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Differences in birth weight and neonatal survival rate of lambs born to ewe hoggets or mature ewes

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Abstract

This experiment investigated differences in birth weights and survival in lambs born to hogget and mature ewes. It included 1082 mature ewes with a scanning rate of 1.87 fetuses per ewe joined and 1026 hoggets with a scanning rate of 0.80 fetuses per hogget joined, that were bred together, and lambed separately, under commercial farming conditions. At lambing, birth weight, lamb vigour score, and ewe maternal behaviour score were recorded. Lambs born to hoggets were lighter and less vigorous than lambs born to mature ewes (P<0.05). Single-born lambs were heavier at birth (P<0.05), and had greater survival at birth (P<0.05) than did twin-born lambs. Twin-born lambs were heavier (P<0.05) at birth, and had greater survival at birth (P<0.05) than triplets. There was an interaction of dam age and birth rank on lamb survival to weaning (P<0.01). At all birth ranks lambs born to hoggets had lower survival to weaning than lambs born to mature ewes, and the difference in survival increased with increasing birth rank. Lambs that had a vigour score of 1 had lower survival (83.5%; P<0.05) than lambs that had a vigour score of either 2 or 3 (88.6- and 91.4%, respectively). Maternal behaviour score did not affect lamb survival (P>0.05). Lambs born to hoggets are at greater risk of mortality, so farmers need to prioritise their time and resources towards hoggets at lambing time.

Key words: lambing; birth weight; survival rate; hogget; ewe

Introduction

Only 30-43% of farmers in New Zealand breed their ewe hoggets at 7-8 months of age (Beef and Lamb New Zealand 2017). Breeding hoggets can have benefits, including increased lamb output per year and per lifetime, and better pasture utilisation during the spring (Kenyon et al. 2004). However, lamb outputs from hoggets are lower, compared with that of mature ewes, weaning fewer lambs that are lighter at birth and at weaning (Kenyon et al. 2004; Kenyon et al. 2014; Pain et al. 2015).

Hoggets are commonly joined one month later than mature ewes in New Zealand (Kenyon et al. 2004). This allows the hoggets more time to attain puberty and maximises the chance that they become pregnant (Corner et al. 2013), but also confounds results of experiments that compare hogget and mature ewes reproductive performance. Corner et al. (2013) joined hoggets and mature ewes to the ram at the same time, and reported lower pregnancy rates in hoggets, which gave birth to fewer lambs, that had lower birth and weaning weights and survival rates to weaning. However, that study had relatively low numbers, using 400 ewe hoggets, and 399 mature ewes.

The majority of lamb deaths between birth and weaning occur during the first three days after birth (McMillan 1983). Mortality rates have been reported between 5-30% in different farming systems (Kerslake et al. 2005; Stevens, 2010), and the main causes of lamb mortality are dystocia and starvation and/or exposure (Everett-Hincks and Duncan 2008; Stevens 2010). Lamb mortality is largely associated with lamb birth weight (McMillan 1983; Everett-Hincks and Dodds 2008). There are few reports on survival rate of lambs born to hoggets and mature ewes during the same lambing period. This experiment was part of a larger experiment examining the effects of birth rank and dam age on replacement ewe performance. This experiment compared birth weight, vigour score and survival rate, in lambs born to either ewe hoggets or mature ewes. It was hypothesised that twin-born lambs from ewe hoggets would display lower rates of survival compared with lambs born to mature ewes of any birth rank, or with singletons born to ewe hoggets.

Materials and methods

All animal procedures were carried out with the approval of the Massey University Animal Ethics Committee.

Experimental design

The experiment was undertaken at Riverside Farm, Massey University, 11 km north of Masterton, New Zealand, between April 2017, and January 2018. It included 1082 multiparous three- and four-year-old Romney ewes, and 1026 nulliparous eight-month-old Romney ewe hoggets (minimum 38 kg) that were randomly allocated to one of two management mobs, each containing 541 ewes, and 513 hoggets. Pre-grazing pasture measures prior to breeding were 2000 kg DM/ha for each mob. Hoggets were run with vasectomised rams for 68 days prior to the start of breeding. Mature ewes joined the hoggets and vasectomised rams 17 days before the start of breeding. Each mob was joined with 18 mixed-age Romney rams on 7th May 2017, for 34 days. After 34 days, mature ewes were removed and hoggets were run as a single group for a further 10 days of breeding. Ewes and hoggets were maintained as separate mobs throughout pregnancy, under commercial farming conditions. Unfasted live weights and body condition scores (BCS) of ewes and hoggets were recorded at breeding, pregnancy detection, and eight days prior to the start of lambing (Table 1). Pre-grazing pasture measures during pregnancy were 1300 kg

DM/ha for hoggets, and 1200 kg DM/ha for ewes, with supplemented baleage. All ewes and hoggets were shorn during late pregnancy (26 days prior to the start of lambing), and fleece weights were recorded. Eight days prior to the planned start of lambing, ewes and hoggets were allocated to lambing paddocks based on dam age, pregnancy rank, and cycle bred. Pre-grazing pasture measures were 800 kg DM/ha for all classes. Mature ewes that were pregnant in the second cycle were grouped together, as were hoggets that were pregnant in the third cycle, regardless of pregnancy rank. Ewes and hoggets were checked twice daily until three days after the expected end of lambing. Lambs were tagged within 12 hours of birth, their birth rank, sex, and dam were identified, and birth weights were recorded. Dam maternal behaviour score (MBS; 1-5 score; 1= ewe flees and does not return during tagging, 5= ewe touches recorder during tagging) (O'Connor et al., 1985), and lamb vigour (adapted from Plush (2013), where 1= no- 2= moderate- and 3= regular struggle/movement during catching and restraint) were also recorded at this time for live lambs. Behavioural observations were made by one of three trained operators. Trained operators were sometimes accompanied by an additional person, who was present during scoring, but did not assign a score. The presence of the additional person was recorded in case ewes retreated further from two people than one. Two sets of quadruplet lambs were removed from the dataset.

Statistical analysis

Statistical analysis was carried out using SAS v9.4 (SAS 2014). Live weight of ewes at breeding, pregnancy detection, and pre-lambing was analysed using a linear mixed model allowing for repeated measures. It included the fixed effects of mating mob, pregnancy rank, pregnancy cycle, ewe age, day of measurement, a two-way interaction of ewe age and day of measurement, and the random effect of ewe. Body condition score of ewes at breeding, pregnancy detection, and pre-lambing was analysed using a generalised linear model allowing for repeated measures, assuming a Poisson distribution and a logit transformation. It included the fixed effects of mating mob, pregnancy rank, pregnancy cycle, ewe age, day of measurement, a two-way interaction of ewe age and day of measurement, and the random effect of ewe. Pregnancy cycle and pregnancy rate were analysed using a generalised linear model, assuming a binomial distribution and a logit transformation. The model included the fixed effect of ewe age, with a Bonferroni adjustment to allow for multiple comparisons.

Lamb birth weights were analysed using a general linear model that included the fixed effects of sex of lamb, birth rank, and age of dam, a covariate of date of birth, and a two-way interaction of age of dam and birth rank. Lamb vigour at birth was analysed using a generalised linear model using a logit transformation, assuming a Poisson distribution, with fixed effects of sex of lamb, birth rank, person scoring, and age of dam, a covariate of date of birth, and a two-way interaction of age of dam and birth rank. Maternal behaviour score was analysed using a generalised linear model using a logit transformation, assuming a Poisson distribution, with fixed effects of birth rank, person scoring, number of people present, and age of dam, a covariate of date of birth, and a two-way interaction of age of dam and birth rank. For all models two-way interactions of age of dam and sex of lamb, and birth rank and sex of lamb, and a three-way interaction of age of dam, sex of lamb and birth rank were considered in initial models, but removed from all models as they were not significant ($P>0.05$). Analysis of variance for lamb survival to weaning and birth weight was analysed using a generalised linear model, assuming a binomial distribution and a logit transformation. The model included fixed effects of sex of lamb, birth rank, and age of dam, a covariate of date of birth, and a two-way interaction of age of dam and birth rank. This was used to create an equation of probability of death, based on birth weight for lambs born as singletons to either mature ewe or hogget dams.

Lambs were recorded as alive or dead at birth and at weaning, and survival at birth and weaning was analysed using a generalised linear model, assuming a binomial distribution and using a logit transformation. The model included fixed effects of sex of lamb, birth rank, and age of dam, a covariate of date of birth, and a two-way interaction of age of dam and birth rank. In a second analysis, for lambs born alive, vigour score was added to the model predicting survival to weaning. A third analysis was conducted in which birth weight was added to the model to generate a prediction equation for survival to weaning for all lambs born based on birth weight for singleton lambs. The effect of birth weight on survival was modelled for single born lambs from mature dams, and hogget dams.

Results

Ewes were heavier and had greater BCS than hoggets at breeding, pregnancy detection, and set stocking (Table 1). Pregnancy results are shown in Table 1, for ewes and hoggets. Hoggets had a lower conception rate during the first cycle (19.8% versus 94.3%), lower overall pregnancy rate than mature ewes (80% versus 187%) and gave birth to fewer lambs per ewe mated (70% versus 183%).

There were no significant interactions between dam age and lamb birth rank ($P>0.05$) for lamb birth weight, lamb vigour, MBS, and lamb survival at birth (Table 2). Lambs that were born to mature ewes were heavier at birth, and had greater survival and vigour scores at birth than lambs born to ewe hoggets. There was no difference in MBS between mature ewes and ewe hoggets. At all birth ranks lambs born to hoggets had lower survival to weaning than lambs born to mature ewes, and the difference in survival increased with increasing birth rank.

Single-born lambs were heavier at birth ($P<0.05$) than twin-born lambs, which were heavier ($P<0.05$) at birth than triplets (Table 2). There was no effect of birth rank on lamb vigour scores, MBS, or lamb survival at birth ($P>0.05$). Male lambs were heavier at birth ($P<0.05$), and had greater

Table 1 Number of ewes and hoggets present at breeding, pregnancy detection (PD), and pre-lambing, least-squares means (± standard error of mean) of live weights, and body condition scores at these dates, cycle pregnant, along with pregnancy-detection results (percent per birth rank and pregnancy rate; (95% CI)), number of lambs born from mature ewes and hoggets and number of lambs tagged per ewe mated.

	Hoggets	Ewes	P value
n			
Breeding	1026	1082	
PD	1013	1079	
Pre-lambing	604	1050	
Live weight (kg)			
Breeding	49.5 ± 0.4	71.2 ± 0.4	<0.0001
PD	52.2 ± 0.4	70.5 ± 0.4	<0.0001
Pre-lambing	59.8 ± 0.4	74.2 ± 0.4	<0.0001
Body condition score			
Breeding	2.85 ± 0.05	3.36 ± 0.06	<0.0001
PD	2.74 ± 0.05	3.11 ± 0.05	<0.0001
Pre-lambing	3.03 ± 0.05	2.93 ± 0.05	<0.0001
Cycle pregnant (%)			
1st	19.8 (17.1-22.0)	94.3 (93.8-96.4)	<0.0001
2nd	26.9 (23.8-29.2)	4.1 (2.9-5.3)	<0.0001
3rd[1]	15.7	-	
Pregnancy detection			
Pregnancy rate[2]	80	1 87	
Pregnancy rank (%)			
0	37.2 (34.3-40.2)	1.4 (0.8-2.3)	<0.0001
1	44.3 (41.3-47.4)	18.9 (16.7-21.4)	<0.0001
2	17.0 (14.8-19.5)	69.9 (67.1-72.6)	<0.0001
3	0.2 (0.04-0.8)	9.1 (7.6-11.0)	<0.0001
Number of lambs tagged	722	1979	
Number of lambs born per ewe mated (%)	70	183	

[1]Means for animals pregnant in the third cycle were not analysed, as only ewe hoggets were presented for breeding during this time.
[2]Number of fetuses per 100 ewe joined.

survival (P<0.05) compared with female lambs, and there was no difference (P>0.05) between sexes for lamb vigour scores, or the percentage of lambs alive at birth.

Probability of death of a singleton born to a mature ewe

$$= \frac{e^{(14.03475-5.7463xBWT+o.489xBWT^2)}}{1+\ e^{(14.03475-5.7463xBWT+o.489xBWT^2)}}$$

Probability of death of a singleton born to a hogget

$$= \frac{e^{(9.40475-4.8464xBWT+o.5126xBWT^2)}}{1+\ e^{(9.40475-4.8464xBWT+o.5126xBWT^2)}}$$

Low numbers of multiples from hoggets meant that models for twins and triplets born to hoggets or mature ewes were not modelled.

Of lambs that were alive at birth (Table 3), lambs that had a vigour score of 1 were 1.68 times more likely (P<0.05) to die than lambs that had a vigour score of 3. Lambs that had a vigour score of 2 were 1.34 times more likely to die than lambs that had a vigour score of 3, although there was no significant difference (P>0.05) in survival rate of lambs with a vigour score of 2 or 3.

Discussion

Ewe hoggets had lower conception rates during the first cycle, lower pregnancy rates (number of fetuses present per 100 females joined); this was consistent with previous literature (Kenyon et al. 2004; Kenyon et al. 2014). Lower conception rates during the first cycle from ewe hoggets are possibly attributed to ewe hoggets being shy to the rams, and not standing correctly for courtship (Edey et al. 1978). Birth weight was lower for lambs born to hoggets, than for lambs born to mature ewes (Dýrmundsson 1981; Annett and Carson 2006; Gootwine et al. 2007; Young et al. 2010), and lower for lambs born as multiples (Schreurs et al. 2010; Young et al. 2010).

Lamb survival was greater at birth, and to weaning for lambs that were born to mature ewes, compared with hoggets (Kerslake et al. 2005; Stevens 2010). Everett-Hincks et al. (2005) reported that lambs born to two-year-old dams had lower rates of survival than did lambs born to older dams. They also noted that female lambs had greater survival rates than did male lambs, which was also observed in the current study. Lamb survival is largely related to birth weight of lambs (Karn & Penrose 1951; Morris et al. 2005; Schreurs et al. 2010; Mulvaney et al. 2012). Therefore, differences in lamb birth weight due to dam age or lamb birth rank will affect survival rates of these groups. Everett-Hincks et al. (2005) reported that as litter size increased, litter survival decreased, which concur with the results of this experiment. Based on the prediction equation, to achieve a survival rate of 85% or greater, lamb birth weights needed to be in the 3.9 to 5.5 kg range for singleton lambs born to hoggets, and 4.3 to 7.4 kg range for singleton lambs born to mature ewes. Kerslake et al. (2005) and Young et al. (2010) reported that dystocia and starvation/exposure were the largest causes of lamb deaths in the perinatal period.

Maternal behaviour scores did not differ between ewe age groups, or between litter sizes. This contradicts previous results, which suggests that higher dam age or higher litter size resulted in higher MBS, however, that research did not use hogget dams (O'Connor et al. 1985). O'Connor et al. (1985) showed that an increase in MBS resulted in greater lamb survival, as did Everett-Hincks et al. (2005), however this was not seen in the current study, where there was no difference in lamb survival based on maternal behaviour scores. This shows that the flight or fight response to people during tagging may not indicate the ability of the ewe as a mother.

Lamb survival was affected by lamb vigour scores, and lambs that had greater vigour scores had greater survival

Table 2 Least-squares means (95% CI) for birth weight of lambs (BWT), lamb vigour (Vigour) and maternal behaviour score (MBS), and percentage (95% CI) of lambs survival at birth and survival to weaning based on the number of lambs born, by dam age (ewe vs. hogget), birth rank (single vs twin vs triplet), sex of lamb (male vs female) and the interaction of dam age and lamb birth rank (E=ewe, H=hogget, 1=single, 2=twin, 3=triplet). Values are back-transformed means and 95% confidence intervals.

	n	BWT (kg)	Lamb survival at birth (%)	n	Vigour	n	MBS	Lamb survival to weaning (%)
Dam age								
Ewe	1967	5.14^{b} (5.09-5.19)	96.1^{b} (94.6-97.1)	1877	2.38^{b} (2.23-2.54)	985	2.69 (2.49-2.91)	83.1^{b} (80.4-85.5)
Hogget	717	3.47^{a} (3.27-3.66)	82.2^{a} (72.1-89.2)	624	1.85^{a} (1.56-2.19)	499	2.66 (2.09-3.39)	47.3^{a} (30.5-64.8)
P value		<0.001	0.001		0.002		NS	<0.001
Birth rank								
Single	622	5.31^{c} (5.24-5.38)	94.4 (91.5-96.3)	570	2.23 (2.08-2.40)	554	2.61 (2.43-2.80)	85.5^{c} (82.0-88.4)
Twin	1763	4.34^{b} (4.28-4.39)	94.0 (92.5-95.2)	1667	2.17 (2.03-2.31)	839	2.64 (2.46-2.86)	76.3^{b} (73.7-78.8)
Triplet	299	3.27^{a} (2.99-3.55)	82.1 (66.6-91.3)	264	1.91 (1.50-2.43)	91	2.78 (1.94-3.97)	32.8^{a} (14.5-58.4)
P value		<0.001	NS		NS		NS	<0.001
Sex								
Male	1288	4.44^{b} (4.34-4.55)	90.6 (87.1-93.3)	1197	2.07 (1.87-2.28)	-	-	64.1^{a} (55.0-72.3)
Female	1389	4.16^{a} (4.06-4.27)	92.1 (90.0-94.4)	1306	2.14 (1.94-2.35)	-	-	71.2^{b} (62.9-78.4)
P value		<0.001	NS		NS	-	-	<0.001
Dam age * birth rank								
E1	216	6.14 (6.03-6.25)	97.4 (94.3-98.8)	209	2.48 (2.25-2.74)	201	2.60 (2.35-2.87)	90.5^{e} (85.9-93.7)
E2	1461	5.18 (5.13-5.22)	97.4 (96.5-98.1)	1411	2.39 (2.25-2.55)	696	2.70 (2.51-2.92)	84.1^{d} (82.1-85.9)
E3	290	4.11 (4.01-4.20)	91.1 (87.3-93.9)	257	2.27 (2.07-2.50)	88	2.78 (2.43-3.18)	70.3^{c} (64.7-75.3)
H1	406	4.48 (4.39-4.56)	88.3 (84.4-91.4)	361	2.01 (1.85-2.19)	353	2.63 (2.42-2.85)	78.6^{b} (73.9-82.6)
H2	302	3.49 (3.40-3.59)	86.4 (81.8-90.1)	256	1.96 (1.79-2.16)	143	2.59 (2.31-2.91)	66.4^{b} (60.5-71.7)
H3	9	2.43 (1.88-2.98)	67.1 (28.6-91.2)	7	1.61 (1.00-2.58)	3	2.77 (1.38-5.59)	9.1^{a} (1.2-45.1)
P value		NS	NS		NS		NS	0.042

$^{a, b, c, d, e}$ Means with different superscripts are significantly different (P<0.05)

Table 3 Survival (% (95% CI)) until weaning of lambs that were born alive by lamb vigour score (Vigour; 1-3 score; 1= no struggle during catching and restraint, 3= regular struggle during catching and restraint), and maternal behaviour score (MBS; 1-5 score; 1= ewe flees and does not return during tagging, 5= ewe touches recorder during tagging). Values are back-transformed means and 95% confidence intervals.

	n	Lamb survival to weaning (%)
Vigour		
1	388	72.5^{a} (61.6-81.2)
2	922	77.0^{b} (67.8-84.2)
3	1196	82.3^{b} (74.2-88.2)
P value		0.005
MBS		
1	282	76.8 (65.8-85.0)
2	900	79.0 (70.2-85.7)
3	681	79.6 (71.1-86.1)
4	498	75.2 (65.0-83.2)
5	135	76.8 (63.5-86.3)
P value		NS

$^{a, b}$ Means with different superscripts are significantly different (P<0.05)

rates; Dwyer (2008) reported previously that higher lamb vigour at birth resulted in higher lamb survival rates until weaning. Smith (1977) and Owens et al. (1985) reported that increasing ewe age resulted in fewer weak lambs at birth. However, those studies did not involve ewe hogget dams.

In conclusion, lambs that are born to ewe hoggets are smaller at birth, have lower vigour scores and lower rates of survival at birth and until weaning, than lambs that are born to mature ewes. There was no difference in maternal behaviour score between mature ewes and ewe hoggets. Poor lamb vigour may be a good indicator for farmers to use for intervention to improve survival rates.

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