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A longitudinal study of factors associated with acute and chronic mastitis and their impact on lamb growth rate in 10 suckler sheep flocks in Great Britain

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ABSTRACT

A 2-year prospective, longitudinal study of 10 suckler sheep flocks in Great Britain was run to identify factors associated with acute mastitis (AM) and chronic mastitis, and their impact on lamb growth rate. Data were collected on AM, intramammary masses (IMM; a marker for chronic mastitis), udder and teat conformation, teat lesions, body condition, ewe nutrition, litter size, lamb weight and general flock management. Each flock was visited twice each year, approximately 4 weeks before lambing and 9 weeks into lactation, for two years and all ewes present at a visit were examined. There were 7021 examinations in total. AM was reported in 2.1–3.0% of ewes/year; this ranged from 0.0% to 37.1% by flock. IMM were detected in 4.7% of ewes in pregnancy and 10.9% of ewes in lactation. Once an IMM had been detected there was an increased risk of future IMM although IMM were not consistently present. The majority of ewes had good udder conformation to suckle lambs. Factors associated with AM, IMM in pregnant and lactating ewes, udder conformation and lamb daily live weight gain were explored using mixed effect multivariable models. An increased risk of AM was associated with underfeeding protein in pregnancy (OR 4.05), forward pointing teats (OR 2.54), downward pointing teats (OR 4.68), rearing ≥ 2 lambs (OR 2.65), non-traumatic teat lesions (OR 2.09); and marginally associated with the presence of IMM. An increased risk of IMM in lactation was associated with AM during lactation (OR 12.39), IMM in pregnancy (OR 4.79), IMM in the previous lactation (OR 4.77), underfeeding energy in pregnancy (OR 6.66) and traumatic teat lesions (OR 2.48). An increased risk of IMM in pregnancy was associated with IMM in the previous pregnancy, IMM in the previous lactation and underfeeding energy in the previous lactation (OR 2.95). Lower lamb daily live weight gain was associated with traumatic teat lesions, IMM in lactation (−0.01 kg/day) and AM (−0.04 kg/day). We conclude that inadequate nutrition is an important cause of mastitis in suckler ewes which farmers could address in part using current nutritional guidelines but further work is needed. The relationship between AM and IMM indicates that separating or culling ewes with IMM would help reduce AM.

1. Introduction

In ewes, acute mastitis (AM) can lead to sudden death, loss of an affected udder half, chronic intramammary infection detected as masses (abscesses) in the mammary gland, raised somatic cell count (SCC), or full recovery. Farmers have reported a flock incidence of AM of 0–5% per year in England and Ireland (Cooper et al., 2016; Onnasch et al., 2002), although the true figures might be higher. It has been suggested that farmers under-report AM, even in dairy ewes that are observed more frequently than suckler ewes (Lafi et al., 1998). Anecdotal reports from farmers indicate that 20–30% of ewes culled from the flock at weaning have udder damage from AM or chronic mastitis with palpable intramammary masses (IMM). Given that the average replacement rate in suckler flocks in the UK is 20%, this amounts to approximately 8% of the national flock removed because of mastitis each year.

The economic costs of mastitis for the farmer therefore come from treatment costs, costs of replacement ewes when ewes die or are prematurely culled (due to losing the function of one or both glands or other udder damage such as IMM), reduced income

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from loss of lambs and for ewes with a SCC > 400,000 cells/ml milk, reduced milk production that causes slower growth rates in lambs (Arsenault et al., 2008; Huntley et al., 2012). AM is also a significant welfare concern; it is a painful disease that can lead to death while ewes with IMM are often prematurely culled by farmers. AM and IMM both affect milk production (Arsenault et al., 2008; Huntley et al., 2012) which impacts negatively on lamb health and welfare.

Larger litter size, older age, a previous case of mastitis, breed, management systems and geographical region are all reported risk factors for AM (Arsenault et al., 2008; Larsgard and Vaabenoe, 1993; Pereira et al., 2014; Waage and Vatn, 2008) indicating that both individual ewe and environmental factors are involved in disease pathogenesis. Poor body condition has been linked to increased risk of subclinical mastitis (Arsenault et al., 2008; Huntley et al., 2012), clinical mastitis (Onnasch et al., 2002) and traumatic teat lesions (Cooper et al., 2013) and so poor nutrition is also likely to be an important risk for mastitis.

In dairy sheep, good udder conformation is associated with a decreased risk of mastitis (Casu et al., 2010). A number of linear scoring systems of udder traits have been developed in European dairy sheep to assess udder conformation (de la Fuente et al., 1996; Marie-Etancelin et al., 2005; Casu et al., 2006). In some dairy breeds udder traits, such as vertically aligned teats (Labussière, 1988), have been included in breeding programmes with the aim of improving machine milking ability (de la Fuente et al., 1996; Marie-Etancelin et al., 2005; Casu et al., 2006). In suckler ewes an optimum teat angle of 45° downwards to the horizontal (score 5 in Casu et al., 2006) was associated with greater weight gain in lambs (Huntley et al., 2012) and decreased risk of traumatic teat lesions caused by lambs (Cooper et al., 2013) than other teat angles. This indicates that suckler and dairy ewe 'ideal' udder conformation varies for some traits. Other traits are uniformly consistent, for example, dairy ewes with pendulous udders and teats placed high on the udder are more prone to poor udder health (Casu et al., 2010) and in suckler ewes pendulous udders are associated with higher milk SCC (Huntley et al., 2012).

A common practice among suckler sheep farmers is to check the udder of each ewe at the end of lactation or 6 weeks before the start of the breeding season. Ewes with udder damage or IMM are often, but not always, culled. The impact of this practice is unknown; possible hypotheses include that it reduces onward transmission of bacterial strains causing mastitis, reduces the number of slow growing lambs in a flock, reduces the selection of replacement lambs from ewes with chronic mastitis and slows down the selection of more susceptible offspring.

The aims of this study were to examine the hypotheses above, by investigating ewe risks for, and inter-relationships between, AM, IMM and udder conformation and their impact on lamb growth rate, in approximately 4000 ewes observed prospectively for two years.

2. Materials and methods

2.1. Selection of study farms

Study farms were identified from farmers with existing relationships with the University of Warwick and from a list of farmers interested in participating in research on mastitis provided by AHDB Beef & Lamb. Farmers who expressed an interest were visited by Edward Smith (EMS) and Laura Green (LEG) and the project was explained in full. Once farmers agreed to participate, informed consent was obtained; participants were free to withdraw from the project at any stage. We aimed to recruit 4000 ewes, assuming that 8% of ewes would have udder abnormalities, this sample size had a power of 80% with 95% significance to detect factors that double the risk of disease, assuming a minimum exposure of 10%.

2.2. Data collection

Data collection occurred from November 2012 to July 2014. Each flock was visited twice each year, once when ewes were in late pregnancy and once when ewes were in mid-late lactation. Farmers were interviewed to gather information on flock management and nutrition. Data on number of lambs in pregnant ewes at scanning, lambing dates, litter size and lamb birth and 8-week weights were obtained from farm records. Farmers were asked to record all cases of AM treated during each lactation; this was part of their routine prior to participation in the study. In addition, researchers took note of any ewe they observed with AM during the examination in lactation. If that ewe was missing from the farmer's records it was added to the list of ewes with AM used in the analysis.

Every ewe was inspected at each visit. Sheep were examined upright in the narrowest portion of a race, while held by a clamp, or while restrained by an assistant. Udder conformation scores were assessed from a kneeling/crouched position behind the ewe using sight and touch. One of two trained researchers (EMS or CG (Claire Grant)) examined the ewes. An assistant recorded data into a handheld data-logger (Agrident APR500) using custom-designed software (Border Software Ltd).

At the examination during pregnancy, ewe identification, body condition score (BCS: 0–5 in 0.5 increments; Defra PB1875) and the presence/absence of IMM in each udder half were recorded. Masses were defined as a physically detectable mass of abnormal consistency compared with the rest of the glandular tissue. At the examination during lactation, ewe identification, BCS and the presence/absence of IMM in each udder half were also recorded. In addition, udder conformation, including teat position, teat angle, udder drop and degree of separation of udder halves; was recorded using a linear scoring system of udder traits adapted from Casu et al. (2006) and similar to that reported in Cooper et al. (2013) (Fig. S1). Udder width was measured at the widest point of the udder (1 cm increments) and teat length was recorded by measuring the left teat in 0.5 cm increments. The presence of wool on the udder was recorded, as were any teat lesions, recorded as traumatic (broken skin) or non-traumatic (e.g. warts, spots, orf-like lesions).

Two researchers carried out the examinations, so an inter-rater reliability study was conducted to test between observer variability. Both researchers (EMS and CG) carried out the examination during lactation on the same 137 ewes at different times on the same day supported by different assistants.

Nutrition was assessed by taking representative samples of forage and concentrates and submitting them to Sciantec Analytical Services (Selby, Yorkshire, England) for analysis. The metabolisable energy (ME; MJ/kg), crude protein (CP; %), moisture (%), ash (%), oil-b (%) and dry matter (DM; %) content of the concentrates; and the DM (g/kg), CP (g/kg), oil-b (g/kg), ash (g/kg), neutral detergent fibre (NDF; g/kg), acid detergent fibre (ADF; g/kg), sugar (g/kg), D value (digestibility of the dry matter) (%), ME (MJ/kg) and digestible energy (DE; MJ/kg) of the forages were determined. Silage samples were analysed for intake and fermentation characteristics, effective rumen degradable protein (ERDP; g/kg), digestible undegraded protein (DUP; g/kg) and nitrogen solubility. Spring and winter grass (nutrition value assumed to be 12.3 MJ/kgDM and 19% CP and 10.8 MJ/kgDM and 17% CP respectively) was assumed to be in sufficient supply to meet the appetite of the ewes in combination with any supplementary feeds offered, unless otherwise advised.

ADAS UK Ltd., were contracted to carry out analysis of each farm's nutritional data using the ADAS Sheepfeed rationing program (a computer program based on the Agricultural and Food Research Council (Great Britain) 1993 advisory manual on the energy and protein requirements of ruminants (AFRC, 1993)) and Microsoft Excel 2010 (Microsoft Corp., Redmond, WA) for grass based diets. Adequacies of energy and protein levels were