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## CHANGES IN BODY MEASUREMENTS OF HEIFERS AT FIRST PARTURITION<sup>1</sup>

R. LAIRD<sup>2</sup>, L. O. GILMORE, AND J. M. TREECE

*Department of Dairy Science, Ohio Agricultural Experiment Station, Wooster*

It is generally recognized that changes occur in some of the body measurements at parturition. Cattlemen are cognizant of the relaxation of the pelvic bones before parturition and the reduction in the circumference of chest and paunch after parturition. Little seems to be known about other possible changes except the swelling of the udder which causes an increase in the stifle measurement.

The changes in body measurements at parturition are of importance to those interested in the developmental phases of cattle. Information of this nature might be valuable for predicting certain details of show condition on an anticipated date and for interpreting research data. However, it is likely that the changes

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<sup>2</sup>Present Address: Animal Husbandry Department, West of Scotland Agricultural College, Auchincruive, Ayr, Scotland.

may be of greater interest from the standpoint of physiological behavior. The present paper is concerned with a study of body measurements before and after first parturition.

#### EXPERIMENTAL PROCEDURE

The data used in this study were taken from a project concerning growth and development in cattle in which twins and triplets were the prime experimental subjects. A minimum of 18 body measurements were taken each week from time of acquisition of the cattle until at least one month after first parturition and then once a month thereafter. As a result, there are no comparable data for parturition subsequent to the first. A preliminary analysis of the data from the twins was undertaken and additional data on those measurements showing changes were collected on other heifers, singly-born, from the Experiment Station dairy herd to obtain more accurate estimates of these changes.

The twin animals used in this study consisted of one pair of monozygotic Guernseys, one pair of monozygotic Shorthorn x Guernseys, two pairs of Holstein-Friesians, at least one pair of which was monozygotic, one pair of monozygotic Brown Swiss twins, one pair of dizygotic Jersey twins, one Red Poll and one

TABLE 1  
*Model used in the analysis of variance*

Source of Variation	D.F.	Composition of Mean Square
Between periods (P)	1	$\sigma_{WA}^2 + 3\sigma_{PA}^2 + 3a\sigma_P^2$
Between animals (A)	a-1	$\sigma_{WA}^2 + 3p\sigma_A^2$
Interaction between periods and animals (PxA)	a-1	$\sigma_{WA}^2 + 3\sigma_{PA}^2$
Between weeks within periods (W)	4	$\sigma_{WA}^2 + a\sigma_W^2$
Between weeks within periods x animals or error (WA)	4(a-1)	$\sigma_{WA}^2$

Guernsey for whose twins similar data either were not available or were suspect because of illness. The nontwin heifers consisted of 4 Jerseys and 3 Holstein-Friesians, giving a total of 21 animals. These heifers calved from September through March of three different seasons at an average age of just over 2 years 2 months. Of the 21 heifers, 18 calved at ages from 2 years to 2 years 3 months while the other three calved at ages of 2 years 5 months, 2 years 8 months, and 2 years 9 months.

The data for the three weeks prior to and immediately following parturition were arbitrarily chosen for each animal. Because the measurements were taken on the same day each week, the last measurement before parturition fell 1 to 6 days before the day of parturition. It was desired to isolate the following sources of variation; between periods (P), i.e., before and after parturition; between animals (A); the interaction between periods and animals (PxA); between weeks within periods (W); and weeks within periods times animals or error (WA). Periods and weeks were regarded as fixed variables and animals as a random variable. A method presented by Schultz (1955) was employed to set up the model shown in table 1.

In the tests of significance, the between weeks within periods (W) and the

interaction between periods and animals (PxA) were tested against the error mean square. On the other hand, the mean square between periods was compared to PxA only. The degrees of freedom for this new error term was determined by the method of Satterthwaite (1946). In the statistical model used (table 1) the differences between animals were not of interest since no importance was attached to the magnitude of the measurements and therefore the statistical significance of the mean square between animals was not determined.

An interaction between periods and animals would indicate a differential response to the influence of parturition. To determine whether the interaction was caused by some factor peculiar to breed structure, an additional analysis was made. The measurements for 21 cattle were divided into 5 breed groups comprising (a) 3 Guernseys, (b) 2 Beef Shorthorn x Guernseys and 1 Red Poll, (c) 2 Brown Swiss, (d) 6 Jerseys and (e) 7 Holstein-Friesians. The interaction between periods and animals was subdivided into that between periods and breed groups and that between periods and cattle within breed groups.

TABLE 2  
*Results of analysis of variance for body measurements of heifers  
taken before and after first calving*

	No. of Animals	Change at calving (Before—After) Mean (cm)	Significance <sup>a</sup>	Interaction (PxA) Significance <sup>a</sup>	Weeks within periods Significance <sup>a</sup>
Poll to muzzle	14	+0.05	n.s.	n.s.	n.s.
Head width	14	-0.02	n.s.	n.s.	n.s.
Eye to mandible <sup>b</sup>	11	-0.05	n.s.	n.s.	n.s.
Circum. of muzzle	14	+0.03	n.s.	n.s.	n.s.
Mandible to jaw <sup>c</sup>	14	+0.01	n.s.	n.s.	n.s.
Circum. of neck	21	-1.81	***	n.s.	n.s.
Heart girth	21	-3.84	***	**	n.s.
Withers height	21	+0.92	***	*	n.s.
Width of shoulders	21	-1.23	***	*	n.s.
Depth of chest	21	-0.91	***	n.s.	**
Length of body	21	-0.03	n.s.	**	n.s.
Circum. of metacarpus	21	-0.21	***	*	n.s.
Circum. of metatarsus	21	-0.24	**	**	n.s.
Stifle to stifle (tape)	21	+0.30	n.s.	n.s.	**
Width of hooks	21	-0.30	***	*	n.s.
Width of thurls	14	-0.05	n.s.	n.s.	n.s.
Width of pins	21	-0.26	n.s.	n.s.	n.s.
Hooks to pins	21	-0.14	n.s.	n.s.	n.s.
Body weight	20	-109.0 (1b)	***	***	***

<sup>a</sup>n.s.—not significant. \* =  $P < 0.05$ , \*\* =  $P < 0.01$ , \*\*\* =  $P < 0.001$ .

<sup>b</sup>From top of eye socket to angle of mandible.

<sup>c</sup>From angle of mandible to anterior extremity.

#### RESULTS AND DISCUSSION

The head measurements were unaffected by parturition as indicated in table 2. The circumference of neck declined by an average of 1.81 cm and may be attributed to the dehydration of the body tissues incident to parturition and subsequent lactation. In as much as both circumference of neck and stifle to stifle distance are measurements of muscle developments this drain on the body may affect the stifle to stifle measurement also but be masked by the complicating effect of the udder swelling. This swelling of the udder becomes apparent in the stifle to stifle measurement one or two weeks before parturition and for a week or so afterwards. As anticipated, this measurement reached a maximum soon after

parturition and then declined. Because of this curvilinearity statistically significant differences were recorded between weeks within periods before and after parturition and the quadratic regression of measurements on weeks was significant at the 0.05 level of probability. The mean value before parturition was not significantly different from that after parturition.

A series of weekly changes similar to those of the stifle to stifle measurement, though not statistically significant, was also observed in the case of length of body (from the anteriormost cervical vertebra between the scapulae to the left tuber ischium or pin bone). In fact, most of the variation between weeks was accounted for by the quadratic regression of measurements on weeks. This might be associated with the relaxation of the pelvic bones at parturition since the left tuber ischium was a reference point. The length of body, however, showed no consistent change with parturition but the animals did exhibit highly significant differential responses. These differences might be apparent rather than real due both to a possible sagging of the back and to the difficulty with which the anterior reference point could be palpated.

The leg circumferences, both fore and rear, were less after parturition than before, the fore leg by 0.21 cm and the rear leg by 0.24 cm. This may be due to dehydration of the soft tissue or to improved lymphatic return similar to that observed after parturition in women. These leg measurements seemed to reach minimum values at 4 to 7 weeks after parturition.

Of the pelvic measurements, only the width between external points of tuber coxae (hooks) showed statistically significant sources of variation. This width declined by 0.30 cm at parturition but there was also a significant differential response which was small in comparison with the change at calving. The decline might be attributed to a return to normal after relaxation in preparation for parturition. Although the width of pins showed a decline it just failed to reach statistical significance ( $P < 0.10$ ). There was some evidence, however, that the minimum value after parturition was not reached until about one month postpartum and it is possible that significant differences might have been obtained if data for 4 or 5 weeks postpartum had been analyzed. The width of thurls and length from hooks to pins (length of pelvis or rump) were unaffected by parturition.

In the shoulder region there were highly significant postpartum declines in heart girth, width of shoulders (the straight-line distance between the shoulder points measured by large calipers) and depth of chest. These declines were probably due to the physical effect of the weight of the calf. Similarly, the increase in the height at withers may be attributable to the removal of the calf and placental membranes whose combined weight would seem to depress the height at withers before parturition. In the case of width of shoulders, heart girth and height at withers, significant differential responses were recorded but the between-weeks-within-periods variation was significant only in the depth of chest measurement due to a rise of 0.50 cm in the week prior to parturition and to a marked fall of 0.50 cm in the third week thereafter. The quadratic regression of chest depth on weeks approached statistical significance. These changes may be due to relaxation in preparation for parturition and to tension of ligaments thereafter, respectively.

For purposes of comparison body weights at each of the three weeks before and after parturition were analyzed also. The mean decline in weight was found to be 109.0 lb. The interaction between animals and periods was found to be highly significant indicating that the weight loss varied appreciably from animal to animal, an average increase of 16 pounds in weight was recorded in the second week prior to parturition and in the postpartum period the weight declined presumably due to the drain of lactation on the body reserves. These changes resulted in a statistically significant between-weeks-within-periods mean square. After adjusting for the change at parturition, the quadratic regression of weight

on weeks was significant ( $P < 0.05$ ), due to a gradual increase in weight until parturition and a gradual decline afterward.

For those measures which showed statistically significant sources of variation the original data were converted into logarithms and analyzed with the results as indicated in table 3. The only changes compared with the original analysis concerned the interaction between animals and periods. That of the circumference of the rear leg (metatarsus) was now significant only at the 5 percent level of probability, while that of width of shoulders was not statistically significant. The interaction in the case of the stifle to stifle measurement became statistically significant at the 5 percent level of probability. It would seem, therefore, that the interaction between animals and periods was, in general, not caused by a correlation between the magnitude of the changes in the measures of the individual animals and the magnitude of the measures themselves.

TABLE 3

*Results of analysis of variance of the logarithms of the body measurements of heifers taken before and after first parturition*

	No. of animals	(as a % of magnitude before parturition)	Significance <sup>a</sup>	Interaction (PxA) Significance	Weeks within periods Significance
Circum. of neck	21	-2.18	***	n.s.	n.s.
Heart girth	21	-2.12	***	**	n.s.
Withers height	21	+0.77	***	*	n.s.
Width of shoulders	21	-2.95	***	n.s.	n.s.
Depth of chest	21	-1.44	***	n.s.	**
Length of body	21	-0.02	n.s.	**	n.s.
Circum. of metacarpus	21	-1.24	*	*	n.s.
Circum. of metatarsus	21	-1.24	***	*	n.s.
Stifle to stifle (tape)	21	+0.22	n.s.	*	**
Width of tuber coxae hooks	21	-0.63	***	*	n.s.
Width at tuber coxae pins	21	-0.85	n.s.	n.s.	n.s.
Weight	20	-10.45	***	***	***

<sup>a</sup>See footnote table 2.

Since the difference of two logarithms represents the division of one natural number by another, the difference of the means before and after parturition became the ratio of their measures after and before parturition when converted to antilogarithms. By subtracting one from this ratio and multiplying by 100, the result was the change at parturition expressed as a percentage of the measurement before parturition (table 3).

The circumferences of the legs and the depth of chest show percentage declines of 1.24 to 1.44 percent while heart girth and circumference of neck declined by about 2.1 percent. Width of shoulders showed the highest percentage decline (2.95%) of the body measurements whereas width of hooks showed the least (0.63%). Height at withers increased by 0.77 percent. As expected, body weight showed the largest decline of all, viz., 10.45 percent.

With regard to the interaction between periods and animals, it was only in the case of the stifle to stifle measurements that the interaction between periods and breed groups was significantly greater than that between periods and animals within breed groups. This significant interaction was largely attributable to most of the Jerseys showing a decline after parturition, the Holstein-Friesians showing no change and the other three groups showing increases. To what this differential

response was due could not be ascertained. From these results it can be concluded that, with this one exception, the interaction between periods and animals was not a breed difference but was due to individual differences between animals irrespective of breed.

These changes seemed to be largely independent of the inheritance of the individual. This is partly borne out by the absence of breed differences as indicated above. However, to test this in another way the interaction between periods and animals was divided into the interaction between periods and animals within twin-pairs and the residual interaction (i.e., the interaction of periods with twin-paired and single-born animals). If there are changes attributable to inheritance, then the differences of the changes within twin-pairs should be less than the differences of the changes between twin-pairs and singly-born animals. In only one instance was this so. For heart girth, the interaction within twin-pairs was significantly less ( $P < 0.05$ ) than the residual interaction and in only two other cases did it approach statistical significance ( $P < 0.10$ ). These were stifle to stifle and width of shoulders. This is interpreted as indicating that members of a twin pair at parturition tend to have declines in heart girth, and possibly stifle to stifle and width of shoulders, of a closer magnitude than one would expect from pairs of animals taken at random. With these possible exceptions it would appear that the inheritance of the animal plays a negligible role in influencing these changes and so these results are applicable to cattle in general. These results may serve as an indication of the type of change likely to occur at later parturitions although the magnitude of these changes may be different.

In the literature the only paper that could be found to give any details regarding changes in body measurements at parturition was that of Crichton and Aitken (1954). Their paper dealt with comparisons of monozygotic twins on high and low planes of nutrition during rearing through first lactation. As in the present study, they found declines in heart girth at first parturition with the possible exception of low plane animals. With regard to width of hooks (hips) figures 2 and 3 in their paper showed little or no change. Height at withers of 3 out of 4 groups showed a decline and only one group (the low-low group) showed an increase with parturition. With the exception of the latter group, these results are in conflict with those of the present study. Crichton and Aitken suggested that the temporary reduction in the height at withers of the high plane animals might be due not to differences in bone development but to drawing on muscle or fat deposited over the shoulders. If this were so, it might mean that the animals in the present study were comparable to the low plane animals. However, the animals in the present study were raised on a normal to above normal plane of nutrition and so the plane of nutrition would seem not to be the cause of the similarity. It must be appreciated that the data of Crichton and Aitken are less reliable than those of the present study since they are based on averages of 2 or 4 animals.

#### SUMMARY

The changes in body measurements of heifers at first parturition have been studied. The magnitude of the changes was calculated from the difference of the means before and after parturition and the analysis of variance technique was employed to test the statistical significance of these changes.

Height at withers showed a significant increase of 0.92 cm (or 0.77%) after parturition. Measurements showing significant declines were: circumference of fore leg (0.21 cm or 1.27%), circumference of rear leg (0.24 cm or 1.24%), circumference of neck (1.81 cm or 2.18%), heart girth (3.84 cm or 2.12%), width of shoulders (1.23 cm or 2.95%), depth of chest (0.91 cm or 1.44%), width of hooks (0.30 cm or 0.63%), and body weight (109.0 lb or 10.45%). The other 10 measures showed no statistically significant changes.

Possible explanations of these changes are discussed. Individual variations were encountered but these were independent of the inheritance of the individual as heredity was found to play a very minor role in influencing these changes.

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