Study demonstrates poor maternal nutrition during gestation in sheep alters prenatal muscle growth and development in offspring

By Lindsay Pressman

In livestock, poor maternal nutrition during gestation can have immediate and life-long effects on offspring growth and health, which can lead to reduced product quality and increased costs of production. Evidence demonstrates that poor maternal nutrition, either restricted or excessive macro- or micro- nutrient intake during pregnancy can have negative effects on tissues, organs, and cell lineages in offspring pre- and post-natally. This can predispose offspring to alterations in metabolic and endocrine regulation of growth and maintenance as a long-term consequence of fetal programming. Both restricted- and over-feeding are known to reduce postnatal muscle mass, which is likely to reduce insulin sensitivity, altering insulin-mediated metabolic pathways and adequate postnatal muscle development. This is dependent upon prenatal myogenesis and muscle development; however the mechanisms contributing to these changes are not completely understood. This research paper published in the Journal of Animal Science by Mary C. Gauvin et al., entitled “Poor maternal nutrition during gestation in sheep alters prenatal muscle growth and development in offspring”, explores the mechanisms of myogenic progenitor cells and the global expression of genes contributing to changes in growth and development of offspring muscle prenatally. This is involved in prenatal muscle development and function in Western White-faced offspring, using transcriptomic and immunohistochemical approaches when evaluating the effects of both diets.

Animals were individually housed and assigned to one of three diets adjusted weekly based on individual ewe body weight until day 45, 90, or 135 of gestation and one group until parturition. Muscle samples for histological analysis were collected from the subsets of fetuses

and lambs mid-belly of the longissimus dorsi (muscle along the back), semitendinosus (hamstring muscle located in the back of the thigh), and triceps brachii (muscle on the back of the upper limb) to coincide with developmental periods of myogenesis, at each time point, including an early postnatal time point. Muscle fiber cross-sectional area, number of primary and secondary fibers, and percentage of paired box (PAX)7 positive [PAX7(+)] progenitor cells, a key marker of myogenic progenitor cells in prenatal development and satellite cells (muscle stem cells) during postnatal development, were visualized using immune-histological procedures. Longissimus dorsi tissue samples were collected from a subset of male fetuses at day 90 and day 135 of gestation and lambs at birth and RNA was isolated for RNA-Seq analysis.

The authors concluded that both restricted- and over-feeding during gestation alter the population of myogenic cells expressing PAX7 in a muscle-specific manner in the offspring, and that one mechanism by which maternal diet impairs postnatal offspring muscle growth may be through a limited progenitor cell population. The gene expression of several biological processes and molecular functions are also altered during fetal myogenesis in support of increasing protein accretion, muscle function, and increased metabolic activity. It was concluded that poor maternal nutrition during gestation contributes to altered offspring muscle growth during early fetal development which persists throughout the fetal stage. The authors suggest that based on muscle-type specific effects of maternal diet, it is important to evaluate more than one type of muscle to fully elucidate the effects of maternal diet on offspring muscle development. Additionally, further analysis of these genes, their proteins, and mechanisms contributing to altered muscle growth and metabolism in offspring are necessary.

“For the past 8 year, our Fetal Programming Group, including myself, Steve Zinn, and Sarah Reed, in the Animal Science Department have developed a well-established model of poor maternal nutrition during gestation in sheep to further our understanding of the impacts of fetal programming on livestock production including growth, health, and well-being of offspring. In addition to demonstrating that poor maternal nutrition impairs offspring growth, muscle development, metabolism, and stem cell function, we are currently conducting studies to elucidate the mechanisms at the cellular and whole body level as well as multigenerational effects of maternal diet. The long-term goal is to identify management tools to improve health and production of these offspring to improve production efficiency and reduce costs for producers and consumers.” -Dr. Kristen Govoni

To view the full article, Gauvin, Mary C., Sambhu M. Pillai, Sarah A. Reed, John R. Stevens, Maria L. Hoffman, Amanda K. Jones, Steven A. Zinn, and Kristen E. Govoni (2020). Poor maternal nutrition during gestation in sheep alters prenatal muscle growth and development in offspring, visit: *Journal of Animal Science* 98. J Anim Sci. 2020 Jan 1;98(1). pii: skz388. doi: 10.1093/jas/skz388.

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