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EFFECT OF PRENATAL STRESS ON CALVES' PLASMA CORTISOL RESPONSES, BODY WEIGHTS, AND PITUITARY GLAND WEIGHTS

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Background. During fetal development, an individual is susceptible to change and many environmental factors are known to alter the physiology and morphology of the developing fetus. Stress appears to be an especially potent factor that can cause permanent changes in the developing fetus. Rodents who were exposed to prenatal stress have certain areas of the brain enlarged, a greater number of corticosterone receptors in the hippocampus, and an increased ability to cope with stress when mature. If this effect occurs in cattle, the deleterious effects of stress associated with some production practices could be decreased. In the following study, cows were stressed during pregnancy to determine what effects prenatal stress had on their calves' morphology and response to restraint stress.

Experiment. Seventy-seven pregnant Brahman cows were randomly assigned to one of three treatments: 1) transported in a stock trailer for 14 miles, unloaded at a second farm and penned for 1 h and then returned to the original farm (TR); 2) i.v. injections of ACTH, 1 IU/kg BW (ACTH); or 3) controls who merely walked through the facilities (C). Treatments were repeated at 60, 80, 100, 120, and 140 d of gestation. The ACTH treatment was included to cause concentrations of plasma cortisol that were comparable with concentrations that occurred in the TR cows so that we could determine if plasma cortisol may be responsible for changing the developing fetus. Twelve calves (n = 6 for TR and C) were taken by Cesarean section and sacrified at 266 d at gestation. The remaining calves were allowed to be delivered naturally. For the Caesarean-sectioned calves, body, adrenal gland, and pituitary gland weights were recorded. The remaining calves were delivered naturally and 21 of these calves (n = 7 for TR, C, and ACTH) were challenged with restraint at 10 and 150 d of age for 3.5 h while heart rates and blood samples were recorded. A second group of 21 calves (n = 7 for TR, C, and ACTH) were restrained and given an injection of ACTH (.125 IU/kg BW) at 10 and 150 d of age. The injection of ACTH should maximally stimulate the adrenal gland and help determine its capabilities to secrete cortisol.

Caesarean-sectioned calves taken from dams that had been transported during gestation had larger body weights and pituitary glands ($P < .08$) but not adrenal glands ($P > .4$; Table 1) than calves taken from C cows. When the remaining calves, who were born naturally, were subjected to restraint at 10 and 150 days of age; the TR and ACTH calves exhibited plasma cortisol concentrations that were maintained for a longer duartion than the calves from the SHAM treatment (Table 2). There were no treatment differences between calves who were restrained and given an injection of ACTH at either 10 or 150 days of age (P > .2).

Implications. Repeated activation of the hypothalamic-pituitary-adrenal axis during pregnancy produced not only larger body weights but heavier pituitary glands as well. Because such an important organ and was affected by stress during gestation, the effects of prenatal stress are likely to be profound. Prenatal stress also causes cattle to maintain elevated plasma cortisol concentrations for a longer duration when challenged with restraint. The elevated concentration may enable the calf to better cope with this mild stressor. Further research is warranted to determine the long term effects of prenatal stress on reproduction, growth, and the stress response.

Table 1. Data for calves delivered by Caesarean-section on day 266 of gestation. Organ weight data are adjusted according to body weight (gm per kg body weight).

	Body weight (lb)	Pituitary gland (gm/kg)	Adrenal gland (gm/kg)
Transported	63.7 ± 5.6^a	$.013 \pm .0007^a$	$.03 \pm .002$
Control	53.1 ± 2.4^b	$.008 \pm .002^b$	$.02 \pm .004$

^{a,b}Numbers within the same column with different superscripts differ (P < .08).

Table 2. Least square means (± SE) for cortisol (ng/ml) during restraint at 10 and 150 days of age. The column headed with an "n" denotes the number of animals in each treatment (Trt).

			Time (min)								
	n	TRT	-15	0	15	30	45	60	90	120	180
10 days	5	SHAM	19±6	26±6	24±7	26±5	26±3	25±4	23 ± 4^a	10 ± 4^a	9 ± 4^b
	7	TRANS	19±5	36±5	38±6	35±3	32±2	33±3	34 ± 3^b	35 ± 3^b	27 ± 3^b
	7	ACTH	19±5	33±6	29±6	32±4	31±2	28±3	22 ± 4^a	19 ± 4^a	16 ± 4^a
150 days	5	SHAM	19±8	63±9	53±9	46 ± 8^a	40 ± 8^a	43 ± 7^a	36 ± 6^b	34 ± 7^a	25 ± 7^a
	7	TRANS	21±7	44±8	60±9	$60 \pm 7^{a,b}$	60 ± 7^b	52 ± 6^a	56 ± 6^a	55 ± 7^b	50 ± 7^b
	7	ACTH	20±6	54±8	81±11	76 ± 9^b	78 ± 9^a	79 ± 8^b	75 ± 7^c	63 ± 8^b	49 ± 9^b

^{a,b}Numbers within the same column and age group with different superscripts differ (P < .04).