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Milking collar activity data is associated with health events and feed intake in lactating Holstein cattle

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Introduction

- Individual cow feed intake impacts profitability but is expensive to obtain.
- Health events (e.g. mastitis/ lameness) are associated with feed intake.[1]
- Milking systems on commercial dairies now routinely collect cow activity.
- **Objective**: **Determine if milking collar activity is associated with feed intake, efficiency, or health.**

Materials and Methods

Data collected (n=155 cows with feed intake)

Feed Intake | Milk Weight & Components | Body Weight BCS | Health (Health categories (5): healthy, mastitis, lame, multiple, or other) | Temperature Humidity Index (**THI**)[3] | Activity

- Health was classified as current time of event, overall throughout the whole trial, or onset-from diagnosis throughout the rest of the trial period

Data Cleaning (n=1600 cows with activity data)

➢ $\ln(activity) = \mu + CG_i + Parity_j + \varepsilon_{ij}$

μ = mean natural log activity counts, **CG** = contemporary group, ε_{ij} = residual is adjusted sensor measure (**ASM**)

Statistical Associations with Dry matter intake (DMI) and efficiency (n=155)

➢ Adjusted dry matter intake (**aDMI**)[1,2] and DMI were associated with ASM and several covariates

Base models:

$$aDMI = \mu + ASM_i + \varepsilon_i$$
$$DMI = \mu + ASM_i + \varepsilon_i$$

Results

Table 1. Are milking collar activity sensors associated with feed intake?

Model	2-Hour Activity estimates	Daily Activity estimates
	Units: kg/log count of activity	Units: kg/log count of activity
$aDMI = \mu + ASM_i + \varepsilon_i$	0.17**	0.16**
$DMI = \mu + ASM_i + \varepsilon_i$	0.23**	0.23**

** = p < 0.005

Table 2. What is the relationship between activity and health?

Model	2-Hour Activity LSMeans difference estimates	Daily Activity LSMeans difference estimates
	Units: log count of activity	Units: log count of activity
[1]$ASM = \mu + Overall\ Health_i + \varepsilon_i$		
Healthy vs. Lameness	-0.1479**	-0.1543**
Healthy vs. Mastitis	-0.0596*	-0.0635
[2]$ASM = \mu + Current\ Health_i + \varepsilon_i$		
Healthy vs. Lameness	-0.0184	-0.0214
Healthy vs. Mastitis	0.0046	0.0035

[1]Association: p < 0.0001
[2]Association: p < 0.0004
*Model using onset health did not have a significant association with ASM

* = p < 0.05, ** = p < 0.005

[1,2] How do sensor measure associations with feed intake differ with health events of different durations?

$$aDMI = \mu + ASM_i + Overall\ Health_j + ASM*Overall\ Health_{ij} + \varepsilon_{ij}$$

$$DMI = \mu + ASM_i + Overall\ Health_j + ASM*Overall\ Health_{ij} + \varepsilon_{ij}$$

$$aDMI = \mu + ASM_i + Current\ Health_j + ASM*Current\ Health_{ij} + \varepsilon_{ij}$$

$$DMI = \mu + ASM_i + Current\ Health_j + ASM*Current\ Health_{ij} + \varepsilon_{ij}$$

*Effects for all variable terms in the above models were significant at p < 0.005

[1]Models adapted from Siberski et al., 2019[1]
[2]Models displaying results from log of daily activity only

Table 4. Does activity differ by stage of lactation (days in milk: DIM) or in response to heat stress (THI)[3]?

Model	Models using Log of 2-Hour Average Activity	Models using Log of Daily Activity Count
	Units: log count of activity/1 DIM	Units: log count of activity/1 DIM
$ASM = \mu + DIM_i + \varepsilon_i$	-0.00056**	-0.0006**
	Units: log count of activity//1 degree THI	Units: log count of activity/1 degree THI
$ASM = \mu + THI_i + \varepsilon_i$	-0.001**	-0.001**

Conclusions

- Both daily total and average two hour activity (log values) were significantly associated with aDMI and DMI (p<0.005).

- Health events were also associated with milking collar activity measures, but the strength of the association varied depending on the duration of time the event was modeled.

- Significant interactions (p < 0.005) between health events and activity measures indicate the relationship between sensor measures and feed intake may vary depending on the health status of the cow. Thus, efforts to use sensors as proxies for feed intake will require health information for proper interpretation.

- Stage of lactation (DIM) and heat stress (THI) were associated with activity measurements (p < 0.005), indicating they are important factors in evaluating dairy cow activity data.

References

1. Siberski, C.J., et al. 2019. Iowa State Master's Thesis: https://lib.dr.iastate.edu/etd/17783/
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3. Yousef, M. K. 1985. Stress Physiology in Livestock. CRC Press, Boca Raton, FL.