GENETIC PARAMETERS OF EARLY NEO-NATAL PIGLET SURVIVAL AND NUMBER OF PIGLETS BORN

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INTRODUCTION
Breeding programs to improve sow productivity invariably include number born as one of the most important traits. Both the national swine improvement program in Canada and the regional evaluation program in the province of Ontario have provided breeders with litter size genetic evaluations based on total number born for close to 10 years. The use of total number born rather than number born alive dates was a decision made at the outset of the program to use the trait with the higher heritability. With this definition of litter size, in addition to improvements in the total number of piglets born, breeders in Canada were also noticing that as the number of piglets born increased, the frequency of stillbirths and early neo-natal mortality also seemed to be increasing. Lecour (2000) reported a similar problem in French pigs. Johnson et al. (1999) found that the number of stillborn pigs increased with litter size after selection on ovulation rate and 50-day embryonic survival. Other studies have looked at the relationship between survival to weaning and piglet birth weights (Wise et al., 1997; Leenhouwers et al., 2001, 2000; Knol et al., 2001) and universally report higher piglet survival rates to weaning with higher birth weights. However, pig breeders in Ontario typically do not collect individual piglet birth weights. Our study was initiated with the objective of determining if there is a detectable genetic relationship between number born and neo-natal piglet survival defined as stillbirths and survival in the first 24 hours after farrowing in Ontario breeders’ herds.

MATERIALS AND METHODS
Sow productivity data. The data for this study were the accumulated litter records from the Ontario Swine Improvement Program (OSIP). Early performance recording was based on paper records but recent years has seen a shift to electronic data transfer between on-farm herd management computer systems and the OSIP database. With the electronic transfer of data, the quality and quantity of data available has increased dramatically. Two breeds are predominantly involved in maternal trait selection; the Landrace (L) and Yorkshire (Y) breeds. In addition to litter weight and farrowing intervals, two litter size traits are recorded, total number born (NB) and number alive, recorded after 24 hours (NBA). For this study, early neo-natal piglet mortality was defined as the difference between NB and NBA; in other words the number of dead piglets (ND) which includes both stillborn piglets and those that die within 24 hours of birth. Neither NB nor ND includes mummified fetuses. Since the distribution of ND is bounded by zero with the 0 category of ND most prevalent, the distribution was heavily skewed. Even with grouping together the less frequent categories in the tail of the distribution, there were still 12 possible categories of ND.
Statistical analyses. The preferred analysis for NB and ND would have been to apply a combined multiple trait linear and threshold model. However, primarily due to the number of categories of ND as well as the number of fixed and uncorrelated random factors in the model and the size of the data set, such an analysis was not possible with any of several available packages that were investigated. Another approach, which offers additional advantages for implementation, was to apply a transformation to the ND data and use a multiple trait linear model to analyse NB and the transformed ND trait. While investigating suitable transformations, the similarity of the ND data to calving ease data in beef or dairy cattle suggested the Snell score transformation (Snell, 1964) may be appropriate. After applying the Snell score methodology, the transformed trait is analysed as a linear trait (Schaeffer and Wilton, 1977; Tong et al., 1977). This approach offered a computable alternative to a threshold model for this study and also provided an easily implemented system of analysis should these results be adopted by the Ontario swine breeding industry. Based on previous research using these data, the model for NB and by extension also for ND was well documented (Southwood and Kennedy, 1990; Roehe and Kennedy, 1993). The two-trait animal model included the fixed effects of herd-year of farrowing, parity, season of farrowing and mating type (A.I. or natural service), breed of boar and the random effects of animal, litter of sow’s birth, permanent environment and residual. Parity was coded as “1” = first, “2” = second, “3” = third, “4” = fourth and fifth and “5” = sixth and later. Seasons were defined as quarters of the year: January to March, April to June, July to September and October to December. All available litter records for sows were included along with all available pedigree information. For the Landrace breed, there were 24,729 litter records with 11,349 individuals (males and females) in the pedigree file. For the Yorkshire breed, there were 43,415 litter records and 20,723 individuals in the pedigree file.

Snell scoring. The technique of Snell scoring (Snell, 1964) calculates numerical scores for a trait measured and recorded in subjectively defined categories. The method assumes that the underlying trait follows a logistic distribution. Tong et al. (1977) presented a method that approximates the exact, iterated solution outlined by Snell (1964). In their approximation, Tong et al. (1977) estimate all possible pairs of boundary points separating any three categories by maximizing the log likelihood of the distribution using observed proportions in the derivatives of the log likelihood. Once all possible pairs of intervals are computed, substitute 0 for the first interval and solve for the rest. The midpoint between two boundary points is taken as the score for the category and for the two extreme categories, the scores are computed from the expected values under the tails of the distribution (Tong et al., 1977). The resulting scores have homogenous residual variances over subclasses with residual deviations that are approximately normally distributed. For this study, categories of ND greater than 10 were grouped into a single category. Snell scores were assigned separately by parity.

Variance components estimation. The data set with NB and the transformed ND (TND) was analyzed using VCE 4.2.5 (Neumaier and Groeneveld, 1998). The analytical gradients approach was used allowing for the possibility of approximate standard errors of the ratios.
RESULTS AND DISCUSSION

Snell scores. The frequency of each category of ND and the corresponding Snell score are shown in Figures 1 and 2 below. These figures illustrate the technique but the values shown are aggregated across all five parity codes in the interest of space. In the analysis, Snell scores were generated separately by parity since ND tended to increase slightly with each subsequent parity.

Heritabilities and genetic correlations. The estimates of heritabilities and genetic correlations are shown in Table 1 for the Landrace breed and in Table 2 for the Yorkshire breed. VCE produces approximate standard errors of the estimates and those are shown in parentheses next to the estimate.

Table 1. Heritabilities (diagonal), genetic correlations (above the diagonal) and product-moment phenotypic correlations (below diagonal) of NB and TND in the Landrace breed.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Number Born</th>
<th>Transformed Number Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Born</td>
<td>0.104 (0.004)</td>
<td>0.501 (0.055)</td>
</tr>
<tr>
<td>Transformed Number Dead</td>
<td>0.345</td>
<td>0.039 (0.004)</td>
</tr>
</tbody>
</table>

Table 2. Heritabilities (diagonal), genetic correlations (above the diagonal) and product-moment phenotypic correlations (below diagonal) of NB and TND in the Yorkshire breed.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Number Born</th>
<th>Transformed Number Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number Born</td>
<td>0.100 (0.005)</td>
<td>0.490 (0.039)</td>
</tr>
<tr>
<td>Transformed Number Dead</td>
<td>0.347</td>
<td>0.066 (0.003)</td>
</tr>
</tbody>
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The averages of the untransformed ND values for each possible value of NB, as plotted in Figure 3, showed an increasing trend in average ND as NB increases. This confirms the breeders’ observations and is similar to the results of Lecour (2000); as litter size increases so too does the incidence of stillbirths and early neo-natal mortality. The positive genetic correlation between the traits suggests that there is a need to include ND in any economic index.
that includes NB to simultaneously select against piglet loss while selecting for total piglets born.

CONCLUSION

This study found an antagonistic genetic relationship between the number of piglets born and the number of piglets surviving farrowing and the first 24 hours of life. These results suggest that it may be advisable to incorporate ND in maternal line economic indices where total number born is already included in the index.

REFERENCES