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Genetic analysis of early lamb survival in extensively reared lambs

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RIASSUNTO – Analisi genetica della sopravvivenza in agnelli allevati in condizioni estensive. *La sopravvivenza degli agnelli è uno dei caratteri economici più importanti nell'allevamento ovino. A questo scopo sono state esaminate 4.583 osservazioni di agnelli Scottish Blackface di cui erano noti i dati ripetuti di sopravvivenza (nascita, 1, 4, 8 e 12 settimane) e di peso (nascita, 4, 8, 12, 16, 20 e 24 settimane). Sono stati utilizzati un sire model per la stima dei parametri genetici della sopravvivenza e un animal model per la stima delle correlazioni genetiche tra la sopravvivenza e gli incrementi ponderali degli agnelli. Le ereditabilità stimate sono risultate più alte di quelle riportate in bibliografia e le correlazioni genetiche tra la sopravvivenza e gli incrementi ponderali sempre positive e moderate (in media 37,5%), confermando la possibilità di inserire la sopravvivenza degli agnelli nei programmi di selezione della razza Scottish Blackface.*

KEY WORDS: lamb survival, binary trait, genetic parameters, live weight.

INTRODUCTION – In sheep production, lamb survival is an important economic trait (Conington *et al.*, 2004). Therefore, this trait has been studied by many scientists, especially in countries with an extensive husbandry system. In the United Kingdom, the number of lambs dying before weaning has been estimated ranging from 5 to 40% (Eales *et al.*, 1983). The genetic evaluation of survival is complicated because this trait has a binomial distribution whereas most analytical procedures assume normality. Although a lot of studies have been carried out on lamb survival, very little is available in literature on estimates of genetic parameters and non-genetic effects. Further, little has been reported about the genetic correlations between this trait and weight at fixed ages. The object of this study was to estimate genetic parameters for lamb survival and the genetic relationships with early growth in Scottish Blackface sheep.

MATERIAL AND METHODS – The dataset accounted for 4,583 records collected from 1988 to 2003 in a Scottish Blackface flock. It contained animal identification, sire, dam, sex (S), death-date, date of birth (DB), year of birth (YB), age of dam (AD), husbandry group at lambing (G) and litter size (LS). Five traits were calculated, showing if lambs were alive or dead (coded with 0 or 1 respectively) at birth, and at 1, 4, 8 and 12 weeks. The lambs' weights at birth, and at 4, 8, 12, 16, 20, 24 weeks of age were also available. The pedigree file comprised 1,416 dams and 178 sires. Binary analyses were carried out, fitting a Generalized Linear Model (GLM), assuming a Bernoulli distribution and using a logit link function with Genstat software (Lawes Agricultural Trust, 1983). Several models were fitted and compared using the deviance values. In Model 1 the effect of YB, LS, YB×LS×G interaction, S, AD, DB (covariate) and YB×DB interaction were fitted as fixed effects. The other models were similar to Model 1, except a fixed effect (S, LS, AD and YB from Model 2, 3, 4 and 5, respectively) was eliminated in each in order to determine its significance using the χ^2 test. Genetic parameters were estimated using ASREML (Gilmour *et al.*, 2000). The heritabilities (h^2) of survival traits were estimated using the same fixed effects of the Model 1, fitting sire as a random effect. Analyses were first carried out assuming lamb survival as normally distributed and later using probit transformation within a GLM framework. A logit transformation was fitted, but it produced h^2 estimates outside the parameter space and therefore it was discarded. Genetic correlations were estimated fitting the same model with the sire as a random effect in analyses of survival traits and animal as a random effect in analyses of survival and weight traits.

RESULTS AND CONCLUSIONS – Results from GLM demonstrated that the most important factor for the survival at birth was S: it was highlighted that males were more likely to die than females. For the other survival traits, the most important factor was LS. Single-born and twin-born were less likely to die than triplet-born. Hinch *et al.* (1983) also reported that mortality usually increases with LS. AD was also important and lambs born from two-years-old ewes were more likely to die than lambs born from older ewes. A common observation is that very young ewes have lower lamb survival (Atkins, 1980), probably because lambs born from young ewes receive less attention from the mother.

Table 1. Heritability estimates for survival traits both with probit and normal analyses.

	Normal analyses (*) h^2	Probit analyses h^2	Expected underlying value h^2
Birth	0.09 ± 0.03	0.33 ± 0.11	0.30
1 week	0.10 ± 0.03	0.22 ± 0.09	0.27
4 weeks	0.07 ± 0.03	0.17 ± 0.07	0.17
8 weeks	0.07 ± 0.03	0.14 ± 0.07	0.16
12 weeks	0.05 ± 0.03	0.08 ± 0.06	0.10

(*) treating survival as a continuous variable

Heritabilities for survival traits, estimated using a sire model, considering these traits both as binary and continuous traits are shown in Table 1. The estimates from the probit analyses are very close to the expected underlying h^2 values, calculated with Dempster and Lerner's formula (1950). Note that the h^2 estimates decline from birth onwards. These results show that at birth the genetic component has a more significant influence on survival than at higher ages; this probably confirms the large influence of environmental factors on subsequent survival. Several results for survival have been reported in the literature, but generally we have obtained higher heritabilities than comparable studies. For example, Matika *et al.* (2003), fitting a sire threshold model, estimated a h^2 of 0.04 in Sabi sheep and Snyman *et al.* (1998) in Afrino sheep found h^2=0.02.

Table 2. Genetic correlations with s.e. between survival traits and weight traits.

	Birth Weight	Weight 4 weeks	Weight 8 weeks	Weight 12 weeks	Weight 16 weeks	Weight 20 weeks	Weight 24 weeks
Birth	0.37±0.10	0.75±0.05	0.52±0.07	0.52±0.08	0.30±0.10	0.29±0.08	0.35±0.12
1 week	0.06±0.10	0.71±0.05	0.53±0.07	0.45±0.09	0.15±0.10	0.26±0.08	0.32±0.11
4 weeks	0.09±0.11	0.66±0.06	0.47±0.09	0.44±0.10	0.26±0.11	0.31±0.08	0.47±0.12
8 weeks	0.18±0.12	0.33±0.12	0.26±0.11	0.46±0.11	0.41±0.12	0.32±0.10	0.59±0.13
12 weeks	0.16±0.13	0.31±0.12	0.14±0.12	0.37±0.12	0.40±0.12	0.32±0.11	0.58±0.13

The estimated genetic correlations between survival traits were high, in particular those between survival at 1, 4, 8 and 12 weeks converged to the boundary value set in ASREML (0.99). The genetic correlations between survival at birth and other survival traits were lower but their standard errors were rather high. More interesting results were obtained in terms of correlation between survival traits and weight traits (Table 2). The estimates resulted always moderately positive, so there seem to be no antagonism between survival traits and weight traits. Many authors have suggested a positive relationship between survival and birth weight (e.g. Mukasa-Mugerwa *et al.*, 2000), but no published estimate of this relationship appears to be available. In conclusion, the results of this study have shown that lamb survival is a heritable trait in the Scottish Blackface sheep. It is most heritable at birth and declines later on due to environmental factors. Therefore it might be possible to include early lamb survival in a selection programme for this breed. Moreover, the moderate and positive genetic correlations between survival and weight traits suggest that including survival traits in breeding programmes could lead to indirect improvement of weight traits in Blackface sheep.

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