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Allometric comparison of Georgia dairy heifers on farms and at youth shows

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ABSTRACT

Studies were conducted to determine the relationship between allometric measures of growth of Holstein dairy heifers and placing in the show ring, and to compare differences in growth between Holstein heifers that are shown and not shown. In the first study, 494 Holstein show heifers were evaluated at the 2012 and 2013 Georgia Junior National Livestock Shows. Measurements were obtained for weight, head length, withers height, hip height, thurl width, and tail length. Heifer mass index (HMI), average daily gain (ADG), and age were calculated. In total, 72.5% of Holstein show heifers were underweight. Average ADG was 0.63 kg/d, which is below the industry recommendation of 0.7 to 0.8 kg/d. Variables were ranked and converted to percentages to account for differences in class size. Withers height, head length, and HMI were most indicative of show placing. In the second study, we compared differences between growth patterns of show heifers and non-show heifers. An additional 293 non-show Holstein heifers were evaluated on 3 Georgia dairy farms during the same period as the show. In total, 43.3% of non-show heifers were underweight. Average ADG for non-show heifers was 0.71 kg/d, which is within the industry recommendation of 0.7 to 0.8 kg/d. Show heifers weighed less for their age than non-show heifers and tended to be taller at the withers than non-show heifers. The HMI scores were similar for younger show and non-show heifers, but older show heifers had lower HMI scores than non-show heifers of the same age. Show heifers had HMI scores that were lower than values calculated from standard growth data. As show heifers matured, ADG decreased, whereas as non-show heifers matured, ADG increased. Youth, leaders, and parents need to be aware of the importance of growing replacement heifers correctly so that heifers calve at 22 to 24 mo of age at an acceptable size and scale and become profitable members of the milking herd.

Key words: commercial dairy heifer, allometric growth, heifer mass index, average dairy gain

INTRODUCTION

Dairy producers strive to raise their replacement heifers as efficiently as possible, minimizing costs and maximizing profitability for breeding at 14 to 15 mo of age and calving between 22 and 24 mo of age. The standards of weight and height for Holstein heifers of various ages were reported by Jones and Heinrichs (2013). Heifers must grow so that they are of adequate skeletal size and weight. This is especially important for attainment of puberty. Underfeeding heifers with lower DMI and fewer nutrients can have negative effects on puberty, calving, and lactation.

Growth is indicative of developmental maturation. Body weight and ADG are the most common indices for measuring growth. However, recent studies have explored skeletal measurements, because these are not as influenced by gut fill or body condition. Body mass index (**BMI**), calculated in humans as a function of weight and height, provides a practical and reliable indicator of body fat and is used in health screening (CDC, 2014). Developing similar indices for use on heifers may prove beneficial to monitor growth and development.

Since 1997, the Georgia Commercial Dairy Heifer Program has provided youth from both rural and urban backgrounds who either do not have access to dairy animals or lack resources to purchase dairy animals the opportunity to gain hands-on experience caring for and showing borrowed heifers. London et al. (2012) reported that only 82 youths entered the first year of this program, but there have been at least 300 entries since 2002. Well-grown replacement heifers must come from this program to ensure producer involvement in the future. Our studies have been driven by industry concerns for returned underweight show heifers.

The objective of the first study was to examine the relationship between weight, age, ADG, heifer mass index (**HMI**), head length, withers height, hip height, thurl width, tail length, and placing of commercial Holstein dairy heifers shown in the Georgia Junior Na-

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tional Livestock Show in 2012 and 2013. A new index (HMI) was developed that combined height and weight to evaluate growth. The objective of the second study was to examine the growth of Holstein non-show dairy heifers from 3 farms across the state of Georgia over the same consecutive 2 yr, using the same parameters and measurements as the first study, and compare it with growth of Holstein show heifers.

MATERIALS AND METHODS

Evaluation of Commercial Dairy Show Heifers

In the first study, 454 Holstein commercial show heifers shown at the Georgia Junior National Livestock Show were evaluated for 2 consecutive years (2012 and 2013). Heifers were born between March 1 and September 30 of the previous year (Georgia 4-H and FFA Livestock Shows Rules and Regulations, 2012–2013). Birthdates from entry information were used to calculate age (d) and ADG. Heifers exhibited at the Georgia Junior National Livestock Show each had a state ear tag with a unique number.

Data were collected at check-in at the Georgia Junior National Livestock Show in Perry. Identification number, birth date, and county of origin were previously obtained for each animal from entries. Weight for show heifers was obtained using a calibrated digital scale at the time of check-in. Head length, withers height, hip height, thurl width, and tail length were the skeletal measurements obtained on each heifer. Every measurement except thurl width was obtained using a Ketchum Deluxe Livestock Measuring Device (Ketchum Manufacturing Inc., Brookville, ON, Canada). Head length was measured as the distance from back of the poll to tip of muzzle. Withers height was measured as the distance from the point of withers to ground. Hip height was measured from top of the hip to ground. Tail length was measured from tail head to end of tail bone. Heifers with docked tails were excluded from tail length analysis. Thurl width was obtained using a custom-designed measuring device developed by The University of Georgia Instrument Shop (Athens). Thurl width measurement is defined as distance between thurl joints (London et al., 2012).

Heifer mass index was determined by dividing the weight (kg) of the heifer by hip height (m^2; CDC, 2014). This formula is adapted from the human BMI formula with height at the hip replacing height from head to toe.

Average daily gain was determined by subtracting weight at the show from average birth weight, and then dividing by age (d) of the heifer (London et al., 2012). Average birth weight used for a Holstein calf was 42.2 kg (Tyler and Ensminger, 2006). Age (d) was calculated by subtracting birth date from the date that measurements were obtained (London et al., 2012).

Each show class was ranked in descending order for each of the traits. Rankings were converted to percentile rank by taking each rank and dividing by the total number of heifers within that class. Spearman rank correlations using SAS (SAS Institute, 2008) were estimated for show animals between the raw traits and between traits after conversion to percentile rankings. GLMSELECT stepwise selection (SAS Institute, 2008) was used to determine which traits were significant when placing was the dependent variable. The model used with GLMSELECT had placing in a class as the dependent variable, with year-class as 1 dependent variable and then the model selected traits that provided the best fit.

Comparison of Holstein Show and Non-Show Heifers

To provide a basis of comparison for growth of show heifers, the same allometric measurements were collected on 293 heifers from 3 farms in Georgia over the same 2-yr period. Non-show heifers selected for allometric evaluation had to meet the same age requirements and criteria as Holstein show heifers from the first study. Farm identification numbers were used as the identification number for each non-show Holstein heifer. Birth date was provided for each heifer by the producer. A Dairy Weight Tape (Nasco, Fort Atkinson, WI) was used to estimate weight of non-show heifers (McDaniel and Legates, 1965; Quaife, 2004; Dingwell et al., 2006). All remaining measurements were collected in the same manner for farm heifers as for commercial dairy show heifers. Spearman correlation calculations in SAS were used to correlate traits measured on the farm (SAS Institute, 2008).

Combined data from both non-show and show heifers were analyzed using the GLM procedure (SAS Institute, 2008). Each of the dependent variables weight, head length, withers height, hip height, thurl width, tail length, ADG, and HMI were analyzed by a model that contained type (non-show or show) and year as fixed class effects, the interaction between type by year, and age as a covariate. The effect of type (non-show vs. show heifers) was tested using the interaction of type by year as the error. Least squares means (**LSM**) were estimated for each of the type by year subclasses, and the standard errors (**SE**) for LSM were derived from type by year mean squares. Scatterplot graphs using Microsoft Excel (Microsoft Corp., Redmond, WA) were created for weight, head length, withers height, hip height, thurl width, tail length, HMI, and ADG. Scatterplots were created with age (mo) on the x-axis and