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The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK

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Can environmental variables replace some animal-based parameters in welfare assessment of dairy cows?

C Mülleder*†, J Troxler†, G Laaha‡ and S Waiblinger†

† Institute of Animal Husbandry and Animal Welfare, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria
‡ Institute of Applied Statistics and Computing, University of Natural Resources and Applied Life Sciences, Vienna
* Contact for correspondence and requests for reprints: cornelia.muelleder@gmx.at

Abstract

Animal-related parameters best fulfil the requirements of a valid welfare assessment, but often they are less feasible than other parameters. Therefore, this paper examines whether animal-based parameters are connected with each other and with environmental factors in order to find out if some can be discarded without loss of information.

Eighty Austrian dairy herds (21-55 Simmental cows) housed in loose-housing cubicles were visited. Housing, management and the human-animal relationship were assessed. Animal-based parameters such as lameness, skin lesions and social behaviour were recorded. For the statistical analysis, Spearman correlation coefficients and regression trees with additional cross-validations for the assessment of the predictive performance of models were calculated.

The animal-based parameters could be explained by environmental variables only around 2/3 (goodness of fit). The calculated regression trees explained 62% of the percentage of lame animals, 58% of leg injuries on the carpal joints and 69% of the agonistic interactions. Leg injuries on the tarsal joints could be explained to quite a high degree (77%). Cross-validated regression trees, however, which are more significant for prediction on farms in excess of this study, accounted for 31% of the total variance of lameness, 44% of the leg injuries on the tarsal joints, 33% on the carpal joints and 25% of the agonistic interactions.

Only a few correlations between animal-related parameters were found: lameness was correlated with leg injuries on the tarsal joints and on the carpal joints. Leg injuries were correlated with each other.

Due to the lack of interrelations between animal-related parameters and the moderate prediction by environmental factors, we do not suggest replacing the investigated animal-related parameters for on-farm welfare assessment in dairy cattle.

Keywords: *animal-based parameters, animal health, animal welfare, dairy cows, environmental parameters, on-farm welfare assessment*

Introduction

An appropiate welfare assessment tool for use on farms demands that the single measures, but also the protocol as a whole, are valid, reliable and feasible. One significant component in making an assessment tool feasible is to reduce the time needed for its use. Animal-based parameters best fulfil the requirements of a valid welfare assessment, but are often more time consuming compared to measuring environmental factors, however the latter also has the advantage of revealing the causes for welfare problems (Waiblinger *et al* 2001). Therefore, to cover the different aspects of animal welfare, a range of animal-based parameters needs to be included (Johnsen *et al* 2001; Winckler *et al* 2003). However, if close relationships between more easily assessable environmental factors and animal-related parameters could be demonstrated in the multifactorial farm situation, such criteria may replace some of the animal-based parameters (Winckler *et al* 2003). Similarly, if some of the latter show strong interrelationships, it would be reasonable to include the indicator which is most easily and reliably measured in the assessment protocol (Waiblinger *et al* 2001).

Little is known about such relationships in the farm situation. Therefore, this paper examines the relationships between the animal-based parameters of lameness, injuries, agonistic social interactions, body condition score and somatic cell count as well as environmental factors to find out if some can be discarded without a loss of information.

Materials and methods

The study was carried out on 80 Austrian dairy farms with cubicle loose-housing. Farms were randomly selected under the following criteria: a herd size of 21 to 60 cows, containing Austrian Simmental cattle, and membership of the Austrian Cattle Breeding Organisation (ZAR). Each farm was visited twice for half a day on two consecutive days. All measurements were carried out by the same person in the same order on all farms.

Table 1 Summary of the end models of the regression trees calculated for the animal-based parameters lameness, leg injuries at carpal and at tarsal joints, and agonistic interactions.

	Target variable			
Explaining variables	**Lameness**	**Carpal injuries**	**Tarsal injuries**	**Agonistic interactions**
Bedding (rubber without straw, rubber with straw, straw < 2cm, straw 2-10 cm, straw > 10 cm)	**	**	**	
Neck rail position (m)	**			
Floor walking area (slatted, partly slatted, solid)	*			
Outside run (no, few days, < 6 months, > 6 months)	*			
Relation cubicles: cow	*			
Height separation cubicles (cm)			*	
Height feeding barn (cm)		*		
Stable arrangement (resources clumped, partly clumped, separated)				*
Welfare management (14 single variables grouped)	*			
Way of integration heifers (without, with, partly with arrangements)				*
Milkers' behaviour (number, % positive, % negative, % neutral)	*	**		**
Attitude of stockpeople (14 factors)		*		*
Body condition (% thin, % thick, herd median of 5-point score)	*	*		
Duration lying down (sec)			*	
Age of herd (year)	*			*
Number of cows per herd				**

* explaining variables included in the model; ** the most important factors, which additionally were confirmed in the cross-validation.

Table 2 Spearman correlation coefficients of certain animal-based parameters.

	Lameness	Carpal injuries	Tarsal injuries	Agonistic interactions
Carpal injuries	0.343**			
Tarsal injuries	0.490**	0.264*		
Agonistic interactions	-0.174	< 0.1	< 0.1	
Somatic cell count	< 0.1	< 0.1	< 0.1	< 0.1
% Thick cows	0.198	< 0.1	< 0.1	< 0.1
% Thin cows	< 0.1	0.178	0.125	0.155

* $P < 0.05$; ** $P < 0.001$.

The lying, walking and feeding areas were measured to assess arrangement, dimension and design of the housing at each farm. The management was recorded by filling in a questionnaire with the stockpeople on the second day. To assess the human-animal relationship, the milkers' behaviour towards the cows was observed during one evening's milking. Additionally, the attitude of 220 stockpeople taking care of the cows was documented with the help of a questionnaire (for methods see Waiblinger *et al* 2002). Avoidance distances of the cows were taken as described in Mülleder *et al* (2003).

Agonistic social interactions were recorded by continuous behaviour sampling for a period of one hour after the evening milking, excluding interactions in the feeding rack (Mülleder *et al* 2003).

On the second day of the farm visit, all cows were fixed in the feeding rack after the morning milking for standardised recording of injuries (skin lesions and swellings) and scoring of the body condition modified from Metzner *et al* (1993). After releasing the cows individually from the feeding rack, each cow's gait was assessed using a five-point lameness scoring system according to Winckler and Willen (2001).

For statistical analysis, regression trees (Breimann *et al* 1984) were calculated in two steps. Firstly, regression trees including only one group of influencing factors (housing, management, human-animal relationship) were calculated and afterwards all identified explaining variables and, additionally, animal-based parameters probably associated with the target variable, were included for calculating the end model.

Additionally, regression trees were cross-validated to assess the predictive performance for other farms. This method repeatedly splits the data set into 10 (roughly) equally-sized parts, and subsequently uses nine parts for calibration and one part for validation. Cross-validation may therefore be used to calculate the optimal tree size which corresponds to the best performing predictive model.

Between animal-based parameters, including somatic cell count and body condition score, Spearman correlation coefficients were calculated.

Results

Variation in animal-based parameters

The percentage of lame animals ranged from 0-77% (median: 36%). The percentage of cows showing leg injuries on at least one joint ranged from 26-100% (median: 88%) for carpal and from 0–100% (median: 54%) for tarsal joints. On average 1.82 (0.44-5.08) agonistic interactions per cow per hour were performed.

Multivariate analysis

Factors that appeared to be important in the end regression trees are summarised in Table 1.

Around 2/3 of the total variance could be explained by environmental variables and other animal-based parameters (goodness of fit).

With respect to the prevalence of lameness, the calculated regression tree (end model) explained 63% of the total variance. The regression trees including only housing or human-animal relationship explained 60 or 65% of the total variance.

For leg injuries at the carpal or tarsal joints the end model regression trees explained 58 and 77% respectively, of the total variance, whereas the agonistic interactions were explained by 69%. These agonistic interactions were mainly explained by management factors and human-animal relationship with single models explaining 41 or 47% of the total variance.

Cross-validated models explained 31% of the total variance of lameness prevalence, 33% of leg injuries on the carpal joints, 44% on the tarsal joints and 25% of agonistic interactions.

Discussion

The assessed animal-based welfare parameters (ABP) as well as environmental factors that could potentially influence animal welfare varied largely between farms. By means of multivariate statistics the variance in lameness, leg injuries and agonistic social behaviour could be explained to a high degree by environmental factors. This highlights the value of the assessment of environmental factors for advisory purposes and risk assessment on farms (Capdeville & Veissier 2001). However, in our opinion, the explanatory part is still too low to replace the ABP. This is underlined especially by the cross-validated models, where variance is found to be even lower. This means that the assessment of environmental features does not allow sufficiently assured predictions of the actual welfare status in farms outside of the investigated populations and, thus, does not give enough certainty regarding 1) possible welfare problems on farms and/or, 2) the classification for label production.

Possible reasons for the unsatisfactory predictive value of environmental features may be due in part to the huge variation both between and within farms and the attempt to make them comparable may have lead to a loss of information. Secondly, although a wide range of environmental factors were assessed, recording of some of them was not detailed enough as this would require similar or even higher work levels than those for assessing ABP (eg quality of claw trimming). Finally, a huge number of special combinations of influencing factors exist on farms and the results support the importance of interactions for the animal welfare outcome.

The results show that different environmental features are vital for the different aspects of animal welfare and this is in agreement with the moderate or non-existent interrelations between the ABP. The lameness and leg injuries, which showed significant correlations, were influenced most by the bedding of cubicles, while agonistic behaviour depended on other factors.

Conclusions

The results support earlier notions that the huge variation in animal welfare can only be monitored through animal-based parameters (Johnsen *et al* 2001). Therefore, none of the investigated animal-based parameters can be discarded from an on-farm welfare assessment tool for dairy cows which aims at covering all the different welfare aspects.

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