

Influences on fetal and placental weights during mid to late gestation in prolific ewes well nourished throughout pregnancy

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Abstract. This study investigated associations between fetal and placental weights from 85 to 130 days gestation in 49 fetuses from 21 ewes of a prolific genotype used as an experimental model of intrauterine growth retardation. The proportion of variation in fetal weight explained by placental weight increased from zero at 85 days to 91% (residual standard deviation (RSD) = 260 g) at 130 days. Overall, stage of pregnancy plus placental weight accounted for 96% of fetal weight variation (RSD = 212 g). Litter size and number of fetuses per uterine horn also influenced individual fetal weights. Gestational age, litter size, placental weight per ewe, and liveweight and condition score of ewes during early to mid gestation (initial LW and CS) explained 99.5% of the variation in fetal weight per ewe (RSD = 236 g). Most variation (86%) in placental weight was explained by stage of pregnancy, litter size, number of placentomes, and initial LW and CS (RSD = 53 g). Placental weight per ewe was influenced by stage of pregnancy, litter size and initial ewe LW and CS ($R^2 = 0.97$; RSD = 89 g). The association of fetal and placental weights with initial ewe LW was positive, and with initial CS was negative. The results show that in the absence of overt nutritional restriction of pregnant ewes, fetal and placental weights are tightly coupled during late gestation and ewe fatness during early pregnancy is inversely related to placental and fetal weights. They demonstrate that placental weight explains most of the variation in fetal weight in the present intrauterine growth retardation model.

Extra keywords: fetus, nutrition, placenta, sheep.

Introduction

We have previously reported the use of a natural, fetal growth retardation model to investigate the effects of intrauterine growth on fetal, newborn and neonatal sheep (Greenwood *et al.* 1998, 1999a, 2000). The model uses well-nourished, prolific ewes to provide a high level of variation in both weight for fetal age and weight at birth.

Fetal growth during mid to late gestation is regulated by the mass (Alexander 1964; Stegeman 1974; Mellor 1983) and functional capacity (Ehrhardt and Bell 1997) of the placenta, by maternal nutrition (Mellor and Murray 1981) and by the genotypes of the dam and the fetus (Hammond 1944; Ferrell 1991). In prolific ewes, litter size and uterine distribution of fetuses are also important determinants of fetal weight, such that within-litter variation in fetal weight increases as litter size increases (Rhind *et al.* 1980; McDonald *et al.* 1981).

The objective of this study was to determine the degree to which utero-placental and other factors are associated with fetal and placental weights during mid to late gestation in prolific ewes in the absence of overt maternal nutritional restriction during pregnancy.

Materials and methods

Experimental animals

All procedures were performed with the approval of the Cornell University Institutional Animal Care and Use Committee. Fifty-five Finnsheep × Dorset ewes were obtained from a flock at the Cornell University Mt Pleasant Sheep Farm and managed as a separate group as previously described by Greenwood *et al.* (1999a). A vasectomized ram was maintained with these ewes to identify ewes in oestrus, which were then segregated from the flock and mated to a Suffolk ram. Prior to mating and for the first 50–60 days of pregnancy, ewes were offered pasture hay *ad libitum* plus an average daily allowance of 450 g of barley. Pregnancy status was diagnosed at approximately 40 days gestation and litter size estimated at approximately 50 days (White and Russel 1987) by an experienced ultrasonographer (R.M.S.) using an Aloka 210 ultrasound unit fitted with a 3.5 MHz or 5 MHz transducer (Corometrics Clinical Systems, Wallingford, CT, USA).

Thirty pregnant ewes were selected to provide litter sizes ranging from singletons to quadruplets. They were moved to the Cornell University Large Animal Research and Teaching Unit (LARTU) at 50–60 days of gestation. Ewes were penned in two equal sized groups based on stage of pregnancy, and were group-fed daily a total mixed ration (TMR) comprising 90.9% dry matter (DM), 2.60 Mcal metabolizable energy, 155 g crude protein and 215 g acid detergent fibre per kg DM, and including 2% of a mineral mix. The daily allowance was calculated from average estimated requirements for