

Effect of dam age on the growth and body composition of singleton ram offspring to 11 months of age

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Abstract

Studies in sheep suggest that ewe-lamb dams produce smaller offspring compared to mature adult ewes. This study was designed to examine the growth trajectory, body composition and carcass characteristics of 48 singleton Romney male progeny born to either ewe-lambs (ELP; n = 17) or adult ewes (AEP; n = 21). Both dam groups were maintained together under commercial grazing conditions during breeding, pregnancy and lactation. After, weaning the ram lambs continued to be managed together under commercial conditions. Ram offspring were weighed and measured at birth. They were subsequently weighed every two months until 11 months of age (d322). At d322, nine ELP and 10 AEP were euthanised and several body-size and composition measurements were taken. The ELP were lighter and smaller ($P < 0.05$) at birth compared with AEP and they remained significantly ($P < 0.05$) lighter until d218. After d218 this difference in live weight became a tendency ($P < 0.1$). Slaughter data revealed that ELP tended ($P < 0.1$) to have more visceral fat than AEP ($P < 0.05$). Similarly, dual-energy X-ray absorptiometry (DXA) was performed on the left hind-leg and showed that AEP tended to have greater ($P < 0.1$) lean mass compared with ELP. Despite the liveweight differences and the tendency towards differences in adiposity observed at slaughter, ram lamb carcass weight and dressing-out percentage were unaffected indicating that ram offspring meat production from ewe-lamb dams is similar to that from mature adult ewes.

Keywords: ewe-lamb; mature ewe; male offspring; growth; carcass composition

Introduction

Studies in sheep have shown that lambs born to ewe-lamb dams (hoggets, 8 to 9 months of age at breeding) are lighter and smaller at birth (Joshi et al. 2005; Annett and Carson 2006; Gardner et al. 2007; Schreurs et al. 2010) and at weaning (Safari et al. 2005; Kenyon et al. 2011) than those born to adult ewes. However, the majority of these studies have bred the two dam age groups at different times, often to different rams and/or had different feeding levels during pregnancy. There is a paucity of information comparing offspring born to ewe-lamb dams or adult ewes when both groups have been bred to the same rams and managed together as a single flock throughout pregnancy and lactation. The study of Kenyon et al. (2009), comparing singleton male offspring from ewe-lamb dams to offspring from mature ewe dams, found that rams born to ewe-lamb dams had a tendency to have more abdominal fat. Given the increasing interest in breeding ewe-lambs (also referred to as hoggets), a better understanding of the impacts of maternal age on the growth and carcass characteristics of male progeny is essential and will assist farmers regarding market options for the offspring. The aim of this study was to examine the effect of dam age (ewe-lambs and adult ewes) on the growth trajectory and body composition of singleton male offspring from birth to 11 months of age, when their dams are bred and managed together as a single flock.

Materials and methods

This study was conducted at Massey University's Keeble farm (latitude 41° 10'S, longitude 175° 36'E), 5 km south of Palmerston North, New Zealand. The study occurred between September 2007 and August 2008 and was conducted with the approval of the Massey University Animal Ethics Committee.

Experimental design

The present study utilised 38 singleton Romney ram offspring born to either primiparous ewe-lambs or multiparous mature adult ewes, respectively: creating two progeny groups, ewe-lamb progeny (ELP, n=17) and adult ewe progeny (AEP, n=21). The ram offspring were randomly selected from a larger study, which comprised 296 Romney ewe-lamb dams (8 - 9 months of age at breeding) and 307 Romney mature adult ewe dams (3-7 years of age at breeding) that were progesterone synchronised (CIDR, Pharmacia & Upjohn, New Zealand) (Mulvaney et al. 2013). At breeding (in May) the ewe-lambs weighed 40.6 ± 2.14 kg and the adult ewes were 63.6 ± 2.08 kg. The ewes (ewe-lambs and mature ewes) were naturally bred with mature Romney rams during an interval of 22 days, at a ram to ewe ratio of 1:12. At all times the ewe-lambs and ewes were managed as one group under commercial New Zealand grazing conditions with a minimum post-grazing cover of 1000 kg DM/ha during gestation and 1200 kg DM/ha during lactation (Mulvaney et al. 2013). In the overall study, of which the present ram progeny were a cohort, the mean birth weight and weaning weights of singleton ELP and AEP were 4.0 ± 0.14 kg vs. 5.3 ± 0.14 kg and 16.8 ± 0.56 kg vs. 21.6 ± 0.57 kg, respectively (Mulvaney et al. 2013).

Experimental measures

Within 12 hours of birth (day 1; d1) the ram lambs were weighed (birth weight; BW) and their crown-rump length (CRL), thoracic girth (TG1), fore-leg length (FL), hind-leg length (HL) measurements taken. The ram lambs were weighed again at average d24, d72 (weaning), d128, d218, d297 and d322. At d322 a randomly selected subsample of 19 ram lambs (9 ELP and 10 AEP) were euthanized (captive bolt followed by exsanguination). After slaughter carcass weight was recorded and dressing-out percentage (DO%). Thoracic girth (TG322) was recorded, and weights were taken for liver, heart, spleen, kidneys, lungs, adrenal glands, visceral fat (omental and mesenteric), and remaining visceral tissue mass. The left hind-leg of each animal was collected and stored at -20°C until dual-energy X-ray absorptiometry (DXA). For DXA analysis, the samples were scanned using the Lunar Prodigy (General Electric, Madison, WI), with a dorsoventral projection. The DXA manufacturer's coefficient of variation (CV) was 0.54 % and 1.02 % for bone mineral content (BMC) and lean tissue mass (LM), respectively. Areal bone mineral density (aBMD) was calculated as BMC divided by bone area. Total composition of the hindquarter was determined as the sum of BMC, LM and fat tissue mass (FM). Percentage of fat was calculated by dividing FM by total composition. The ratio of BMC:LM was calculated as BMC divided by LM.

Statistical analysis

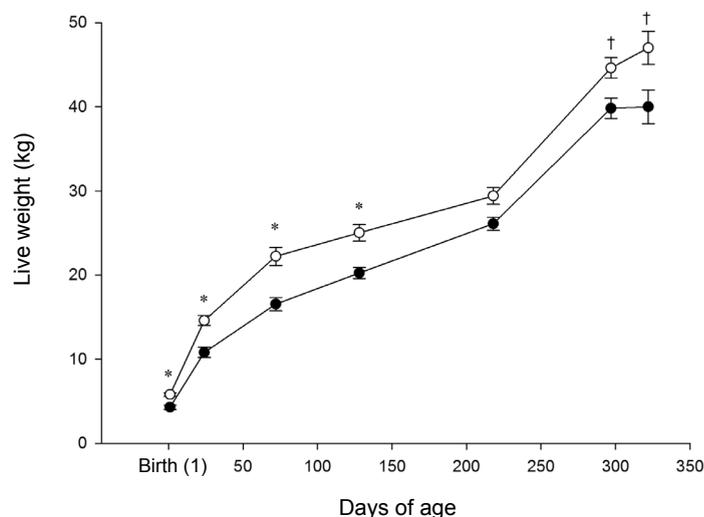
All statistical analyses were performed with Minitab® (version 16, Minitab Inc, Cary NC, USA) using the General Linear Model (GLM) procedure. Lamb live weights were analysed with dam age (EL vs. AE) as a main effect and date of birth as a covariate. Lamb size measurements at birth were analysed using a GLM procedure with dam type as a fixed effect and date of birth as a covariate, and with, and without, BW as an additional covariate. Slaughter data were analysed with dam type as a fixed effect and with, and without, the live weight at slaughter (d322) as a covariate. DXA data were analysed using a GLM procedure with date of birth and carcass weight as covariates and dam type as a fixed effect.

Results

Measurements at birth

At birth, when compared with AEP, ELP were both lighter and smaller (BW: 5.7 ± 0.24 vs. 4.2 ± 0.27 kg; CRL: 56.6 ± 0.94 vs. 51.8 ± 1.06 cm; TG1: 43.2 ± 0.79 vs. 39.4 ± 0.90 cm; FL: 41.6 ± 0.77 vs. 37.2 ± 0.87 cm; HL: 42.0 ± 0.86 vs. 37.5 ± 0.97 cm; for AEP and ELP respectively, $P < 0.05$). When BW was included in the analysis as a covariate the differences in body size dimensions were no longer apparent.

Figure 1 Live weight, from birth (day 1) to average 322 days of age, of ram offspring born to ewe-lambs (●) or adult ewes (○). Data presented are least square means \pm standard error of the mean from analysis without inclusion of birth weight covariate. * indicates values that significantly differ ($P < 0.05$) and † indicates a tendency ($P = 0.06$).



Live weight and liveweight gain after birth

ELP were lighter ($P < 0.05$) at d24 (11.0 ± 0.68 vs. 14.4 ± 0.62 kg), d72 (17.1 ± 1.14 vs. 21.8 ± 0.98 kg) and d128 (20.4 ± 0.97 vs. 24.9 ± 0.89 kg) than AEP, respectively (Figure 1). Live weights were not significantly different ($P > 0.05$) after d218 (Figure 1). However, at d297 (40.4 ± 1.39 vs. 44.2 ± 1.20 kg) and d322 (40.6 ± 1.99 vs. 46.3 ± 1.88 kg), ELP still tended ($P < 0.1$) to be lighter than AEP, respectively (Figure 1). When live weights after birth were analysed with BW as a covariate, there were no differences ($P > 0.05$) in live weight between groups at any time points (data not shown).

Slaughter data

At slaughter (d322) ELP tended ($P < 0.1$) to be lighter than AEP (Live weight: 40.6 ± 1.88 vs. 46.3 ± 2.0 kg; ELP and AEP respectively). There were no differences between groups in DO%, TG322, and weights of heart, lungs, adrenal glands, visceral fat ($P > 0.05$; Table 1); however carcass, spleen, liver and remaining viscera weights of ELP were lighter than AEP ($P < 0.05$; Table 1). When slaughter data were re-analysed with live weight at d322 as a covariate, ELP tended ($P < 0.1$) to have greater visceral fat than AEP (563.4 ± 51.43 g vs. 409.5 ± 54.65 g, respectively). There were no differences ($P > 0.05$) in carcass, spleen, liver and remaining viscera weight after adjustment for d322 live weight (data not shown), nor for any other measures ($P > 0.05$).

DXA data

ELP had less ($P < 0.05$) lean mass than AEP (Table 2). There were no differences ($P > 0.05$) between groups for left hind-leg area, BMC, aBMD, fat mass, total composition, percentage of fat and BMC:lean mass ratio (Table 2). When the DXA measurements were re-analysed with date of birth and carcass weight as covariates, the lean mass difference remained as a tendency ($P < 0.1$) (data not shown).

Table 1 Live weight pre-slaughter, carcass weight, thoracic girth (TG322), dressing-out percentage (DO%), liver, heart, spleen, kidneys, lungs, adrenal glands, visceral fat and rumen/visceral weights at average 322 days of age (d322) of ram lambs born to either ewe-lamb dams or adult ewes. Data are presented as least square mean (\pm standard error of the mean) from analysis without inclusion of d322 live weight covariate.

Parameter	Ram lambs born to:	
	Ewe-lambs (n=10)	Adult ewes (n=9)
Live weight d322 (kg)	40.6 \pm 1.88 ^c	46.3 \pm 1.99 ^d
Carcass weight (kg)	17.7 \pm 0.78 ^a	20.2 \pm 0.82 ^b
TG322 (mm)	6.8 \pm 0.76	8.1 \pm 0.80
DO %	44.9 \pm 1.54	43.0 \pm 1.62
Liver (g)	689.9 \pm 35.62 ^a	809.3 \pm 37.54 ^b
Heart (g)	236.8 \pm 15.43	250.6 \pm 16.26
Spleen (g)	67.7 \pm 4.49 ^a	84.1 \pm 4.74 ^b
Kidneys (g)	119.4 \pm 4.93	134.3 \pm 5.20
Lungs (g)	485.2 \pm 42.66	472.5 \pm 44.96
Adrenal (g)	3.3 \pm 0.16	3.5 \pm 0.17
Visceral fat (g)	471.8 \pm 70.51	511.3 \pm 74.33
Remaining visceral weight (g)	1212.6 \pm 56.56 ^a	1403.2 \pm 59.62 ^b

^{ab} different superscripts within rows indicate values that significantly differ ($P < 0.05$). ^{cd} different superscripts within rows indicate values that tended to differ ($P < 0.10$)

Table 2 Dual-energy X-ray absorptiometry (DXA) measurement of left hind-leg area, bone mineral content (BMC), areal bone mineral density (aBMD), fat mass, lean mass, total composition, fat percentage and BMC:lean mass ratio at slaughter (average 322 days of age) of ram lambs born to either ewe-lamb dams or adult ewes. Data are presented as least square mean (\pm standard error of the mean) from analysis without inclusion of date of birth and carcass weight covariates.

Parameter	Ram lambs born to:	
	Ewe-lambs (n=10)	Adult ewes (n=9)
Area (cm ²)	231.6 \pm 11.30	250.0 \pm 11.94
BMC (g)	135.3 \pm 9.65	158.5 \pm 10.20
aBMD (g/cm ²)	0.6 \pm 0.02	0.6 \pm 0.02
Fat mass (g)	810.6 \pm 76.13	877.8 \pm 80.42
Lean mass (g)	2686.2 \pm 113.38 ^a	3152.8 \pm 119.76 ^b
Total composition (g)	3632.1 \pm 180.01	4189.0 \pm 190.15
Percentage Fat (%)	21.9 \pm 1.32	20.6 \pm 1.40
BMC:Lean mass ratio	0.05 \pm 0.0018	0.05 \pm 0.0019

^{ab} different superscripts within rows indicate values that significantly differ ($P < 0.05$)

Discussion

This study was designed to compare the growth and carcass composition of singleton male progeny born to primiparous ewe-lambs or multiparous adult ewes mated at the same time to the same rams and managed together under commercial conditions. The present study found that singleton male offspring born to ewe-lamb dams (ELP) were lighter at birth compared with singleton male offspring born to adult ewe dam (AEP). This is in agreement with findings from other sheep studies (Dýrmondsson 1973; Corner et al. 2013; Kenyon et al. 2014).

In the present study, ELP remained lighter than AEP until approximately four months of age and tended to remain lighter until 11 months of age. These findings support those of Craig (1982) who found that progeny born to ewe-lamb dams were lighter than those born to adult ewes at birth and remained lighter until 11 months of age. The observed differences in live weight to weaning are likely due to the combined influence of lower birth weight and lower milk production in young dams (Nicol and Brookes 2007), both of which affect lamb growth (Kenyon et al. 2004).

Under the conditions of the present study, despite the lower live weights of ELP, there was little impact on carcass weight or carcass characteristics, with only minor effects on adiposity. At slaughter, there was a tendency for greater levels of visceral fat in ELP compared with AEP, matching the previous results found by Kenyon et al. (2009). Additionally, DXA of the hind-leg indicated that ELP had less lean mass compared with AEP, however, the amount of fat in the hind-leg did not differ. Afolayan et al. (2007), compared the carcass traits of progeny born to ewe-lamb dams and adult ewes and reported that offspring born to ewe-lamb dams displayed a greater level of carcass fat (fat measured over the maximum depth of eye muscle) and lower carcass weight compared with lambs born to mature ewes.

In the contemporary sheep-meat industry there has been a focus on breeding for leaner carcasses (McPhee et al. 2008). The present study provides evidence for greater adiposity in male offspring born to ewe-lamb dams, and whilst carcass value is affected by the level of fatness (McPhee et al. 2008), the higher levels of adiposity observed here are unlikely to affect the economic value of the carcass. Additionally the findings reported here indicate that at 11 months of age, meat production performance of male progeny born to ewe-lamb dams is comparable to that of male progeny born to adult ewes.

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