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BRIEF COMMUNICATION: Ewe live weight and body condition in mid- to late-pregnancy does not affect the maximum heat production capacity of its lamb at birth

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Introduction

Under pastoral conditions, lambs are often exposed to wind, cold and rain that result in neonatal mortality. Thus any improved thermoregulatory response has the potential to increase lamb survival. Especially in light lambs, there is a strong negative relationship between birth weight and mortality (Everett-Hincks & Dodds 2008). Birth weight also regulates the lamb's thermoregulatory capability (Kerslake et al. 2010). Lamb birth weight is influenced by ewe live weight, ewe body condition score and the variation in these parameters (Everett-Hincks & Dodds 2008; Schreurs et al. 2012). Therefore, ewe live weight and ewe body condition score may influence the thermoregulatory capability of the newborn lamb and its survival to weaning.

The aim of this study was to utilise data from several experiments to determine if ewe live weight, ewe body condition score or change in ewe live weight or ewe body condition score in mid- to late-pregnancy affected heat production of the newborn lamb and its survival to weaning.

Materials and methods

Experimental data collection

Individual ewe and lamb records were collected from seven experiments undertaken at the Massey University Keeble Farm (5 km south of Palmerston North, New Zealand) between 1999 and 2011, involving twin- and triplet-bearing ewes and their lambs under different nutritional conditions. The experiments listed in alphabetical order, which have been published previously except for one set of currently unpublished data, were PJ Back (Unpublished data) with 120 twin-born lambs; Hutton et al. (2011) with 39 twin- and 37 triplet-born lambs; Kenyon et al. (2002) with 56 twin-born lambs; Kenyon et al. (2010a) with 48 twin- and 42 triplet-born lambs; Kenyon et al. (2010b) with 32 twin- and 35 triplet-born lambs; Kerslake et al. (2009) with 54 twin- and 19 triplet-born lambs; Kerslake et al. (2010) with 35 twin- and 56 triplet-born lambs. Data from a total of 573 lambs were available from 384 twin-born lambs and 189 triplet-born lambs. Each lambs heat production was measured as a summit metabolic rate (LSMR) in watts/kg live weight at between 24 hours and 36 hours of age via open circuit calorimetry, as described by Kerslake et al. (2009). Unfasted ewe live weights, without adjustment for fleece or conceptus weight (ELW), were recorded between Day 70 (P70) and Day 146 (P146) of pregnancy. Ewe body condition scores (EBCS) (Jefferies 1961) were recorded between P112 and P146. Survival to weaning of all lambs born to each experimental ewe was also recorded.

The experiments were approved by the Massey University Animal Ethics Committee.

Statistical analysis

Statistical analysis was conducted using SAS (SAS, version 9.3, SAS Institute Inc., Cary, North Carolina, USA). A quadratic regression equation for ELW over time was generated for individual ewes that had at least three live-weight records between P70 and P146. This equation was used to predict ELW at P115, P128 and P140 for each ewe. The mean and range for each set of predicted weights (kg) were 72.4 (49.3–91.4), 76.6 (51.1–93.6) and 81.3 (54.8–101.8) respectively. Using these predicted ELW values, liveweight changes between P115 and P128, between P128 and P140, and between P115 and P140 were calculated. The mean and range for each set of estimated liveweight changes (kg) were 4.1 (-3.1–12.7), 4.8 (-2.8–17.8) and 8.9 (-2.7–17.8) respectively. These predicted ELWs were used to examine the relationship between ELW and LSMR.

As there were considerably fewer measurements of EBCS than of ELW it was not appropriate to use a regression approach to predict EBCS. Instead, two time points were chosen. These were the closest measurements to P115 and P140. The mean and range for the two sets of EBCS data were 2.6 (1.5–3.5) and 2.7 (1.5–4.0). The mean and range of the change in EBCS between the measurements closest to P115 and P140 was 0.1 (-0.5–1.5).

Lamb summit metabolic rate data were collected from 573 lambs. Mixed models were used to determine the effect of ELW, EBCS or the change in either of these on LSMR. The models included the fixed effects of study, treatment nested within study, sex and birth rank of the lamb, and the random effect of ewe. The analysis for the effect of EBCS and change in EBCS was conducted with and without adjustment for ELW at P115. The models for ELW change between P115 and P128, between P128 and P140, and between P115 and P140, each included adjustment for ELW at P115.

Survival of lambs to weaning was analysed as a binomial trait of either surviving or not surviving to weaning, using logistic regression with birth rank and

Table 1 Relationship between ewe live weight, ewe live weight change, ewe body condition score and ewe body condition score change during pregnancy, and lamb summit metabolic rate calculated from data sourced from seven experiments. ELW at P115 = Ewe live weight at Day 115 of pregnancy.

Measurement	Time of measurement during pregnancy (Days)	Covariate	Number of lambs	Regression coefficient ± standard error	P value
Ewe live weight	115		573	-0.09 ± 0.08	0.26
	128		573	0.07 ± 0.12	0.56
	140		573	0.01 ± 0.08	0.92
Ewe live weight change	115–128	ELW at P115	573	0.08 ± 0.08	0.33
	128–140	ELW at P115	573	0.01 ± 0.08	0.92
	115–140	ELW at P115	573	0.04 ± 0.05	0.41
Ewe body condition score	115		371	0.12 ± 0.58	0.84
	140		371	-0.20 ± 0.51	0.69
	115	ELW at P115	371	0.35 ± 0.60	0.55
	140	ELW at P115	371	-0.06 ± 0.51	0.91
Ewe body condition score change	115–140		371	-0.17 ± 0.46	0.71
	115–140	ELW at P115	371	-0.17 ± 0.46	0.71

sex of lamb considered as fixed effects and lamb birth weight and LSMR as covariates.

Results and discussion

Survival of lambs from 24–36 hours of age when LSMR was measured, through to weaning was 89%. Amongst those measured lamb survival tended to increase with increased LSMR ($P = 0.054$), such that the likelihood of a lamb surviving from just after birth until weaning increased by 1.08 times (95% confidence interval 1.00–1.17) for every 1 watt/kg increase in LSMR. This indicates that any management technique that increases LSMR can have a small positive influence on lamb survival.

Lamb summit metabolic rate was not affected ($P > 0.05$) by ELW at P115, P128 and P140 or change in ELW between P115 and P128, between P128 and P140, or between P115 and P140 (Table 1). Similarly LSMR was not affected ($P > 0.05$) by EBCS at P115 and P140 or change in EBCS between P128 and P140 (Table 1). There was a significant interaction ($P < 0.05$) between birth rank and sex of lamb for all of the analyses, such that female twin-born lambs had a greater LSMR than male twin-born lambs, but there was no significant difference between female and male triplet-born lambs. For example, for the analysis examining the effect of ELW on LSMR, female twin-born lambs had a greater LSMR than male twin born lambs of 15.9 ± 0.3 versus 14.9 ± 0.3 watts/kg respectively ($P = 0.004$), while the LSMR of female and male triplet-born lambs was 15.5 ± 0.4 watts/kg versus 15.8 ± 0.4 watts/kg respectively ($P = 0.57$).

These data indicate that manipulation of ELW or EBCS in mid- to late-pregnancy is unlikely to be an effective way of increasing the potential maximum heat production of twin- or triplet-born lambs. The lack of an effect may not be surprising as recently it has been reported that ELW may only have a small impact on lamb birth weight (Schreurs et al. 2012). Since EBCS and ELW are highly correlated within a population (Quigley et al. 2008; Sanson et al. 1993), it is not unexpected that EBCS did not influence lamb heat production. Furthermore, it has been suggested that the constraints on the fetus imposed by being a twin or triplet have a stronger influence on lamb birth weight (Gootwine et al. 2007) than ELW during pregnancy.

It is possible that the time periods we investigated were not the most appropriate to examine the potential impacts of ELW or EBCS on the lamb heat production. However, the increase in brown adipose tissue weight plus specific enzymic and morphological changes that affect heat production, do occur predominantly between Day 120 of pregnancy and term (Clarke et al. 1997), indicating that the periods examined in this study were likely to be appropiate.

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