Applications for comprehensive support of improving health and welfare in dairy cattle

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Abstract

Documentation and control of health and welfare in dairy herds have worldwide increased in importance. Given the great demand, several tools for farmers are today allowing the recording of veterinary diagnoses, findings from claw trimming and other health-related observations, so on-farm data collection on dairy health has technically become much easier than several years before. Furthermore, the ICAR Central health key, appendix of the guidelines for direct health traits, and the ICAR Claw health key and atlas are providing the basis for standardized data collection which is crucial for implementing monitoring concepts and improvement programs across farms. Among the animal-based welfare indicators, health aspects are playing a key role, implying further motivation to extend and strengthen the data basis on animal health and develop applications supporting health management and improvement. However, the often limited amount of historical data and difficulties of ensuring completeness and high quality of data across farms and over time are major challenges. Additional consideration of data which is broadly available through long-established recording routines, such as specific disposal reasons of cows, can therefore be valuable for both management and breeding. Comparative statistical analyses were performed to highlight similarities and peculiarities of distribution patterns of data which were from different sources of information and related to animal health and welfare. The study was based on data from the national genetic evaluation in German Holstein dairy cattle and included more than 1.7 millions of lactation records from almost 2.700 farms for direct health traits. Milk performance records and information on disposal of cows were used as complementary data sets. For refined analyses of data structure, a subset of data was used which included records from eight German federal states, with information on health events and health-related disposals. Similarities of distribution patterns of certain health events and respective disposals of cows support the approach of integrated data usage.

Keywords: heath data recording, disposal reasons of dairy cows, gain in reliability, improved decision support.

Introduction

In the dairy sector, the awareness of the importance of health and welfare of the cows and of their proper management has increased worldwide over the years (Egger-Danner *et al.*, 2015). Sustainability and efficiency of milk production are relying on the ability of dairy farmers to balance and maintain high milk yields with long-term stability of metabolism and health. This requires continuous, thorough monitoring of the dairy herd in order to react as early as possible to abnormalities which may indicate the

need for management measures or the treatment of individual cows. Accordingly, the proportion of farms in which systematic health data recording has become part of the on-farm documentation routines is today considerably higher than just a few years before. Furthermore, the availability of an internationally approved recording standard for health data in dairy cattle, the ICAR Central Health Key (ICAR, 2019), which was first published in 2012, has facilitated extending the range of applications around the recording and use of health data.

In Germany, the uniform reference is used in different herd management software and also in, for example, special software for veterinarians and hoof trimmers. Health reports with vertical statistics (developments within-herd over time) as well as horizontal statistics (comparison across herds) are regularly compiled and made available in different formats for several years now. However, further development, especially in the field of breeding applications, was complicated by the overall still limited access to information on direct health traits: There are relatively few historical data which are also unevenly distributed across regions;, the coverage of the population regarding the collection of health data is, also in the most recent data, much lower than of standard traits like milk yield, calving ease or reason for disposal from milk recording. Therefore, the power and reach of tools for herd health management depends on the strength of concepts to optimize the use of health-related information

The aim of this study was to illustrate how applications for direct health traits - resembling typical examples of challenging traits for which information is valuable and scarce - can benefit from data integration and combined usage with indicator traits, especially when reference is possible to the huge amount of information available through long-established routine data collection related to milk recording. In addition, we wanted to show the practical importance of providing a strong portfolio of applications relating to direct health traits by quantifying the potential gain in farm efficiency through targeted improvement of health in German Holstein dairy cattle.

Material and methods

Data bases

Data from the routine genetic evaluation for dairy cattle in Germany was used for this study. Considering health events recorded until February 2019, there were in total more than 1.7 million lactation records from almost 2,700 farms which were informative for direct health traits. The recording included veterinary diagnoses, records from hoof trimming and observation of farmers, and was comprehensive with regard to the types of health events. To reduce the overall heterogeneity of the analyzed data, a study sample was defined by region and time period: Considering data from eight German federal states from 2010 to 2018, the sample included 1.1 million lactations of 497,982 cows from 590 dairy farms. Definition of health traits was based on 1.5 million recorded health events in that time period.

Milk performance records and information on disposal of cows were used as complementary data sets. The specific and health-related disposal reasons of dairy cows were identified as potential indicator traits to be used in joint analyses with direct health information. Standardized documentation of disposal reasons is part of the data collection in all cows under milk recording since decades, and includes - besides others - the following four health-related disposal reasons: mastitis, claw disorder, metabolic disorder, reproduction disorder. A total of 169,924 health-related disposals matched to the sample data set. For the analyses on the relationship between herd health and performance, no restrictions regarding the documented disposal reasons of dairy cows were applied, and 280,000 lifetime yields of disposed cows from the 590 farms with available direct health data from 2010 to 2018 were considered.

Statistical analyses

Statistical analyses were performed for the health complexes for which information was available from health data recording and from routine documentation of disposal reasons: udder health, claw health, metabolic stability, and reproduction. Characteristic distribution patterns of health-related phenotypes, derived from the each of the two data sources, were determined and compared.

The relationships between herd health and performance were investigated by analyses of variance in general linear models using the procedure GLM of SAS software version 9.2 (SAS Institute Inc., Cary, NC, USA). For this purpose, dairy farms were grouped according to their annual disease incidence levels, distinguishing between the 25 percent of farms with the highest disease frequencies within year and region (D1) and the reminder of the farms (D0). This grouping of farms was performed separately for each of the four health complexes, and group was then considered as fixed effect in the model. Time effects were accounted for by modelling the year of recording. The following traits were considered as dependent variables: proportion of disposals related to the corresponding disposal reason, time of disposal relative to calving, life yield of milk, and daily life yield of milk.

$$y_{ijk} = \mu + GROUP_i + YEAR_j + e_{ijk}$$

with y_{ijk} = dependent variable resembling the ijk-th expression of the trait (disposal-related and efficiency-related parameters), μ = model constant, $GROUP_i$ = fixed effect of the i-th farm group (i = 1 - 2; D0, D1), $YEAR_j$ = fixed effect of the j-th year of recording (j = 1 - 9; individual years from 2010 to 2018), e_{ijk} = random residual.

Results

For all four health complexes, characteristic distribution patterns of diagnoses on the one hand and of health-related disposal reasons on the other hand were found. Regardless of the data source, there was some variation between parities. High numbers of both health events and health-related disposals in early lactation were recorded for udder health, claw health and metabolic stability, and respective distributions showed reasonable similarities across data sources (Fig. 1 - 3). For reproduction, the majority of health events was recorded up to day 150, whereas most disposals due to reproduction disorders occurred after day 200 (Fig. 4).

In the analyses of variance, significant differences between the farm groups were found in disposal- and efficiency-related parameters (Tab. 1). The higher relative importance of specific disposal reasons and earlier disposal (udder health, claw health, metabolic stability) or later disposal (reproduction) after calving was in accordance to the increased disease frequencies in the D1 farms. Results for the efficiency-related parameters indicated significant negative impact of unfavorable udder health status and claw health status of the herd, whereas high frequencies of metabolic disorders showed significant relationship with higher milk yields.

Discussion and conclusions

The different quality of available health-related information (direct versus indirect) must be considered when analyzing the data and presenting results. In previous studies, the relationships between certain diseases and reproduction traits on the one hand and disposals of cows have been addressed, and analyses revealed significant effects of parity and lactation stage (Beaudeau *et al.*, 1994; Gröhn *et al.*, 1998; Rajala-Schultz and Gröhn, 1999a,b). Our results were in agreement with what has been described as

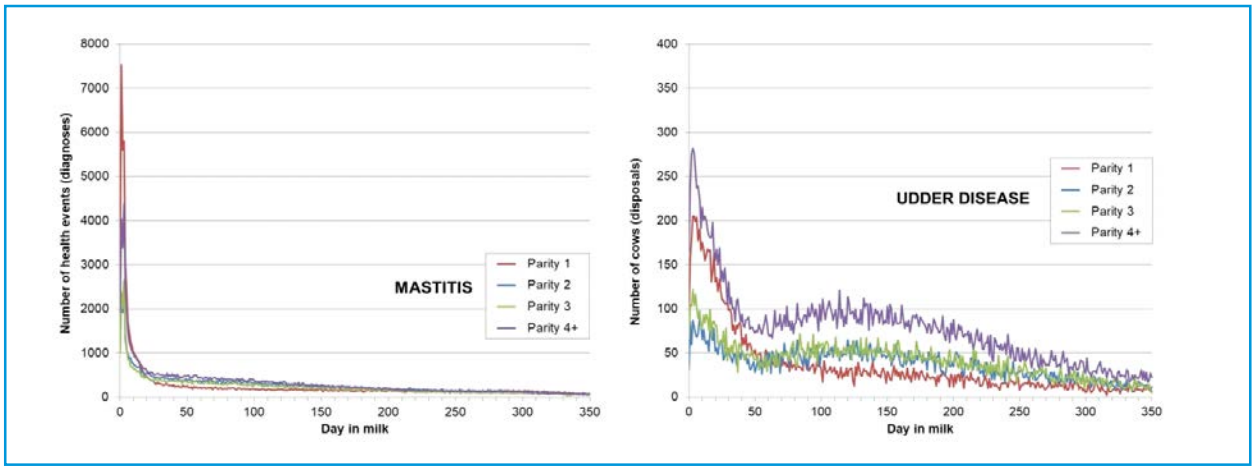

Figure 1. Distribution of recorded health events (diagnoses; on the left) and health-related disposals relative to calving (on the right) for the complex udder health.

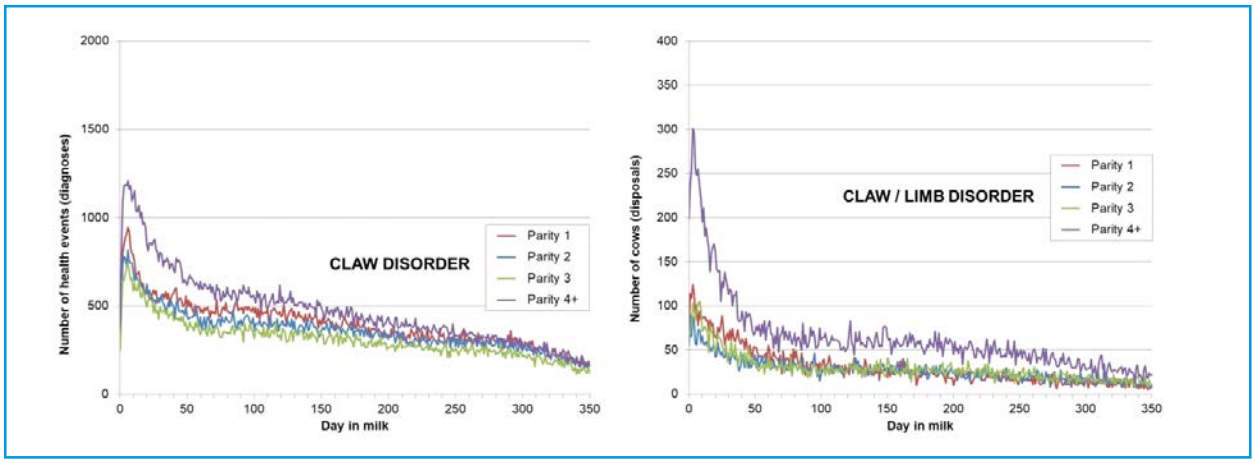

Figure 2. Distribution of recorded health events (diagnoses; on the left) and health-related disposals relative to calving (on the right) for the complex claw health.

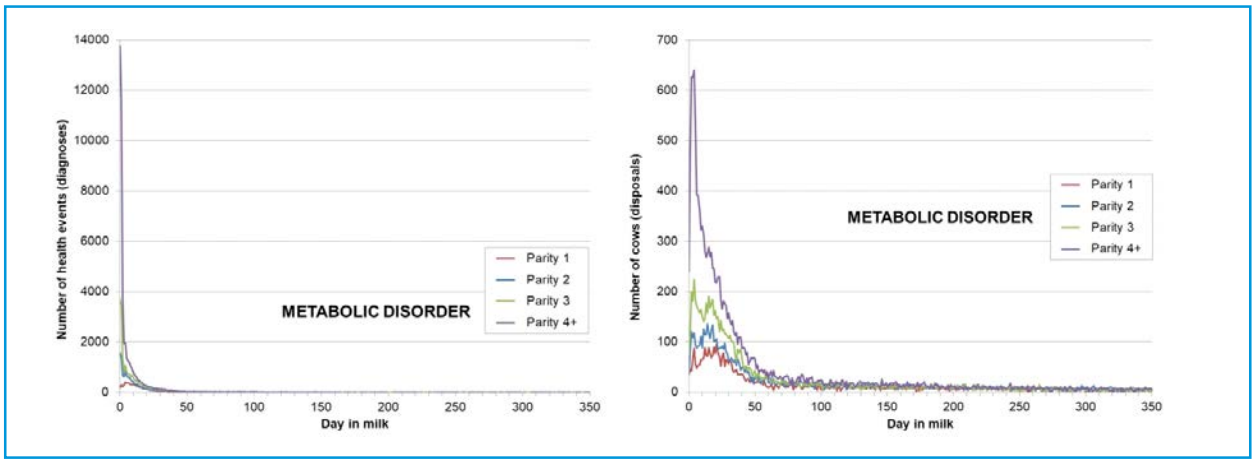

Figure 3. Distribution of recorded health events (diagnoses; on the left) and health-related disposals relative to calving (on the right) for the complex metabolic stability.

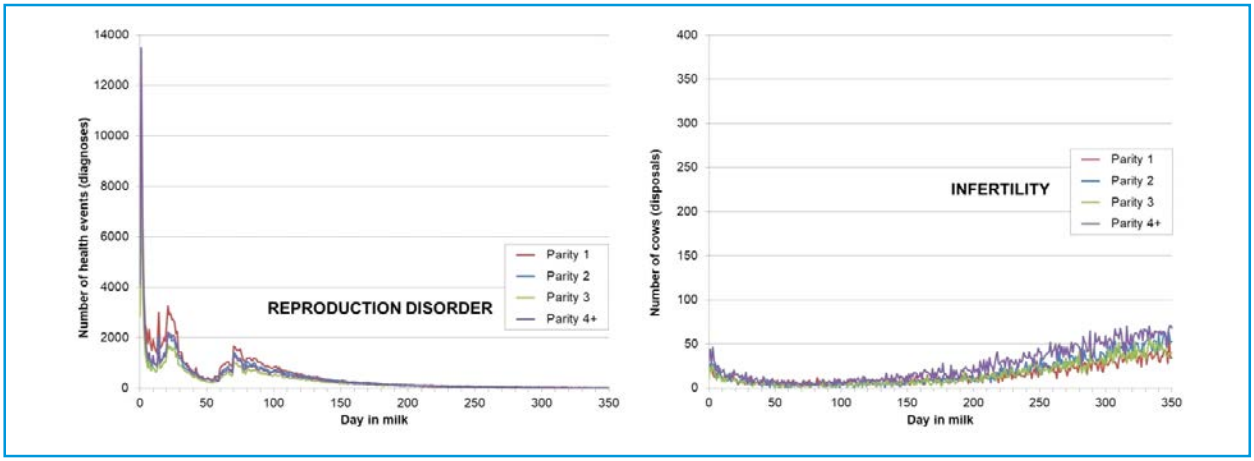

Figure 4. Distribution of recorded health events (diagnoses; on the left) and health-related disposals relative to calving (on the right) for the complex reproduction.

Table 1. Results of analyses of variance with least square mean (LSM) estimates of disposal- and efficiency-related parameter for farms with high diagnosis frequencies (upper quartile within year and region; D1) and the farms with lower diagnosis frequencies (D0)

Parameter	Group	Udder health	Claw health	Metabolic stability	Reproduction
Disposal reason (specific)	D0	22.3	18.7	12.8	20.3
	D1	29.6	22.2	14.7	20.8
Time of disposal [DIM]	D0	188.2	187.9	187.2	185.1
	D1	183.5	183.9	185.7	192.8
Life yield [kg milk]	D0	26,421.4	26,358.1	25,780.4	26,328.7
	D1	25,924.4	26,055.6	27,639.1	26,622.4
Daily life yield [kg milk / day]	D0	12.57	12.61	12.38	12.53
	D1	12.47	12.42	13.04	12.62

DIM = days in milk, kg = kilogram.

typical distribution patterns. Accordingly, they also support the approach of using refined trait definitions and multiple-trait models for genetic evaluation of longevity (Sewalem *et al.*, 2007; Heise *et al.*, 2016).

Reasonable similarities between distributions of health events and corresponding health-related disposal reasons were found for three of the four major health complexes in dairy cattle, indicating the importance of proper herd health management with regard to udder health, claw health and especially metabolic stability in order to avoid premature culling of cows. On the other hand, effects of reproductive disorders tend to become obvious only towards the end of the lactation because they often do not require immediate decisions and allow continued milking of the cows. This makes it plausible that comparisons in this study revealed different shapes of distributions for the fourth of the analyzed health complexes (reproduction).

For optimal integrated use of direct and indirect health data, clear distinction must be made between the sources of information in both management- and breeding-oriented applications supposed to identify and specifically indicate potential for improvement. Separate statistics in health reports and multiple trait approach in genetic and genomic evaluation (indices of increased reliability) allow to maximizing the benefit from all available health-related information while minimizing the risk of misinterpretations.

The high value of applications which support herd health management were illustrated by the comparisons between farm groups. Using lifetime yields for quantification of efficiency, the results indicated reasonable potential for increasing farm efficiency by improved management of udder health and claw health in the dairy herd. At the same time, above-average frequencies of metabolic disorders may not be in conflict with high lifetime yields. However, metabolic stability requires special attention in high yielding herds in order to ensure sustainability of milk production.

The new applications for direct health traits in German Holstein dairy cattle balance the qualitative and quantitative requirements. Tools for farmers which provide comprehensive, consistent and practice-oriented support in management and breeding imply great opportunities for improving animal health and welfare in the dairy herds and by that overall efficiency and sustainability of milk production.

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