Estimates of Genetic Parameters for Calving Performance from Designed Selection Studies

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Summary and Implications

A multiple trait animal model was implemented to study the direct genetic and maternal genetic relationship among four traits, dystocia (DYS), perinatal mortality (PM), birth weight (BW) and gestation length(GL), expressed at the birth of a calf. The sign and magnitude of genetic correlations among calving traits demonstrates the need to use multi-trait animal models for genetic evaluation of animals for calving performance. Adequate information exists to begin developing a calving performance index. This index will enable breeders of dairy cattle to optimize the health and well-being of replacement animals and reduce the incidence of dystocia and perinatal mortality.

Introduction

Traits with low heritability but high economic value, such as fertility and calving performance, received early emphasis in Scandinavia (Steinbock et al., 2003). Within the last decade, however, substantial gains have been made to understand the genetic relationship between daughter calving ease and service sire calving ease, and provide an evaluation of sires used in the AI industry (Van Tassell et al., 2003).

The cost associated with dystocia depends on the level of difficulty; values range from $50.45 for slight assistance to $397.61 for extreme difficulty. The incidence of PM was reported to have increased from 1985 to 1996 in Holstein herds in several Midwestern states. Johanson and Berger (2003) found a nonlinear relationship between BW and PM, i.e., exceptionally light or heavy calves tended to have a higher incidence of PM.

The objective of this research was to estimate direct genetic and maternal genetic correlations among DYS (1 = assisted, 0 = unassisted), PM (1 = alive, 0 = dead at birth), BW [kg], and GL [days].

Materials and Methods

Data were summarized from 5712 calving records collected between 1968 and 2005 at the Iowa State University research dairy farm in Ankeny, IA (Table 1). The data were edited to remove twins and malpresentations, and to keep BW and GL records within ±3σ of the mean.

Table 1. Summary of calving data, ISU Dairy 1968-2005.

Trait	$\bar{x}$	SD	Parity	
			first	later
Dystocia (%)	28.8		45.1	16.8
Perinatal mortality (%)	8.8		13.6	6.2
Birth weight (kg)	40.5	5.8	38.5	41.9
Gestation length (d)	278.5	5.6	278.0	279.0

Results and Discussion

Heritability estimates are given in Table 2. Both DYS and PM have larger maternal components of variation than BW and GL. A negative direct-maternal genetic correlation (r_{AM}) will decrease the efficiency of phenotypic selection as expressed by the low h^2_{A+M} for DYS and PM compared to the near equality of h^2 and h^2_{A+M} for BW and GL.

Estimates of genetic correlations are given in Table 3. PM and DYS have high direct and maternal genetic correlations, 0.67 and 0.45, respectively. These two traits, however, are not controlled by the same genes as shown by the negative r_{AM} of -0.67 for DYS and -0.48 for PM.

BW and GL provide additional information about genetic merit for calving performance. Figure 1 shows the phenotypic relationship between BW and frequency of DYS and PM. Briefly, DYS is more prevalent than PM across the full range of BW, 18.1 to 62.6 kg. Some PM can be expected at all levels of BW, however the incidence of PM is higher in light (18.1 to 33.6 kg) or heavy (47.6 to 62.6 kg) calves than calves at other, more intermediate weights.

Table 2. Estimates of direct heritability (h^2), maternal heritability (m^2), direct-maternal genetic correlation (r_{AM}), and the fraction of selection differential realized if selection was on phenotypic value (h^2_{A+M}).[a]

Trait	h^2	m^2	r_{AM}	h^2_{A+M}
Dystocia	$0.16_{0.04}$	$0.17_{0.04}$	$-0.67_{0.11}$	0.08
Perinatal mortality	$0.15_{0.05}$	$0.13_{0.03}$	$-0.48_{0.16}$	0.11
Birth weight	$0.28_{0.04}$	$0.05_{0.01}$	$-0.15_{0.15}$	0.28
Gestation length	$0.53_{0.05}$	$0.07_{0.02}$	$-0.09_{0.13}$	0.53

[a] Standard deviations of parameters are given as subscripts.

Table 3. Estimates of direct (D) and maternal (M) genetic correlations for dystocia (DYS), perinatal mortality (PM), birth weight (BW), and gestation length (GL)[a].

	DPM	DBW	DGL	MDYS	MPM	MBW	MGL
DDYS	$0.67_{0.19}$	$0.73_{0.08}$	$0.38_{0.11}$	$-0.67_{0.11}$	$-0.48_{0.15}$	$-0.40_{0.13}$	$-0.24_{0.17}$
DPM		$0.57_{0.23}$	$0.45_{0.12}$	$-0.24_{0.29}$	$-0.48_{0.16}$	$-0.31_{0.19}$	$-0.12_{0.20}$
DBW			$0.52_{0.07}$	$-0.22_{0.13}$	$-0.29_{0.17}$	$-0.15_{0.15}$	$0.08_{0.16}$
DGL				$-0.06_{0.11}$	$-0.17_{0.14}$	$-0.41_{0.11}$	$-0.09_{0.13}$
MDYS					$0.45_{0.16}$	$0.27_{0.15}$	$0.25_{0.15}$
MPM						$-0.41_{0.14}$	$-0.31_{0.18}$
MBW							$0.56_{0.12}$

[a] Standard deviations of parameters are given as subscripts.

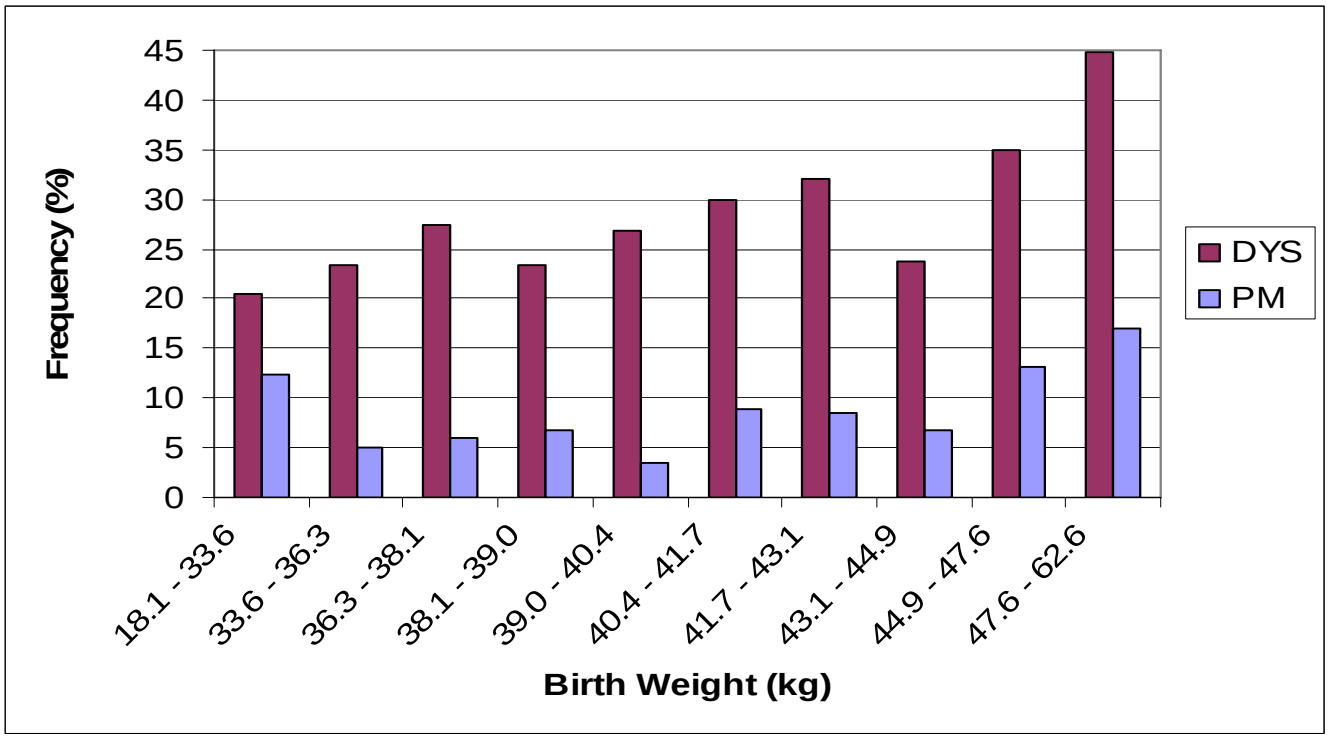

Figure 1. Frequency of dystocia (DYS) and perinatal mortality (PM) for categories of birth weight (BW). Each BW category represents 10% of the observations.