The effect of ewe nutrition and body condition score during very late pregnancy and the perinatal period on the behaviour of twin-bearing ewes and their lambs

GV Gronqvist*, RE Hickson, RA Corner-Thomas, PR Kenyon, KJ Stafford and ST Morris

International Sheep Research Centre, Institute of Veterinary, Animal and Biomedical Sciences, Massey University, Private Bag 11-222, Palmerston North, 4442, New Zealand.

**Corresponding author.* Email: G.Gronqvist@massey.ac.nz

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Abstract

Nutrition of ewes during pregnancy may affect the behaviour and survival of lambs. In this experiment, ewes were allocated 'low' (pasture mass 800-1000 kg DM/ha), 'medium' (pasture mass 1200-1400 kg DM/ha) or 'high' nutrition (pasture mass 1500-1700 kg DM/ha) from day 141 of pregnancy until weaning. All treatments included ewes of body condition score (BCS) 2.0, 2.5 or 3.0 as measured on day 98 of pregnancy to give a 3x3 factorial design. Behaviours of ewes and lambs were recorded in the paddock at tagging 3-18 hours after birth. Lambs born to ewes on the high treatment were quicker to stand than those on the low treatment (median time 15.5 versus 53.5 seconds; $P<0.05$), but neither group differed from lambs on the medium treatment (16.5 seconds; $P>0.05$). There were no differences among treatments or BCS groups in time taken for the lamb to make contact with dam, suck from dam or follow their dam. Maternal behaviour score of the ewes was not affected by BCS or treatment. The percentage of lambs that bleated was similar for lambs from all BCS groups and treatments. BCS and nutrition of ewes in late pregnancy and during the neonatal period had little influence on the behaviour of ewes and lambs.

Introduction

Under pastoral grazing conditions, improved levels of nutrition in late pregnancy and at lambing have been reported to have desirable effects on ewe and lamb behaviour (Everett-Hincks et al. 2005). In addition, nutritional restriction of ewes during pregnancy has been shown to adversely affect their maternal behaviour including lamb grooming, suckling and mothering ability and the behaviour and survival of their lambs (Corner et al. 2010; Kenyon et al. 2011; Thomson & Thomson; 1949).

Few studies have investigated whether body condition score (BCS) of ewes influences ewe and lamb behaviours. Dwyer et al. (2003) reported that ewes that lost condition during pregnancy, as indicated by a reduction in back fat, produced lambs that were slower to stand and suck immediately after birth. No studies have investigated the effects of ewe BCS on ewe and lamb behaviour under extensive pastoral conditions at tagging. Therefore, the aim of this experiment was to investigate the effect of ewe BCS and nutrition in very late pregnancy and throughout the lambing period on the behaviour of twin-bearing ewes and their lambs.

Materials and methods

The experiment was conducted on Massey University's Keeble Farm, 5 km south of Palmerston North, New Zealand, with the approval of the Massey University Animal Ethics Committee. The current experiment included 92 twin-bearing multiparous Romney ewes (aged 3 to 5 years) bred over a 17-day period, and their lambs (n=186). These ewes were part of a flock of 297 ewes used by Corner-Thomas et al. (2015) to examine the effects of ewe nutrition and BCS (a scale of one to five including half units, one = emaciated, five = obese, Jeffries 1961) on twin-bearing ewe and lamb performance to weaning.

Only complete sets of twin-born lambs (where both lambs were alive at tagging) and their dams were included in the analysis due to the potential variation in behaviour of a single lamb as opposed to a complete set.

Background

Twin-bearing ewes were selected based on being either BCS 2.0 (n= 24, 64.5 ± 1.0 kg), 2.5 (n=28, 69.5 ± 0.9 kg) or 3.0 (n=40, 74.1 ± 1.1 kg) 98 days after the start of breeding (P98). From P98 until P141, ewes were managed as one group with average pre- and post-grazing pasture masses of 1154 ± 19.5 and 823 ± 20.0 kg DM/ha, respectively (Corner-Thomas et al. 2015). At P141, ewes from within each BCS group were randomly allocated to either a 'low', 'medium' or 'high' nutrition treatment until the weaning of their lambs 79 days after the mid-point of the lambing period. The aim of the low nutrition treatment was to offer pasture masses of 800 to 1000 kg DM/ha, the medium treatment, 1200 to 1400 kg DM/ha and the high treatment 1500 to 1700 kg DM/ha. The mean pasture masses during the nutrition treatments for the low, medium and high treatments were 902 ± 33, 1226 ± 33 and 1718 ± 34 kg DM/ha, respectively (Corner-Thomas et al. 2015). Lambing began at P146 and continued for 19 days.

Behavioural measurements

During lambing, ewes were inspected twice daily. Lambs were tagged once their coat was dry and the lamb was mobile at 3-18 hours after birth. During tagging all lambs were identified to their dam, ear-tagged and their weight, birth-rank and sex were recorded. Immediately following tagging, the lambs were placed together, lying on the ground while the observers retreated approximately 10 metres. The moment the lambs were released was considered to be 'time zero'. The observers then recorded individual behaviours of the lambs and ewe for five consecutive minutes.

The behaviours recorded included time required for the lamb to stand and fully support itself on all four legs for at least five seconds, the time required for the ewe and lamb to make contact (lamb is within 0.5 metres of the ewe) and the time required for the lamb to follow the ewe (time from 'time zero' until ewe and lamb moved at least five metres away from first contact point) (Everett-Hincks et al. 2005). The time until the lamb sucked from the dam's teat (lamb held teat in its mouth and appeared to be sucking for at least five seconds) was noted. The total number of low-pitched bleats (little mouth movement) and high-pitched bleats (full mouth movement) emitted by the ewe and each lamb during the five-minute observation period were also counted.

A maternal behaviour score (MBS), as described by O'Connor et al. (1985), was recorded for each ewe. The MBS was assessed on a five-point scale based on the distance the ewe moved away from her lambs while the lambs were being tagged.

Statistical Analysis

Statistical analyses were conducted using SAS v. 9.3 (SAS Institute Inc. Cary, 2011, NC, USA).

Lamb behaviours. The time required for lambs to stand, make contact, suck and follow their dam was not normally distributed and could not be normalised. The time to exhibit each behaviour was analysed using survival analysis. Survival curves were obtained using Kaplan-Meyer estimates. The effects of BCS group and nutrition were tested in separate models. Lambs that did not perform a particular behaviour within the five-minute observation period were censored at 301 seconds.

The time for a lamb to exhibit a behaviour was analysed using the non-parametric Kruskal-Wallis test. The effects of BCS and nutrition were tested in separate models. For time to stand and contact the analysis contained all lambs including those that did not show the behaviour during the observation period. The lamb was assigned a value of 301s for a variable if that particular behaviour variable was not shown. For time to suck and follow only those lambs that stood were included. The association between BCS, nutrition and the behaviour variable were investigated using the Wilcoxon Test. If BCS or nutrition treatment was found to be significant, the Wilcoxon two-sample *post hoc* test was carried out with a Bonferroni adjustment.

Ewe and lamb vocalisation. The percentage of lambs that emitted at least one high-pitched bleat and the percentage of lambs that emitted at least one low-pitched bleat were analysed using a generalised model based on a binomial distribution and a logit transformation. The number of bleats emitted was analysed using a generalised model based on a Poisson distribution. The models included the fixed effects of BCS, nutrition treatment and their interaction.

Maternal behaviour score. Ewe MBS was analysed using a generalised model assuming a Poisson distribution containing the fixed effects of BCS, nutrition treatment and their interaction.

Results

Lamb behaviour

Early in the five-minute observation period, fewer lambs stood in the low-nutrition treatment than in the high treatment (Wilcoxon P<0.05, Fig. 1), but neither differed from the medium treatment. By the end of the observation period, fewer lambs stood in the low treatment than in the medium and high treatments (Log-Rank P<0.05, Fig. 1). Only 75% of lambs in the low treatment stood within five minutes compared with 94% and 95% of lambs in the high and medium treatments, respectively. The median time to stand was less (P<0.05) for lambs in the high treatment than the low treatment, but lambs in the medium treatment did not differ from either (P>0.05, Table 1). Time to stand was not affected by BCS group (P>0.05, Fig 2, Table 1).

Ewe BCS and nutrition did not affect the time taken for lambs to make contact, suck or follow their dam during the observation period nor the median time required to do so (P>0.05, Table 1).

Table 1 The effect of ewe nutrition treatment (low [mean pasture mass 902 ± 33 kg DM/ha] vs. medium [mean pasture mass 1226 ± 33 kg DM/ha] vs. high [mean pasture mass 1718 ± 34 kg DM/ha]) and body condition score group (BCS 2.0 vs. BCS 2.5 vs. BCS 3.0 at the 98th day of pregnancy) on the median time (seconds) required for lambs to stand, make contact with the ewe, suck from the ewe and follow her if she moved away.

	n[1]	Stand	Contact	n[2]	Suck	Follow
Nutrition treatment						
Low	48	53.5^{b}	28.5	36	301	293
Medium	56	16.5^{ab}	40	53	301	301
High	80	15.5^{a}	27	75	301	275
BCS group						
BCS 2.0	62	16	34	55	301	269
BCS 2.5	68	20	33.5	59	301	301
BSC 3.0	54	18.5	34	50	301	266

^{abc} Medians within columns and main effects without letters in common differ (P<0.05). [1] The total number of lambs in each group. [2] The number of lambs that stood in each group.

Lamb vocalisation

Number of bleats (Table 2), but not percentage of lambs that bleated (data not shown), differed among BCS groups and nutrition treatments. Within the BCS 2.0 group, lambs in the low treatment emitted fewer high-pitched bleats than those in the medium, which in turn emitted fewer high-pitched bleats than those in the high treatment (P<0.05, Table 2). In contrast, within the BCS 2.5 group, lambs in the low and high treatments emitted fewer high-pitched bleats than those in the medium treatment (P<0.05), but the low and high treatments did not differ from each other (P>0.05). Within the BCS 3.0 group, lambs in the low treatment emitted fewer high-pitched bleats than those in the high treatment (P<0.05), which emitted fewer high-pitched bleats than those in the medium treatment (P<0.05).

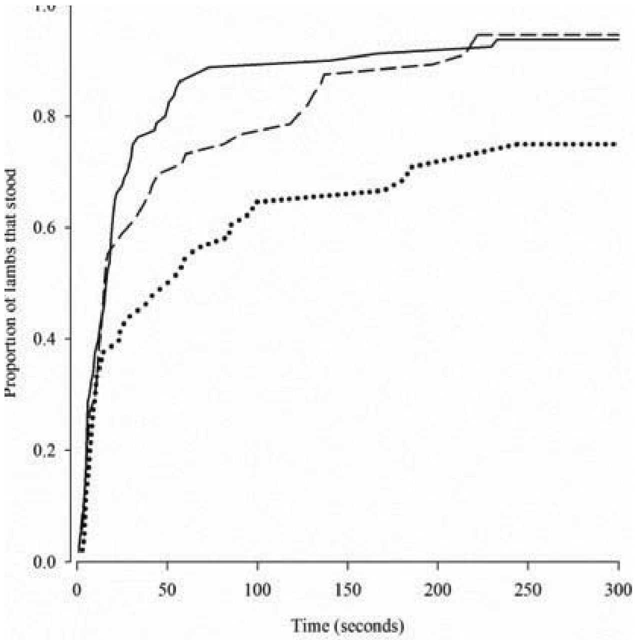

Figure 1 The effect of ewe nutrition treatment (low….. medium - - - vs. high ──) on the proportion of newborn lambs standing in the 300 seconds after tagging. Wilcoxon P<0.05 (signifies differences early in the observation period) for the high versus low nutrition treatments. Log-Rank P<0.05 (signifies differences late in the observation period) for the high versus low nutrition treatments and the medium versus low nutrition treatments.

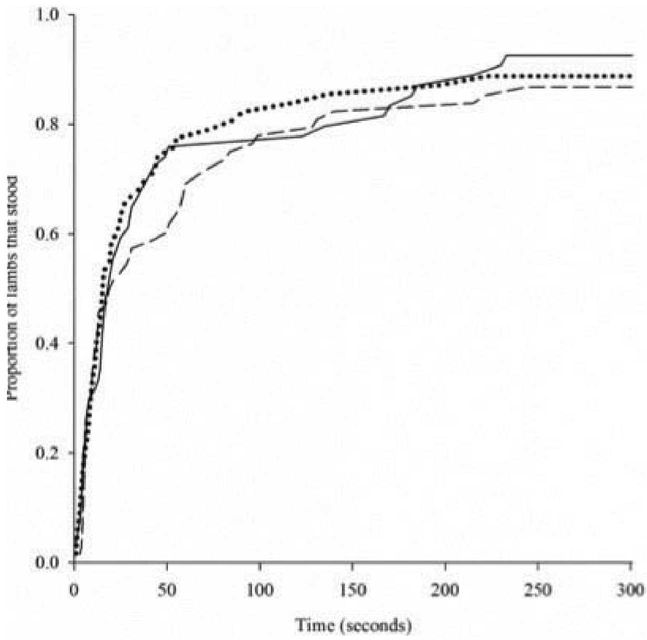

Figure 2 The effect of ewe BCS group (BCS 2.0 ….. BCS 2.5 - - - vs. BCS 3.0 ──) on the proportion of newborn lambs standing in the 300 seconds after tagging. Both the Wilcoxon P-value (signifies differences early in the observation period) and the Log-Rank P-value (signifies differences late in the observation period) are >0.05.

Table 2 The effect of ewe nutrition treatment (low [mean pasture mass 902 ± 33 kg DM/ha] vs. medium [mean pasture mass 1226 ± 33 kg DM/ha] vs. high [mean pasture mass 1718 ± 34 kg DM/ha]) and body condition score group (BCS 2.0 vs. BCS 2.5 vs. BCS 3.0 at the 98th day of pregnancy) on the number of bleats for those ewes and lambs that bleated at least once. Values are the back-transformed median value (with the 95% confidence limit in parenthesis). The number of twin-rearing ewes included within each of the nine groups (three nutrition treatments by three BCS groups) was as follows: low BCS 2.0 n=7, low BCS 2.5 n=10, low BCS 3.0 n=7, medium BCS 2.0 n=11, medium BCS 2.5 n=11, medium BCS 3.0 n=14, high BCS 2.0 n=13, high BCS 2.5 n=14 and high BCS 3.0 n=13.

	BCS 2.0		BCS 2.5		BCS 3.0	
Lambs	n[1]	Number	n[1]	Number	n[1]	Number
High-pitched bleat						
Low	11	13.1^{a} (11.4-15.2)	17	12.4^{a} (10.9-14.0)	13	19.1^{b} (16.9-21.5)
Medium	17	20.9^{b} (19.1-22.9)	19	19.3^{b} (17.5-21.3)	13	30.1^{d} (27.2-33.2)
High	25	31.5^{d} (29.4-33.7)	25	12.8^{a} (11.5-14.1)	22	25.0^{c} (23.2-27.1)
Low-pitched bleat						
Low	11	11.3^{e} (9.7-13.2)	12	5.7^{bc} (4.7-6.8)	8	6.9^{cd} (5.7-8.5)
Medium	15	7.1^{cd} (6.1-13.2)	18	7.9^{d} (6.8-9.2)	11	3.9^{a} (3.0-5.2)
High	20	6.6^{cd} (5.7-7.6)	22	4.1^{a} (3.4-4.9)	19	4.7^{ab} (3.9-5.7)
Ewes						
High-pitched bleat						
Low	7	18.9^{c} (16.7-21.3)	9	16.8^{c} (15.1-18.7)	7	8.6^{a} (7.2-10.3)
Medium	11	9.4^{a} (8.2-10.7)	10	14.9^{bc} (13.3-16.6)	5	9.7^{a} (8.2-11.5)
High	13	19.2^{c} (17.6-21.0)	11	8.4^{a} (7.4-9.6)	12	13.6^{b} (12.3-15.1)
Low-pitched bleat						
Low	5	14.7^{a} (12.8-16.9)	8	26.3^{d} (18.8-22.7)	6	16.4^{a} (14.4-18.7)
Medium	10	26.4^{d} (24.3-28.6)	10	20.7^{bc} (18.8-22.7)	7	29.3^{d} (26.6-32.3)
High	11	22.5^{c} (20.7-24.4)	10	19.4^{b} (17.9-21.1)	11	25.8^{d} (23.9-27.8)

[1]The number of ewes and lambs that bleated at least once. ^{abcde}Values within each bleat type without letters in common differ (P<0.05).

Low-pitched bleats were also variable among groups. Within the BCS 2.0 group, lambs in the low treatment emitted more low-pitched bleats than those in the medium and the high treatments (P<0.05, Table 2), which did not differ from each other (P>0.05). Within the BCS 3.0 group, lambs in the low treatment emitted more low-pitched bleats than lambs in the medium and high treatments (P<0.05). Furthermore, lambs in the low treatment emitted fewer low-pitched bleats than lambs in the medium treatment but more than lambs in the high treatment within the BCS 2.5 group (P<0.05).

Ewe behaviour and vocalisation

The maternal behaviour score of the ewe was not affected by BCS group, nutrition treatment or their interaction (data not shown).

Number of bleats (Table 2), but not percentage of ewes that bleated (data not shown), differed among BCS groups and nutrition treatments. The highest number of high-pitched bleats were emitted by ewes in the low and high treatments within the BCS 2.0 group, by the low and medium treatments within the BCS 2.5 group and by the high treatment within the BCS 3.0 group (P<0.05).

The number of low-pitched bleats also varied among groups. The fewest low-pitched bleats were emitted by ewes in the low treatment within the BCS 2.0 and 3.0 groups, while within the BCS 2.5 group ewes in the low treatment emitted the highest number of low-pitched bleats (P<0.05).

Discussion

In the current study, 25% of lambs in the low treatment never gained their feet within the five-minute observation period. These results support those of Everett-Hincks et al. (2005) who reported that lambs born to ewes grazing lower sward heights during mid- to late-pregnancy were less likely to stand, locate their dam's udder and follow her. Failing to stand within five-minutes of a disturbance event may indicate low levels of energy and could affect chances of survival in adverse conditions.

Of those lambs that did gain their feet, the time taken for the lambs to suck and follow their dam was not affected by ewe BCS or nutrition in the current study. This was possibly due to the ewes being subjected to a shorter period of low nutrition prior to lambing than in the study by Everett-Hincks et al. (2005). Corner et al. (2010) using similar nutrition regimes as the current experiment also reported no significant effects of nutrition on the time taken for the lamb to suck and follow the dam.

The MBS assesses the strength of the ewe-lamb bond by measuring the distance the ewe moves away from her lambs while they are being handled by a shepherd (O'Connor et al. 1985). Dwyer et al. (2003) reported that severely restricted nutrition reduced ewes' MBS. However, neither ewe BCS nor nutrition affected MBS in the current study, supporting previous research conducted using similar nutrition levels as reported here, albeit for longer periods (Everett-Hincks et al. 2005; Corner et al. 2010).

In this experiment, the number of high- and low-pitched bleats emitted by ewes and lambs differed between treatments. However, the preferable nutrition level depended upon different ewe BCS for all bleating variables. Everett-Hincks et al. (2005) reported no effect of nutrition on ewe vocalisation, however, no previous studies have investigated the effect of both ewe BCS and nutrition on ewe and lamb bleating.

In conclusion, the time taken for lambs to make contact, suck and follow the dam did not differ between treatments and the impacts on vocalisation were variable and of questionable practical application. However, the time taken for lambs to stand was significantly longer for lambs born to ewes managed on pasture masses of 800 to 1000 kg DM/ha during very late pregnancy compared to lambs born to ewes managed on pasture masses above 1200 kg DM/ha. Failure to stand could have significant implications for lamb survival in extensive sheep production systems.

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