Behavioural And Morphological Traits Are Not Strongly Correlated With Cold Resistance In Newborn Lambs

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Introduction

Survival rates amongst lambs are currently seen as being undesirable from both a production and welfare perspective. Even well managed flocks have failed to exceed 85% survival in singles and 65% in twins (Copping & Hocking Edwards 2006) signifying that genetic improvement in addition to enhancement of management is required if further progress is to be made. Lamb survival has a low (0.00-0.09) heritability estimate (Safari, Fogarty & Gilmour 2005) indicating genetic gain when practising direct selection for this trait will be slow. A suggested means of overcoming this slow progress is to implement indirect selection for associated traits.

Exposure to cold is one of the main postnatal causes of mortality in the neonate and the trait cold resistance is highly heritable ($h^2 = 0.70$) and correlated to survival (Slee *et al.* 1991). The trait is measured by cooling water temperature surrounding a lamb gradually until the rectal temperature of the lamb reaches 35°C, a process which is both timely and expensive. Whilst previous studies have shown relationships between birth weight, coat grades and skin thickness (Slee *et al.* 1991) no investigations have been made into behaviour and shape. This experiment aimed to identify a practical indicator of cold resistance in the new born lamb using two breeds with known differences in cold resistance (Slee, Griffiths & Samson 1980).

Material and methods

The Border Leicester (BL) and Merino (Mo) breeds were selected on the basis of differences in cold resistance times (BL 80 min versus Mo 51 min; Slee, Griffiths & Samson 1980). Forty ewes from each breed lambed indoors in four pens over a four week time period. Within the first three hours of birth length of labour, time taken for the lamb to first stand and suck, birth weight, type of birth, sex, birth coat score (1 being not hairy..... 7 being extremely hairy; Ponzoni *et al.* 1997), rectal temperature, crown rump and metacarpal length and thorax circumference, and a subjective vigour score (1 being extremely active... 5 being little movement; Brien *et al.* 2009) were recorded for each lamb.

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The day after birth the lamb was placed in a water bath where the temperature of the water was lowered from 36˚C to 15˚C over a one hour period. The time taken for the lamb's rectal temperature to reach 35˚C was recorded and termed cold resistance. Lambs with increased time in the bath exhibited increased cold resistance. Traits measured at birth were recorded for all lambs born however, cold resistance was recorded for 18 Mo and 22 BL lambs.

Data were analysed in ASReml (Gilmour *et al.* 2006) using a general linear model with type of birth, sex, age of dam and breed fitted as fixed effects and birth weight fitted as a covariate where appropriate. Any significant first order interactions were also fitted in the model. Phenotypic correlations were estimated using bivariate analysis.

Results and discussion

Differences in post partum behaviour of the lamb were identified between the breeds (Table 1). Although there was no difference in length of labour, BL lambs were quicker to stand and there was a trend for them to display a quicker time to suck. Slee & Springbett (1986) showed breed differences in postnatal behaviour though the authors identified that Mo lambs stood faster than BL but agreed with the present study that BL were quicker to start sucking.

In addition to the divergence in lamb behavioural measures, shape differences were identified. BL lambs exhibited shorter crown rump and metacarpal lengths whilst thorax circumference was increased in comparison to the Mo lambs. Birth weight was also significantly higher in the BL lambs. With the presence of these size and shape differences it was expected that cold resistance would differ between breeds and a trend for BL lambs to display increased cold resistance was established, which remained even after adjusting for birth weight. This variation was mirrored by the difference in rectal temperature.

Table 1: Breed comparison between Border Leicester (BL) and Merino (Mo) of traits (mean ± SE) recorded at lambing.

Trait	BL	Mo	F Prob
Cold resistance (min)	55.9 ± 1.9	51.1 ± 2.1	<0.1
Birth weight (kg)	5.9 ± 0.3	4.6 ± 0.3	<0.001
Length of labour (min)	23.7 ± 24.1	38.1 ± 20.0	ns
Time to stand (min)	7.7 ± 10.7	39.4 ± 9.2	<0.01
Time to suck (min)	41.5 ± 23.0	77.9 ± 19.6	<0.1
Rectal temp (°C)	39.4 ± 0.2	39.1 ± 0.2	<0.05
Vigour score	2.2 ± 0.3	2.0 ± 0.3	ns
Crown rump (cm)	44.5 ± 1.3	46.3 ± 1.2	<0.05
Thorax (cm)	42.5 ± 0.4	41.3 ± 0.6	<0.01
Metacarpal (cm)	10.2 ± 0.2	11.0 ± 0.2	<0.001

Phenotypic correlation analysis of pooled data was conducted to determine whether an easy to measure indicator of cold resistance could be identified (Table 2). As expected, a positive relationship between birth weight and cold resistance was found indicating the heavier the animal, the longer they resisted the effects of the cold. This is in agreement with previous work where smaller lambs were more susceptible to death from hypothermia as they displayed increased surface area to volume ratio resulting in an exacerbated rate of heat loss (Alexander 1962). In addition to weight, two of the shape measures were positively correlated with cold resistance (crown rump length and thorax circumference). Shape differences also presumably impact on heat loss via effects on surface area/volume relationships. This relationship however, was not independent of birth weight suggesting that it is weight, not shape that is a main determinant of cold resistance.

Surprisingly, no correlation between rectal temperature at birth and cold resistance was identified however standard errors were high. Slee, Griffiths & Samson (1980) demonstrated a relationship between cold resistance and rectal temperature one hour after birth by showing a similar ranking for the two traits across ten breeds of sheep. Whilst this relationship was clear across a large number of breeds, it may not exist within breed. Birth coat score was positively correlated with cold resistance and rectal temperature measured at birth and did not vary with the inclusion of birth weight in the model. Whilst standard errors where high, this relationship was confirmed by Slee *et al.* (1991) who reported a phenotypic correlation of 0.24 ± 0.06 in addition to a genetic correlation of 0.56 ± 0.24 suggesting this trait may be a suitable indicator of both cold resistance and lamb survival in the field (see Brien *et al.* (2009) who showed moderate phenotypic and genetic correlations between birth coat score and lamb survival).

Time taken for the lamb to stand and suck displayed a small, positive relationship with cold resistance however the large standard errors warrant further investigation before meaningful conclusions can be drawn. Dwyer & Morgan (2006) reported that lambs that were slow to suck had lower rectal temperatures suggesting that, in contrast to this study, behaviourally slow lambs have decreased thermoregulatory ability. Whilst it is difficult to practically measure these traits, alternate ways of assessing lamb behaviour and vigour soon after birth and their relationship with cold resistance are being investigated.

Table 2: Phenotypic correlation estimates (mean ± SE) between cold resistance, rectal temperature and traits measured at birth with and without fitting birth weight as a covariate.

	Cold Resistance		**Rectal Temperature**	
Trait	- Birth weight	+ Birth weight	- Birth weight	+ Birth weight
Birth weight	-	0.33 ± 0.16	-	-0.15 ± 0.17
Crown rump length	0.28 ± 0.16	0.13 ± 0.18	-0.11 ± 0.16	-0.12 ± 0.16
Metacarpal length	0.17 ± 0.17	0.13 ± 0.18	-0.12 ± 0.16	-0.09 ± 0.17
Thorax circumference	0.27 ± 0.16	0.04 ± 0.18	-0.14 ± 0.17	-0.11 ± 0.17
Rectal Temperature	-0.03 ± 0.17	0.00 ± 0.17	-	-
Birth coat score	0.20 ± 0.19	0.20 ± 0.18	0.33 ± 0.16	0.36 ± 0.16
Length of labour	0.06 ± 0.23	-0.09 ± 0.25	0.06 ± 0.29	0.30 ± 0.28
Time to stand	0.27 ± 0.20	0.35 ± 0.20	0.18 ± 0.23	-0.04 ± 0.24
Time to suck	0.16 ± 0.20	0.20 ± 0.20	-0.14 ± -0.21	-0.14 ± 0.22

Conclusion

These results clearly show that breed differences in weight, shape, behaviour and thermoregulatory ability exist between BL and Mo lambs. Positive phenotypic correlations between shape and cold resistance were identified however these were largely explained by birth weight. It appears, perhaps not surprisingly, that the weight of the lamb is a major determinant of cold resistance. Lamb behaviour soon after birth also demonstrated a small relationship with cold resistance. Further work should investigate the relationship between birth coat score, behaviour and physiological 'fitness'.

Acknowledgments

The authors would like to thank the Sheep Co-operative Research Centre for Sheep Industry Innovation who in addition to the University of Adelaide and the South Australian Research Institute funded this research.

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