Impact of maternal stress and nutrition on behavioural and physiological outcomes in young lambs

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Abstract

The pre-natal period is of critical importance in defining how individuals respond to their environment throughout life. Stress experienced by pregnant females has detrimental effects on offspring behaviour, health and productivity. The sheep (Ovis aries) has been used as a model to inform human studies; however, in a farming context, the consequences for the lamb of stress experienced by the ewe have received less attention. The stressors that pregnant ewes are most frequently exposed to include sub-optimal nutrition and acute and chronic stressors related to husbandry and the environment. This review focuses upon the young sheep, from around 100 days old until adulthood and uses material identified from a systematic survey of the literature relating to production-relevant maternal stressors and lamb outcomes. Overall, the results demonstrated that stressors imposed upon the ewe altered progeny behavioural and physiological responses. However, detailed analysis of the literature shows several deficiencies in the field, as a whole, which greatly limit the ability to draw conclusions as to how welfare may be affected by pre-natal challenges in commercial sheep. These deficiencies included a lack of consistency in response due to the variety of both stressors imposed and responses measured. Key gaps in knowledge include the impact of ewe disease during pregnancy on outcomes for their progeny and more generally how different commercially relevant stressors interact. Furthermore, there is a need to develop a systematic series of behavioural and physiological measures that can be integrated to provide a holistic and practically applicable picture of offspring welfare.

Keywords: animal welfare, gestation, practical application, offspring response, sheep, stress

Introduction

Previous research has shown that sub-optimal maternal nutrition, stress or ill health during pregnancy can affect how offspring develop before birth, with implications for their later biology (Sinclair et al 2016). In farm animals, maternal state may therefore be an important contributor to health, welfare and productivity of progeny, and paying closer attention to gestation management could contribute to improvements in these parameters on farms (Rutherford et al 2012).

The long-term consequences of changes in the fetal environment have been well-recognised since the first reports (Barker et al 1989) describing epidemiological data linking birth weight and later health in humans. In other epidemiological studies, the children born to mothers who were pregnant during the Dutch famine in 1944–1945 experienced increased incidence of inter alia, type II diabetes and cardiovascular disease (Lumey et al 2011). Other negative human health outcomes have also been seen following stress during pregnancy (eg King et al 2012). These adverse effects are generally classified under the developmental origins of health and disease hypothesis (Gluckman & Hanson 2004) and are likely mediated by epigenetic, non-Mendelian inheritance (Ford & Long 2012). Amongst the variety of animal models used to investigate underlying mechanisms, the sheep (Ovis aries) has proved popular since it is similar to the human in respect of maternal and fetal sizes, organ development and maturity at birth (Luther et al 2005). To date, however, less emphasis has been placed upon the consequences of disturbances to the fetal environment for the health and welfare of the offspring than on endpoints associated with cardiovascular disease and diabetes. This is of increasing relevance as the current status of legislation on the welfare of fetal animals (for a review, see Campbell et al 2014) does not reflect current understanding particularly in the context of post-natal consequences.

In cattle (Bos taurus), Arnott et al (2012) identified a wide variety of stressors the dam could be exposed to during gestation and which may perturb the uterine environment with adverse consequences for the subsequent welfare and health of the offspring. The stressors identified included under-nutrition, social stress imposed by management practices, such as stocking density, acute stress from handling and transport and thermal stress by being maintained outside the thermoneutral zone. Arnott et al (2012)