Body weight prediction and genetic parameter estimation based on type traits in Italian Holstein cows

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Abstract

Body weight (BW) is an important trait used in order to control maintenance cost within herds. It is unfeasible to get routine data collection on BW, but BW can be estimated from routine type classification scores. Body weight for Italian Holstein cows was estimated based on actual BW and linear scores for different type traits of 890 first parity cows collected in 30 different herds over a 3-yr period (2013-2015). Actual BW was collected thanks to availability of automatic weighting systems in milking robots. The selected type traits used to predict BW, included stature, chest width, body depth, rump width and body condition score. The predictive ability of models was tested with 2-fold cross-validation. Correlation between predicted BW in training and validation data-sets ranged from 0.62 to 0.70. The model used for actual BW genetic parameter estimation included herd-year-season of weighted cows, month of calving, age at scoring and interval in days (±30 days) between the weighing and the scoring days. Heritability for actual BW was 0.51±0.06. The BW prediction equation was applied to the national routine type classification data. Average actual BW was equal to 598.24±73.00 kg and average predicted BW was equal to 597.21±40.94. Genetic relationships of predicted BW with type traits included in the prediction equation have been estimated. Heritability for predicted BW was equal to 0.21±0.01. At this stage the derived BW prediction equation has been used in the new economic functional index (IES) for the Italian Holstein population. Next steps will be to make use of this trait in order to develop a proxy for feed efficiency breeding values to include in the national evaluation system.

Keywords: Body weight, automatic milking system, genetic parameter, feed efficiency

Introduction

Body weight (BW) is an important trait used in order to control maintenance cost within herds. This trait can be also involved in the calculation of energy balance (Coffey et al., 2001).
The costs of milk production are mainly related to feed costs, and lately there is a growing interest in improving feed efficiency in dairy cattle. This is defined as the ratio between milk production and dry matter intake. Dry matter intake is a very interesting trait for management and would be interesting to include in a breeding goal in order to select individuals who produce more but simultaneously ingest less dry matter. Unfortunately, it is not easy to collect this trait at population level. In the past, several models and different formulas have been developed to estimate feed efficiency from other traits. Animal body weight is an important factor in managing the cost of managing livestock and in order to derive animal efficiency, not only at farm level, but above all at the individual level. Body weight is not easily routinely recorded but it can be derived by other traits routinely recorded by the national system. Aim of this paper was to set up an algorithm to

predict body weight (pBW) in Italian Holstein cows, using type traits officially recorded, and to estimate heritability values for actual and predicted body weight.

Materials and Methods

Initial data-set consisted of 6,895 individual weights belonging to 3,256 Italian Holstein cows distributed in 36 farms. Actual BW was collected, over a 3-yr period (2013-2015), thanks to availability of automatic weighting systems in milking robots. Data have been merged with routine linear score data-set. Only fist parity records with a maximum interval of 30 days between weighting and linear scoring dates have been retained. Final data-set consisted of 890 first parity cows belonging to 30 different herds. The following final model was used to derive a phenotypic prediction equation for body-weight: Y= HYM + MC +SL + predictors + e.
Where Y= actual body-weight; HYM= herd-year-months of weighting; MC= month of calving; SL=stage-of-lactation. Other predictors: age of cow at scoring and stature, chest-width, body-depth, rump-width and body condition score (if available). The fixed effect were determined in a series of preliminary analysis in which the effect of various factors on body-weight were assessed. Factors included in the model were those with the highest significant effect on body-weight. Based on stepwise regressions estimators have been identified. The data-set has been splitted in training and validation sets. Algorithms have been developed in the training data-set (70% of total data-set) and tested on the validation set (30% of total data-set). Solutions were applied to the validation set using the following formula: Y=constant + b*age-at-scoring + $\sum\beta$ * x. where Y=predicted body-weight phenotype of cow; constant= sum of solution of the overall mean effect and average solutions of HYM + MC + SL effects; b=estimate of slope of regression on age of cow at scoring and β=estimate of slope of regression on conformation trait (x) summed over all conformation traits. Predicted body weight was compared with the actual body weight in the testing data-sets. The final model has been chosen based on higher R^2, lower root MSE, and correlation between real and predicted body-weight. Subsequently the algorithm developed has been applied to the national data-set. A model similar to the official national evaluation for conformation traits has been applied and genetic parameters for the traits have been estimated.

Results and Discussion

In Table 1 are reported statistical descriptions of actual and predicted BW, in the group of validation animals. As expected, predicted BW (pBW) showed similar average and lower standard deviation compared to actual BW (aBW). Once the algorithm was tested on the validation data set was tested we applied the prediction formula on the whole conformation database. At population level, pBW for primiparous and multiparous cows were 567.26±44.00 and 680.00±55.57 kg, respectively. Heritability for actual BW was equal to 0.50 (±0.06), while at population level, pBW showed a lower heritability and equal to 0.21±0.01. Results of this study are comparable to what has already been published by other authors (Haile-Mariam et al., 2014) .
Figure 1 shows the trend for cow's year of birth for type traits included in the prediction formula for pBW. It is evident that until 2005 they animals gained weight, and in more recent years the weight trend remains stable and equal to all type traits included in the formula, with an evident reduction for body condition score. Knowing the increment of milk yield in the last years, this result is an evident result of the production improvement of the whole Italian Holstein population.

Conclusions

An algorithm was set up in order to predict body weight in Italian Holstein cows, using type traits. Heritability value of predicted body weight was estimated and a moderate value was obtained. Therefore, a tool for herd management and monitoring animals is now available for calculating animal maintenance costs, and moreover to estimate feed efficiency and methane emission by rumen. An indirect way is now available for Italian Holstein for implementing new traits to improve profit for farmers and, moreover, to mitigate greenhouse gasses emission. At this stage the derived BW prediction equation has been used in the new economic functional index (IES) for the Italian Holstein population.

List of references

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Haile-Mariam, M., Gonzalez-Recio, O., and Pryce, J.E. 2014. Prediction of liveweight of cows from type traits and its relationship with production and fitness traits. J. Dairy Sci. 97, 3173-3189.

Table 1. Descriptive statistics and genetic parameter estimation for real and predicted body weight in the validation set.

Trait	Mean±SD	Range	h^2±SE
Actual body weight (kg)	598.24 ± 73.00	427 – 821	0.50±0.06
Predicted body weight (kg)	598.29 ± 46.45	453 – 742	

Figure 1. Trend of phenotypic type traits and live weight across years for Italian Holstein