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Positive and negative gestational handling influences placental traits and mother-offspring behavior in dairy goats

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HIGHLIGHTS

- Dairy goats are sensitive to differential handling during pregnancy.
- Aversive prenatal handling can cause fetal loss and alter placental morphology.
- Prenatal handling stress delays behavioral development in neonates.
- Positive prenatal handling results in an enhancement of maternal care.

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ABSTRACT

Dairy animals are subjected to a number of potential stressors throughout their lives, including daily interactions with humans. The quality of these interactions may have direct consequences for the animal undergoing the experience, but if such events occur during gestation it may also affect the developing fetus. This study examined the effects of differential handling during mid-gestation in 40 twin-bearing Saanen × Toggenburg primiparous goats. Between days 80 and 115 of gestation (gestation = 150 days), goats were subjected to aversive (AVS, n = 13), gentle (GEN, n = 13) or minimal (M, n = 14) handling protocols for 10 minute periods twice daily. The control (M) group did not receive handling treatments and all goats received normal husbandry procedures outside treatment periods. Salivary cortisol measured during the treatment period was higher in AVS goats (mean cortisol (sem) in pg/μl: AVS: 176.7 (18.2), GEN: 119.6 (11.1), M: 126.5 (13.7); $P = 0.007$). Data collection was focussed on mother-offspring behaviors 2 h post-partum, placental morphology and colostrum quality. AVS goats were the only treatment group to suffer fetal loss (16% loss vs 0% in GEN and M, $P = 0.05$). Treatment also influenced placental morphology with a tendency for fewer cotyledons evident in placentae from the aversive treatment (AVS: 87.9 (7.8), GEN: 107.1 (7.9), M: 112.1 (9.3), $P = 0.093$), and significantly fewer medium sized cotyledons (AVS: 67.6 (7.8), GEN: 89.3 (6.4), M: 84.3 (5.4), $P = 0.042$). GEN goats displayed more grooming and nosing behaviors towards their young during the first 2 h post-partum (grooming: GEN: 89.3% (7.1), AVS: 72.6% (7.7), M: 63.4% (9.0), $P = 0.045$; nosing frequency: GEN: 58.8 (12.5), AVS: 28.6 (11.1), M: 34.7 (6.5), $P = 0.021$). There was an overall trend for kids from mothers experiencing the AVS treatment to take longer to stand, reach the udder and suck compared to kids from GEN and M treatment groups. Treatment significantly affected latency to perform play behavior, with kids from AVS goats taking on average 25 min longer to play for the first time than kids from GEN and M treatment groups ($P < 0.001$). The results show that handling during gestation affects placental morphology, fetal survival and post-partum maternal behaviors, and influences kid behavioral development. Such results have important animal welfare implications, demonstrating that negative handling of pregnant females results in poorer placental quality with potential for fetal loss. It also demonstrates the beneficial effects of positive handling on enhancement of maternal behaviors.

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1. Introduction

It has become increasingly evident that an animal's early life experiences can have both short- and long-term consequences for its behavioral and physiological responses, health and wellbeing. This phenomenon is known as "early-life programming" [4, 46] and if such experiences are deemed stressful, and occur at a period of time when specific tissues are at a sensitive stage of development, the impact can be detrimental. Studies of prenatal stress (PNS) have largely been focussed in altricial species under laboratory conditions investigating paradigms that are not necessarily relevant across species [44]. The main intention of such studies is translational; using rodents to model conditions in humans. Extrapolating studies in rodents to other mammals may result in a number of inaccurate conclusions, particularly when looking at the effects of PNS on brain development as the maturation of the rodent brain peaks much later in pregnancy than it does in more precocial species. The growing body of literature on early-life programming demonstrates that the effects of PNS are highly sensitive to species, sex, relevance and timing of the stressor (for reviews: [5, 8, 44]).

Farm animals can experience a number of stressors throughout their lives including social (e.g. high stocking densities, dynamic mixing), isolation or handling stress (e.g. restraint, gathering). It is becoming increasingly evident that when pregnant livestock experience such stressors there can be substantial risks of undesirable early-life programming effects for their developing offspring as well as direct cognitive and emotional impacts on the mother. For example, in pigs, disrupted hierarchies and social defeat experienced by sows subjected to dynamic mixing (a social stressor) during gestation resulted in substantial PNS effects; offspring experienced greater stress and pain reactivity [43], poorer growth rates and transgenerational effects were observed whereby female offspring of PNS mothers showed abnormal maternal care [45], including increased savaging behavior [26]. Pregnant sheep and goats can experience a number of stressors in the months preceding parturition; they may be gathered from a largely remote existence under extensive conditions and brought inside to experience higher stocking densities and more forced social interactions with conspecifics and humans. In goats Vas et al. [49] demonstrated that reduced space accompanied by increased stocking densities resulted in greater incidences of defensive and offensive behavior [49], and increased fearfulness in the offspring when subjected to social and isolation tests [9]. Similar results were reported in sheep by Averós et al. [3] demonstrating increased emotional reactivity and fear responses in lambs from mothers experiencing high stocking densities during pregnancy.

One potential stressor of particular relevance to livestock species is the interactions they experience with humans. Dairy goats are subjected to daily interactions with stockworkers and it is the quality of those interactions which could influence the affective state of the animal and have important implications for its well-being. Coulon et al. [11] found that aversively handled pregnant sheep produced offspring that were more fearful. In contrast Roussel-Huchette et al. [42] reported a reduction in lamb fear levels when their mothers were exposed to repeated isolation and transport stress during late gestation. There is little consensus in the literature regarding the effects of handling treatments. In addition it is notable that the majority of handling experiments have investigated the effects of negative interactions rather than applying a positive treatment. Hild et al. [24] and Coulon et al. [11] are an exception; in sheep they applied a gentle and an aversive handling protocol and focussed on studying subsequent offspring brain and behavioral development. Their results centred on evidence of detrimental effects from the aversive treatment rather than positive outcomes from the gentled treatment. However this aspect of prenatal handling warrants further investigation in different species. It is known that stressful early-life experiences can be mitigated via altered maternal behavior [35] and if maternal behavior can be enhanced via positive interactions with humans there maybe long-term benefits for offspring.

Waiblinger et al. [52] assessed the human-animal relationship in farm animals, stating that there is an emotion-based classification of an animal's perception of humans which results in three main categories: frightening (resulting in fear or avoidance responses in human presence), neutral (neither a fear response or a positive reaction such as approach), or pleasant (resulting in an approach response or human presence can be reassuring under adverse conditions). The aim of the current study was to create a paradigm that evokes these negative, positive and neutral perceptions in pregnant dairy goats in order to investigate the influence different affective states have on the mothers as well as their developing offspring.

2. Materials and methods

2.1. Ethical statement

This study was reviewed and approved by the SRUC Ethical Review Committee (approval ID: ED AE 50-2012). All animal management procedures were adhered to by trained staff.

2.2. Animals, housing and feeding

Forty mixed breed (Saanen × Toggenburg) primiparous goats were used in this study. Following an ultrasound scan at approximately 60 days post-service 36 were confirmed as bearing twins, and four as single-bearing. In the barn used for the experiment the goats were initially housed as one single group (as they had been prior to selection). All goats were familiar to each other. The research barn was naturally ventilated with deep straw bedding. Following acclimatisation to the new barn, goats were randomly allocated to one of three handling treatment groups (aversive, gentle and minimal) and put in one of three identical pens per treatment group (4–5 goats per pen, 2.5 m wide,

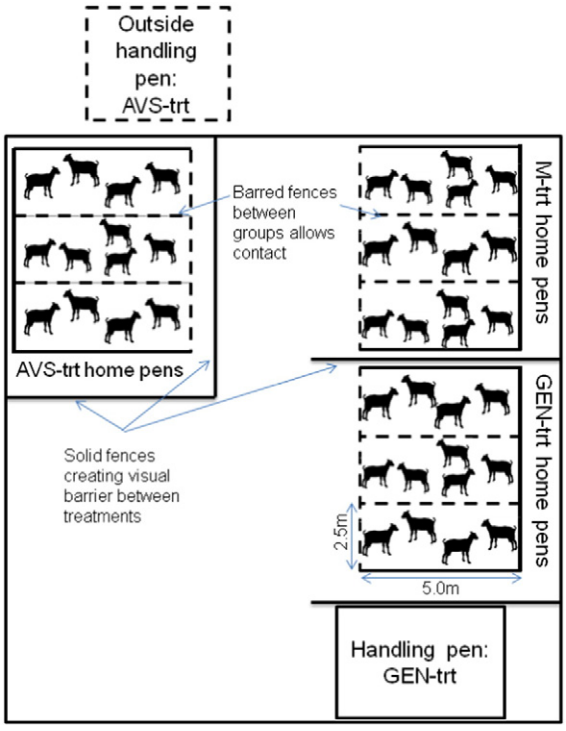

Fig. 1. Diagram (not to scale) of experimental barn showing the pen arrangement and group sizes during the treatment period. Solid-sided partitions maintained a visual barrier between treatment groups, whilst barred partitions between pens within treatment allowed groups of goats to make contact. These barred partitions were removed on completion of the treatment period and goats kidded in larger pens within treatment.