parity categories, and two production outcomes. Farm was considered a random effect in the models and breed was forced into the models a priori.

Figure 1. Least squares mean +/- SEM for rumination time (RT) by day in milk (DIM), parity and breed. Breed categories shown are Friesian (F), Jersey (J), and Kiwi Cross (X) while parity categories are parity 1 (P1), parity 2 (P2) and parity 3 or greater (P3+).

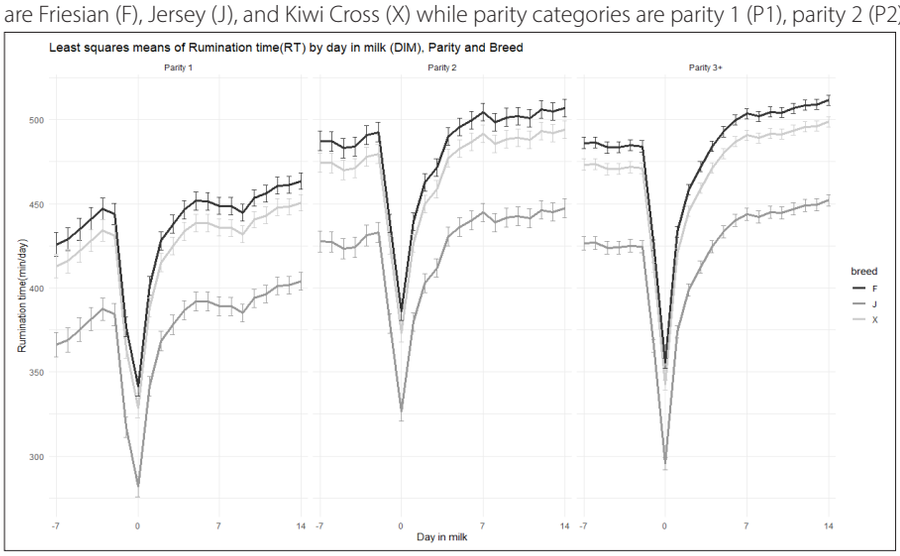


Table 1. Lactation group summary of key variables.

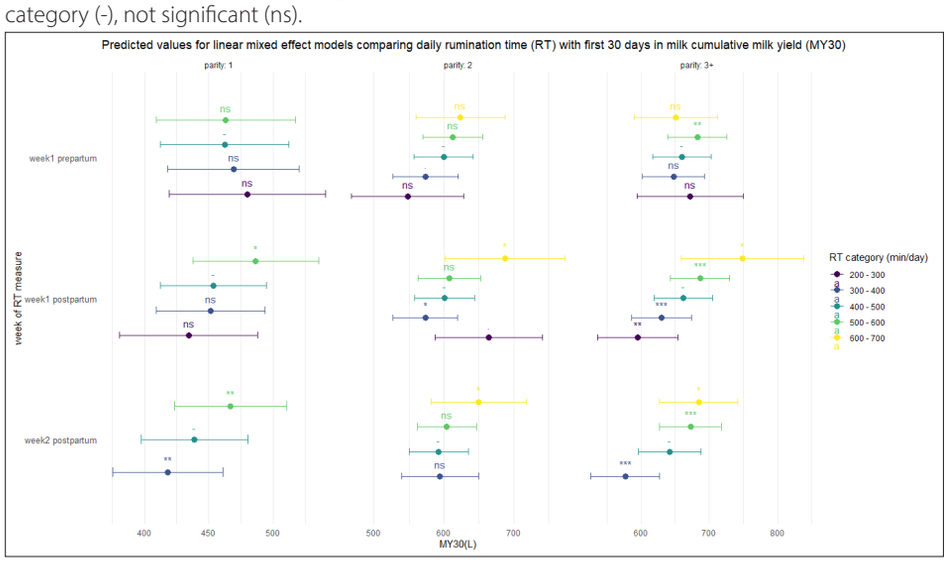
Parity	RT 1st week prepartum (min/day)	RT 1st week postpartum (min/day)	RT 2nd week postpartum (min/day)	Seasonal milk solids (kg)	First 30d cumulative milk yield (L)
1	410.8 ± 80.3 (n=592)	409.7 ± 60.9 (n=929)	442.1 ± 52.7 (n=1198)	397.3 ± 99.4 (n=1424)	449.4 ± 127.5 (n=1374)
2	471.3 ± 70.8 (n=852)	453.4 ± 62.6 (n=1093)	492.6 ± 54.2 (n=1116)	468.9 ± 109.2 (n=1205)	609.6 ± 140.0 (n=1166)
3+	467.2 ± 65.0 (n=2605)	446.2 ± 64.7 (n=3270)	495.0 ± 60.4 (n=3401)	486.9 ± 140.4 (n=3687)	667.5 ± 160.3 (n=3502)

Measurements are given as mean +/- 1.96 standard deviations.

Positive linear associations were found between mean RT and MY30 during the postpartum period, with 41.4L (6.2%) and 47.5L (7.1%) per 100min difference in RT for periods 1PoP and 2PoP in P3+ cows. Positive associations are also evident in P1 and P2 cows (Figure 2). For KgMS, the association was non-linear with categorised RT variables suggesting RT above 500 min in P2 and P3+ cows have diminishing returns.

The current study shows a positive relationship between transition period RT monitoring and milk production, especially during the two weeks postpartum. This suggests significant production benefits from real-time monitoring of transition period RT and adaptation of management practises where opportunities are identified.

Figure 2. Predicted model outputs calculated for a Friesian cow without disease, calving on the median date within the herd. Significance is shown for each categorical RT variable as: P value <0.001 (***), 0.001–0.01 (**), 0.01–.05 (*), 0.05–0.1 (.), reference category (-), not significant (ns).



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