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Herd-level associations between human–animal relationship, management, fecal cortisol metabolites, and udder health of organic dairy cows

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ABSTRACT

Impact patterns of human–animal relationship (HAR) and herd stress level on udder health were investigated in a cross-sectional study on 30 German and Danish organic dairy herds also taking into account influencing factors regarding housing and management. Cow behavior (avoidance distance, tolerance to tactile interaction, release behavior) was assessed in tests, milkers' behavior recorded during milking, and information about contacts with animals during routine work gathered by interview. Additionally, stockpersons' attitudes were recorded via questionnaires. Fecal cortisol metabolites were measured in approximately 30 focal cows on each farm and used as a proxy to determine the level of distress within the herd. Management and housing were assessed on-farm. The following herd udder health indicators were calculated: the prevalence of mastitis quarters (≥100,000 cells/mL), and, from milk recording data over 1 yr retrospectively, the average somatic cell score and the self-cure rates during lactation per herd. Multivariable regression models with stepwise selection were calculated at herd level. The following HAR-related factors were associated with better udder health (in at least 1 of the final models): stockpersons' higher agreement on patience being important when moving the cows and on necessary contact to cows being pleasant, higher amount of positive interactions with cows during milking, more docile cows in the release behavior test, no routine change of milkers, more contact time during routine work, no active heifer habituation to milking, and performance of barn controls beyond routine work. Lower fecal cortisol metabolite levels were related to higher self-cure rates during lactation. Concerning housing, management, and herd characteristics, the following known factors were related to impaired udder health for at least 1 of the indicators: straw yards, automatic milking system, higher average lactation number, and less antibiotic udder treatments. The results confirm earlier findings that HAR is associated with udder health and should therefore be considered in future research and mastitis control programs. First indications of negative associations between herd stress level and mastitis curing capacity should be followed up in future studies.
Key words: organic dairy cow, stress, mastitis, curing, human–animal relationship

INTRODUCTION

Mastitis is a major challenge for the dairy sector in both organic and conventional farming (Marley et al., 2010; Barkema et al., 2015). Mastitis can vary from subclinical with elevated SCC to infections with severe clinical symptoms. Prevention of new IMI is crucial, but another critical point is whether a case of mastitis can be cured or becomes chronic. Chronic subclinical mastitis affects dairy farm economy due to milk losses, treatment costs, and early culling (Halasa et al., 2007).

Mastitis is a multifactorial disease (e.g., Lievaart et al., 2007; Dufour et al., 2011), warranting a multivariable study approach. Besides influencing factors regarding housing and management, human–animal relationship (**HAR**) has been found to be relevant for udder health in a cross-sectional study on 46 small-scale Swiss dairy farms with milking parlor systems (Ivemeyer et al., 2011). An HAR can be defined as mutual perception, developed and expressed by mutual behavior, and aspects of it include the stockpersons' attitudes toward cattle and their interactions with the cows during routine handling situations such as milking, as well as the cows' reactivity toward humans (Waiblinger et al., 2002). The latter can be evaluated by validated and standardized tests such as the avoidance distance test measuring the cows' behavioral reactions toward a moving human (Waiblinger et al., 2006) or the toler-

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ance to tactile interactions and the release behavior (Ebinghaus et al., 2016, 2017). In a study by Ivemeyer et al. (2011), the percentage of positive interactions of milkers with the cows was negatively associated with the average SCS from test-day results over 1 yr and the prevalence of quarters with SCC ≥100,000 cells/mL and of mastitis quarters (bacteriological positive and SCC ≥100,000) in quarter milk samples. Hemsworth et al. (2000) found significant positive correlations between the amount of negative tactile interactions toward the cows during milking and bulk milk SCC. Because of the limited external validity of epidemiological studies and the multifaceted nature of both HAR and udder health, repeated investigations are necessary to support or challenge the findings under slightly different conditions. In addition, none of the previous studies have investigated a possible connection between HAR, herd stress level, and mastitis curing capacity, although there are indications that higher incidences of clinical mastitis are related to increased stress levels in cows, expressed by metabolic parameters and blood leukocyte profiles (Holtenius et al., 2004). However, the measurement of fecal cortisol metabolites (**FGCM**) as an established and noninvasive method to assess adrenocortical activity and thus stress in cattle (Palme, 2012; Palme et al., 1999) has not previously been used to investigate associations with mastitis.

The aim of this exploratory study on German and Danish dairy farms was to evaluate possible associations of HAR measures and herd stress level with udder health indicators, including mastitis cure rate, while taking into account already well-known housing and management risk factors. The question in particular was whether results from Ivemeyer et al. (2011) could be replicated under differing farming conditions regarding herd size, breed, and management, including automatic milking systems in addition to milking parlors. The study approach was on the herd level because improvement strategies usually are applied at this level.

MATERIALS AND METHODS

Farms and Animals

In total, 30 organic dairy herds in loose housing systems were investigated within the European CORE Organic Plus project Organic Dairy Health (http://coreorganicplus.org/research-projects/organicdairyhealth/). All herds consisted mainly (>50%) or completely of Holstein Friesian or Red Holstein cows. All farms participated in official milk recording schemes (11 test days/yr). Beyond these selection criteria, a sample of farms was chosen covering a typical range of different farm conditions on organic dairy farms, especially regarding herd size and milking system. Twenty-five farms were located in Middle and Northern Germany, and 5 were located in Denmark. Ten farms (5 in Germany and 5 in Denmark) used automatic milking systems (**AMS**), and the others milked in fishbone (16 farms) or tandem (4 farms) milking parlors. Herd sizes ranged from 29 to 215 cows (mean: 85.2; ±47.9 SD; range: 29–161 in Germany and 130–215 in Denmark). Average herd milk yield was 7,219 kg/cow per year (±1,614; range: 4,144–11,899 kg/cow per year) with 4.2 ± 0.2% fat and 3.4 ± 0.1% protein content. The majority of farms (21; 70%) were family operated, whereas the others were farming communities. Twelve German farms kept horned cows (>85% horned cows per farm), and all others kept dehorned or partly genetically hornless cows (for more farm characteristics, see Tables 1 and 2).

The present study ran in close cooperation with a German national project "Human–Animal Relationship in Dairy Cows." Therefore, on the 25 German

Table 1. Descriptive data regarding herd characteristics and udder health indicators from milk recording data, quarter milk samples in focal cows, questionnaire, and veterinary treatment records (n = 30 herds), including results of univariable preselection (information about the associated dependent variable and direction of correlation in the last column of the selected variables)

Factor[1]	Mean ± SD	Range	Preselected for model[2]
Herd size (no.)	85.2 ± 47.9	29–215	
No. of cows/stockperson	29.1 ± 25.3	4–108	
Average lactation no.	3.0 ± 0.5	2.4–4.4	SCS (+)
QSAur (%)	2.6 ± 3.4	0–15.5	Cure (−)
TM_All (no./100 cows per year)	38.6 ± 36.3	0–129.4	
TM_AB (no./100 cows per year)	22.5 ± 21.3	0–80.0	SCS (−)

[1]QSAur = prevalence of *Staphylococcus aureus* IMI; TM_All = veterinary udder treatments, including internal teat sealers; TM_AB = antibiotic udder treatments during lactation and at drying off (repeated mastitis treatments connected to the same diagnosis were counted as 1 treatment if not interrupted for longer than 7 d).

[2]SCS = average SCS over 1 yr; Cure = cure rate: 3 consecutive test days with SCC <100,000 after an elevated SCC of ≥200,000 cells/mL per all test-day results ≥200,000 cells/mL in 1 yr. + = positive correlation; − = negative correlation.