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The relationship between weight, age, and average daily gain to show performance of Georgia 4-H and Future Farmers of America (FFA) commercial dairy heifers

M. L. London, J. K. Bernard, M. A. Froetschel, J. K. Bertrand, and W. M. Graves[1]
Department of Animal and Dairy Sciences, University of Georgia, Athens 30602-2771

ABSTRACT

Three studies were conducted to determine the relationship between dairy heifer growth and placing in the show ring. In the first study, 1,744 commercial dairy heifers (all breeds and crossbred animals) were evaluated to determine effects of growth on placing within Georgia Commercial Dairy Heifer Shows from 2007 to 2010. Birth weights were determined using breed birth weight averages, with crossbreeds being the average of 2 parent breeds. Average daily gains (ADG) were calculated and heifers were given rankings based on placing in show and for age and weight. Data was analyzed using the Spearman correlation calculations in the SAS software (SAS Institute Inc., Cary, NC). Age and ADG were inversely correlated (r = −0.89). Mean ADG for all heifers was determined to be 0.65 kg, below National Research Council recommendations of 0.7 to 0.8 kg. No strong relationship (r = −0.07) was observed between ADG and placing. Heavier heifers within a class showed a small positive relationship (r = 0.10) with placing. For study 2, 238 heifers shown at the 2010 Georgia Junior National Livestock Show (Perry, GA) were measured and evaluated for ADG, placing, body weight, age, withers height, hip height, hip width, and jaw width. Height at withers had a moderate relationship (r = 0.42) with placing, followed by hip height (r = 0.32). A positive relationship (r = 0.65) was observed between withers height and hip height. The correlation between weight and placing was determined (r = 0.11). Age and ADG had a strong inverse relationship (r = −0.87). Study 3 evaluated 1,489 Holstein heifers shown from 2007 to 2010. Data was analyzed using the Penn State Growth Monitor Spreadsheet Curves. In total, 63.75% did not meet Penn State recommendations for body weight gain. Performance and physical features associated with age indicates that commercial dairy heifers are underfed. The effects of heat stress and high feed costs also play a role. This has economic implications because these animals will likely require more time before they enter the milk herd. The Commercial Dairy Heifer Program is vital for youth development in Georgia. However, those involved need to be encouraged to improve nutritional management practices.
Key words: average daily gain, heifer growth, weight, showing

INTRODUCTION

Raising dairy replacement heifers is a key component to dairy production. Dairy heifers are grown with the goal that these females eventually entering the milking herd and produce milk according to their genetic potential. Optimum growth patterns for dairy cattle have been studied for some time (Swanson, 1967).

The use of the adjective replacement refers to dairy producers consistently needing to replace or add dairy cows back into the milking herd. Depending on culling rate, replacement heifers can be used to maintain herd size or expand herd size. Cow numbers have decreased and milk production increased the past 30 yr. In 2010, 9,117,000 cows produced 192,819 million pounds of milk (USDA, 2010). A total of 10,799,000 cows produced 128,406 million pounds of milk in 1980, 9,993,000 cows produced 147,721 million pounds of milk in 1990, and 9,206,000 cows produced 167,657 million pounds of milk in 2000 (de Vries et al., 2002). Milk prices have been variable as well, especially during the past few years. Class 1 prices in the past 3 yr have gone from $21.78 per cwt on September 1, 2008 to $9.43 per cwt on March 1, 2009 (Hoard's Dairyman, 2011).

Dairy replacement heifers are generally raised on their farm. The trend for increasing the number of cows and herd size has prompted many producers to look at the need for more labor for milking cows as well as recognizing that using a custom heifer grower would be helpful (Fisher, 2002). In just the past 9 yr, heifer-raising costs have increased from $1,360 in 1998 to $2,149 in 2007, mainly because of higher fertilizer, fuel costs, and feed costs (Huibregtse et al., 2008). A custom grower may raise heifers that are healthier and more cost effective (Fisher, 2002). Dairy heifer rearing

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[1]Corresponding author: wgraves@uga.edu

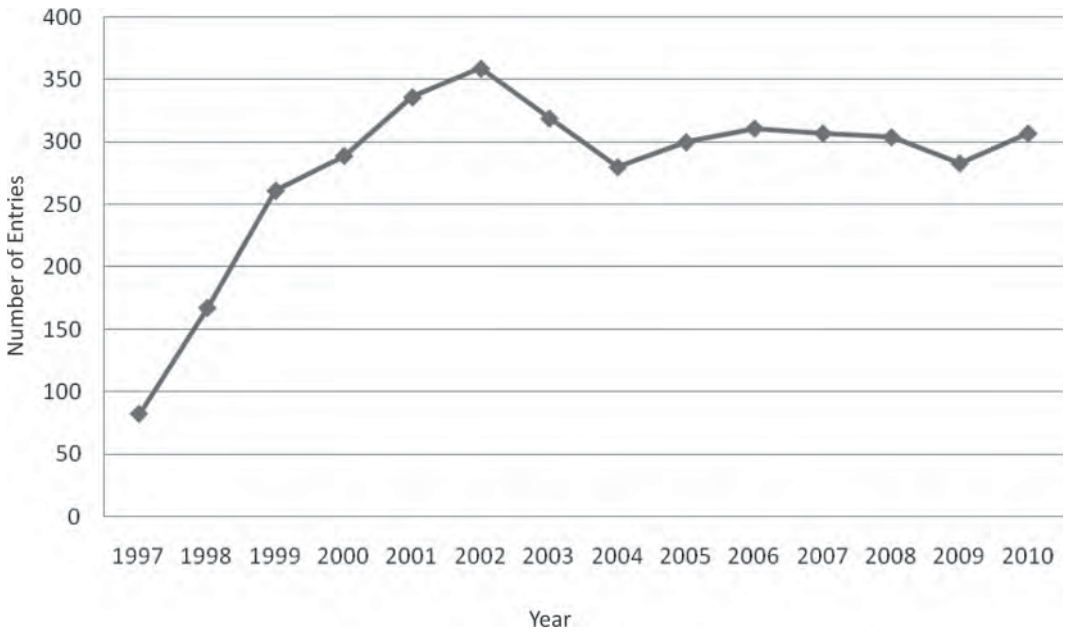

Figure 1. Number of entries in the Georgia Junior National Livestock Show (Perry, GA), 1997 to 2010.

is proving vital to the industry, but also challenging. It can also be a means of attracting interested youth to join the dairy industry and one day become owners, managers, technical personnel, leaders, and advocates of this prosperous and wholesome industry.

Rural youth education programs that teach essential life skills are vital for developing participants into successful young men and women. Aiton (1965) reported on the challenges to extension youth programs and their relationship to the future. However, very little has been published regarding the relationship to heifer growth. A great deal of information has been studied about youth participation. From the USDA youth report (USDA Annual 4-H Youth Development Enrollment Report from 1985–1994; USDA, 1985–1994), Schwanke (1997) was able to determine that both dairy and total 4-H project numbers had increased approximately 5,000 and 1,000,000, respectively, from 1985 to 1994. Dairy projects have increased gradually, a similar trend to the total number of 4-H projects during this period; furthermore, increases were evident in the eastern, southern, and western regions during this period (Schwanke, 1997).

Programs such as the Georgia Commercial Dairy Heifer Program give youth across the state the opportunity to exhibit a dairy heifer, gain knowledge of the dairy industry, and develop personal qualities that will benefit them throughout their life. Eighty-two youths entered the first year, and then 167, 261, and 289. The program grew quickly to over 300 entries in 5 yr. The highest number was in 2002 with 359 entered. Over 300 youths have entered in 6 of the last 7 yr. This program, now in its fourteenth year, has benefited many youths throughout Georgia. Participation is shown in Figure 1. Many participants come from rural, non-farming backgrounds. Because of their involvement with dairy heifers and even other youth livestock programs, several of these young adults have sought an education as well as successful careers related to animal agriculture. Furthermore, if these individuals choose a career outside of agriculture, they still will always be mindful of the goodness of animal agriculture, and its importance to our society and culture as a whole.

The objective of the first study was to determine the relationship between weight, age, ADG, breed, and placing for commercial dairy heifers shown in Georgia over 4 yr. In the second study, the objective was to determine if heifers are being grown according to industry guidelines, looking at specific multiple growth traits. Finally, in the third study, Holstein heifers that were shown using the Penn State Growth Monitor Spreadsheets (Pennsylvania State University, State College; http://www.das.psu.edu/research-extension/dairy/nutrition/heifers) from over a 4-yr period were examined to evaluate growth compared with industry standards.

MATERIALS AND METHODS

ADG and Its Relationships

For the first study, records from 1,744 commercial dairy heifers shown in 2007 through 2010 were used

to determine if ADG or other growth factors had any effect on a judge's placing. Data was collected from heifers shown in the 2 largest shows held in Georgia, The University of Georgia Commercial Dairy Heifer Show held in Athens and The Georgia Junior National Livestock Show held in Perry.

To be eligible for one of these shows, the exhibitor must be a member of a 4-H or Future Farmers of America (FFA) chapter, and be least 9 yr old. Exhibitors become ineligible to show upon graduation from high school. Most of the exhibitors are middle and high school students. Dairy heifers are eligible to be exhibited in the commercial shows as long as they are not registered with a breed association and are born between March 1 and September 13 of the previous year. The dairy heifer must meet the general health requirements of the Georgia Department of Agriculture and must weigh over 200 (90.72 kg) and less than 851 pounds (386.01 kg) at weigh in. Any heifer that was not within these weight requirements was disqualified from the show.

In these studies, we must trust and assume that the exhibitor is providing accurate information about their heifer, especially regarding their birth date. According to Norman et al. (2001), in purebred programs, birth dates for some animals may have been altered intentionally to be assigned a younger show class. However, when studying farms with commercial dairy cows, it was determined that the accuracy of reported birth dates were likely reasonably correct, when it was determined that the offspring studied had a more uniform rate of births throughout each month (Norman et al., 2001).

After all of the heifers are checked and weighed in, youth participate in showmanship based on their grade in school. Heifers are then also split into equal groups or classes of similar weight. Although no official scorecard exists for evaluating dairy heifers that are shown, it is generally accepted to refer to the Purebred Dairy Cattle Association (PDCA) Dairy Cow Unified Score Card (PDCA, 2009) and lowering the weight given to udders.

Information collected from 2007 to 2010 was compiled into a single data set contained in a Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA). Each commercial dairy heifer's information was entered in this spreadsheet. These include identification of the heifer, year the heifer was shown, the show it was shown in, weight of the heifer, date of the weigh in, respective weight class the heifer competed in, breed of the heifer, county in which exhibitor resides, birth date of heifer, and placing within the weight class.

Heifers were then sorted based on their breed. The average birth weight for each breed type as provided from research from Tyler and Ensminger (2006) was entered for each calf and used in ADG estimations. For crossbreeds, the average birth weight of the parent breeds was used for the birth weight of those heifers. The age of the commercial dairy heifer was calculated by taking the birth date of the heifer and subtracting it from the date of the weigh in. This difference was reported on a day basis. The ADG was calculated for each heifer, taking the average birth weight, subtracting the weight at the show from it; then dividing this difference into the age (in days) of the heifer. Each class was then sorted by their ADG, in descending order, and given a rank based on this order. Next, BW and age were ranked as well; each was given a rank of 1 for the heaviest and oldest, respectively. Then, having a ranking for placing in the show, ADG, BW, and age for each heifer, all of these rankings were converted into percentages by taking each ranking and dividing by the total number of heifers within that class. These percentages were then correlated using the Pearson and Spearman correlation calculations in SAS (SAS Institute, 2008).

Pennsylvania State Growth Monitor Spreadsheet Measurements and Their Relationships

For the second study, 238 heifers shown in the 2010 Georgia Junior National Livestock Show were further evaluated. Measurements were taken before the show and entered in the Growth Monitor Spreadsheet (Pennsylvania State University), and used to determine whether these heifers were being developed properly, and decide whether a relationship was present between any of these measurements and the judge's placing in the show. After the heifers were weighed, several specific anatomical measurements were made in each heifer, including hip height, withers height, hip width, and jaw width. For hip height, the measurement was taken along the top and middle of the back of the heifer and the distance from this point to the ground was measured. Similarly, withers height was measured from the top of the back, at the shoulder, to the ground. The hip height and withers height were measured with a Ketchum Deluxe Livestock Measure (Ketchum Manufacturing Inc., Brockville, Ontario, Canada). The hip width was measured as the width between the thurl joints. In addition to these measurements for the Pennsylvania State Growth Monitor Spreadsheet, jaw width was measure. The hip width and jaw width were measured by a custom-designed instrument from the University of Georgia Instrument Shop (Athens).

Input into the Pennsylvania State Growth Monitor Spreadsheet included date of measurement, identification of the heifer, birth date of heifer, weight, hip

height, withers height, and hip width. Correlations were calculated to determine relationships between these measurements and the placing in the show. Similar to the ranking system used in the previous section, the withers height, hip height, hip width, and jaw width were ranked. For the height and other measurements, a rank of 1 was given to tallest individual heifer within the class. For the width measurements, the widest heifer within the class was given a rank of 1. Furthermore, after these rankings were given, a percentage was then given for each measurement by dividing the rank into the number of individuals within the class. For animals with equal measurements, they were given the same rank (i.e., in class 1, 2 heifers had 99.06 cm for withers height and no other animals in the class were taller; both were given a rank of one). All of these rankings were then correlated using the Spearman correlation procedure in SAS to determine potential relationships that may exist between growth and development and placement in the show by a judge.

Holstein Weight Evaluation

After using the Pennsylvania State Growth Monitor Spreadsheet for the 2010 Georgia Junior National Livestock Show, the decision was made to enter Holstein data from 1,489 heifers shown in the 2 shows from 2007 to 2010 into the spreadsheet in an effort to identify heifers not meeting the BW guidelines, based on age, and to determine if any trends existed in certain counties. The analysis included heifer identification, BW, and age for each animal. The spreadsheet is able to predict heifers underweight for their age. Standards are based on the results of measuring a large number of heifers of various breeds throughout the United States. Upon determining whether each heifer was meeting the guidelines set forth in the Pennsylvania State Growth Monitor Spreadsheet, the information was then transferred back into a Microsoft Excel spreadsheet. Proportions of under, meeting, or exceeding weight requirements were determined based on show and county. Also, the difference between guidelines in the spreadsheet and the weight of the individual heifer were determined. These data were then grouped based on this difference to determine how much of a difference between the actual weight and the guidelines from the spreadsheet existed. Heifers that were underweight were grouped as follows: more than 50 kg underweight, more than 25 to 50 kg underweight, and less than 0 to 25 kg underweight. Heifers that met BW requirements were grouped similarly.

RESULTS AND DISCUSSION

ADG and Its Relationships

Mean ADG for the animals participating in 8 shows over a 4-yr period (2007 to 2010) in study 1 were calculated for each show and are presented in Table 1. The ADG was 0.65 kg, which is below the recommended ADG levels of 0.7 to 0.8 kg/d (Kertz et al., 1987; NRC, 2001; Zanton and Heinrichs, 2005). The ADG sorted by breed is presented in Table 2. Breeds and crossbreeds with less than 10 observations were combined together and form the other breeds section. Jerseys had the lowest ADG (0.52 kg), followed by Jersey-Holsteins (0.53 kg), and Brown Swiss (0.55 kg). Holsteins had the highest ADG, with a calculated average of 0.66. Counties that had mean ADG within previously suggested values at or over 0.7 kg were Wilcox (0.77 kg), Murray (0.75 kg), Oglethorpe (0.72 kg), Putman (0.70 kg), and Whitefield (0.70 kg). Counties with ADG values lower than 0.55 kg were Greene (0.55 kg), Dade (0.54 kg), Dawson (0.54 kg), Peach (0.52 kg), and Macon (0.36 kg).

A detailed look at both ADG and placing rank within each class is shown in Table 3. For the ADG ranking of 1, 2, 3, 4, and 5 within a class, the ADG for these rankings were 0.82, 0.75, 0.72, 0.69, and 0.66 kg, respectively. For the first 5 placings (first, second, third,

Table 1. A detailed look at age, weight, and ADG from 2007 to 2010

Show	No. of observations	% of total observations	Mean age (d)	SEM, age (d)	Mean weight (kg)	SEM, weight (kg)
2007 UGA[1]	215	12.33	230.38	4.36	197.73	4.18
2007 Perry[2]	247	14.16	242.50	4.25	200.83	3.97
2008 UGA	220	12.61	247.69	4.42	202.12	4.09
2008 Perry	244	13.99	252.51	4.31	205.69	3.86
2009 UGA	186	10.67	243.37	4.94	202.02	4.91
2009 Perry	216	12.39	251.50	4.51	204.80	4.38
2010 UGA	178	10.21	238.24	4.84	190.16	4.60
2010 Perry	238	13.65	246.98	3.99	197.02	3.76

[1]University of Georgia Commercial Dairy Heifer Show, Athens, GA.

[2]Georgia Junior National Livestock Show, Georgia National Fairgrounds, Perry, GA.

Table 2. Breed comparisons of commercial heifers

Breed[1]	No. of observations	% of total observations	Mean age (d)	SEM, age (d)	Mean weight (kg)	SEM, weight (kg)	Mean ADG (kg/d)	SEM, ADG (kg/d)
BS	34	1.95	231.74	13.84	174.11	10.99	0.55	0.03
HO	1,485	85.15	245.98	1.70	204.28	1.61	0.66	0.00
JE	34	1.95	236.47	9.68	144.00	4.21	0.52	0.02
BS × HO	44	2.52	233.61	11.69	184.02	8.94	0.60	0.02
JE × HO	136	7.80	237.54	5.44	186.06	4.89	0.63	0.01
Other breeds[2]	11	0.63	229.73	17.06	159.34	16.87	0.53	0.04

[1]BS = Brown Swiss; HO = Holstein; JE = Jersey: × = crossbreed.
[2]Includes all breeds and crossbreeds with n <10 from 2007 to 2010.

fourth, and fifth place within a class), the ADG were 0.65 kg for first to fourth and 0.64 kg for fifth place. The average ADG rank for these 5 placings were 6.02, 5.96, 6.21, 6.21, and 6.5, respectively. This indicates that commercial dairy heifers that placed first through fifth in a class had a ranking at or near 6 for ADG, indicating that 5 or 6 individuals in each class had high ADG.

Although the relationship was not strong, a statistically significant correlation was observed between placing rank and ADG rank in a particular class (Table 4). For 1,744 heifers evaluated, the correlation between these 2 parameters was determined ($r = -0.07$, $P = 0.0034$). When placing and BW were analyzed, a small positive relationship was found between placing rank and weight rank (heaviest to lightest; $r = 0.10$, $P < 0.0001$). Similarly, placing rank and age rank (oldest to youngest) were not strongly related ($r = 0.091$, $P = 0.0002$). Correlations have been reported between weight, gain, and feed intake to be small ($r < 0.2$) when related to milk production as the heifer enters the milking herd (Lee, 1997). Further research measuring milk production of heifers shown in the Commercial Dairy Heifer Program would be helpful. A strong, negative relationship was observed between ADG rank and age ($r = -0.89$, $P < 0.0001$). This was expected due to the indirect relationship of these 2. For instance, if weight is equal in 2 dairy heifers, the one that is younger will likely have a higher ADG.

Pennsylvania State Growth Monitor Spreadsheet Measurements and Their Relationships

During the 2010 Georgia Junior National Livestock Show, 238 Commercial Dairy Heifers were measured in the second study for their weight, jaw width, withers height, hip height, and hip width. These measurements were taken to help provide a more complete measure of growth and age related development in the dairy replacement heifer (Heinrichs and Hargrove, 1991; Hoffman, 1997). After entering the data into the Pennsylvania State Growth Monitor Spreadsheet, graphs were made with the Penn State software for weight (Figure 2), withers height (Figure 3), hip height (Figure 4), and hip width (Figure 5). For each graph, an average line is plotted automatically for the heifers entered, based on their measurements and age. Note that in the weight graph (Figure 2), the line representation is well below

Table 3. Average daily gain rank and placing rank within each class from 2007 to 2010

	ADG rank		Placing rank	
Rank	ADG (kg)	Mean placing	ADG (kg)	Mean ADG rank
1	0.82	6.31	0.65	6.02
2	0.75	6.37	0.65	5.96
3	0.72	5.89	0.65	6.21
4	0.69	6.45	0.65	6.21
5	0.66	6.16	0.64	6.51
6	0.64	5.92	0.65	6.33
7	0.62	6.14	0.64	6.32
8	0.59	6.22	0.64	6.10
9	0.57	6.07	0.64	6.24
10	0.55	5.75	0.65	5.75
11	0.53	5.82	0.66	6.06
12	0.52	6.72	0.68	5.52
13	0.50	7.04	0.63	6.72
>13	0.49	8.50	0.60	8.50

Table 4. Spearman correlation coefficients between ADG, placing, weight, and age from 2007 to 2010

	(*P*-value)		
Item	Placing	Weight	Age
ADG	−0.07	0.11	−0.89
(*P*-value)	(0.0034)	(<0.0001)	(<0.0001)
Placing		0.10	0.09
(*P*-value)		(<0.0001)	(0.0002)
Weight			0.10
(*P*-value)			(<0.0001)

the median line. Surprisingly, withers height (Figure 3) is most near the seventy-fifth percentile for all ages of the Holstein heifers. Because approximately half of withers height growth occurs before 6 mo of age (Kertz et al., 1998), these heifers will likely be able to reach proper withers height as mature cows. To increase withers height even greater from the standard, dairy producers and heifer growers alike can increase CP in the preweaned diet (Brown et al., 2005). Hip height (Figure 4) is near the lower guidelines set and hip width (Figure 5) is near the upper end for the younger heifers, decreasing their average ranking as the heifers get older.

A complete list of all anatomical correlations from the second study can be found in Table 5. In determining relationships between any of the measurements taken, age and ADG, just as in the first study, had the strongest relationship ($r = -0.87$, $P < 0.0001$). As expected, a strong relationship ($r = 0.65$, $P < 0.0001$) was found between withers height and hip height. Furthermore, both of these are moderately related to the placing rank within a class. Withers height and placing calculated correlation was ($r = 0.42$, $P < 0.001$). Similarly, hip height and placing were moderately related ($r = 0.32$, $P < 0.0001$).

Data from crossbred dairy heifers were included in the correlation equations; however, due to lack of a growth spreadsheet for crossbreds, they were not entered into the Pennsylvania State Growth Monitor Spreadsheet. As producers become more concerned over fertility, calf survival, and overall health within their cattle, they may implement more crossbreeding systems in their herds (Heins et al., 2008). As a result, more crossbred heifers may be exhibited in the Georgia Commercial Dairy Heifer Program. However, crossbred heifers will likely be difficult to study due to their increased variation in body size (Weigel and Barlass, 2003; Heins et al., 2008).

Holstein Weight Evaluation

Holstein heifers from 2007 to 2010 were evaluated for actual weight versus the predicted weight in the third study. In total, 538 of 1,489 (36.25%) heifers met or exceeded requirements. The 2 shows with the highest proportion of adequately grown heifers were the 2007 and 2009 University of Georgia Commercial Dairy Heifer Shows. At both of these shows, 45% of the Holsteins shown were growing to industry guidelines. From 2007 to 2010, 951 (63.75%) of the Holstein heifers evaluated failed to meet the guidelines set forth

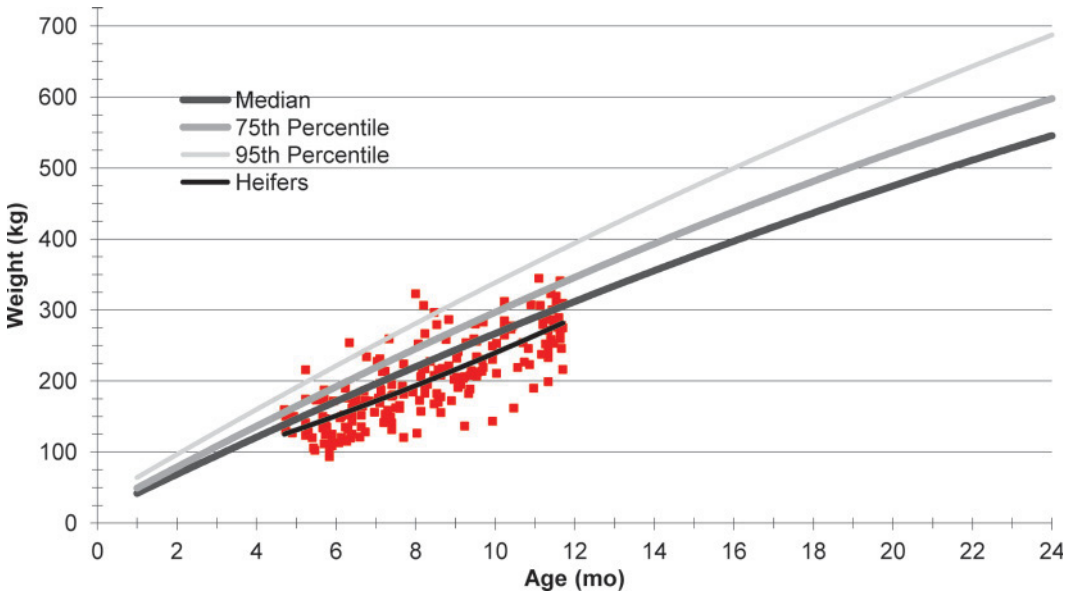

Figure 2. Heifer weights compared with recommended weights at the 2010 Georgia Junior National Livestock Show (Perry, GA). Color version available in the online PDF.

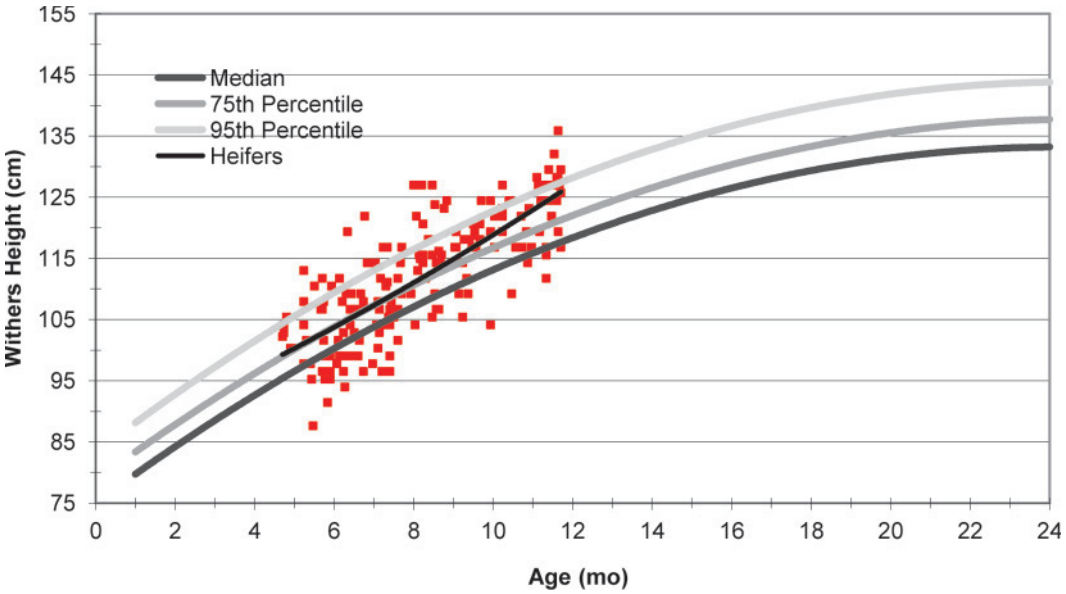

Figure 3. Withers heights compared with recommended heights at the 2010 Georgia Junior National Livestock Show (Perry, GA). Color version available in the online PDF.

in the Penn State Growth Monitor Spreadsheet. This percentage appears to be increasing since 2007, where Holsteins shown in the University of Georgia Commercial Dairy Heifer Show comprised only 55% of entries that were not meeting weight guidelines. Moreover, the 2010 Georgia Junior National Livestock Show had over 70% of its entries that did not meet these established guidelines. Factors that can attribute to failing to meet the guidelines can be poor genetics, nutrition, management, and environment (Heinrichs and Hargrove, 1987). In addition, dairy heifers are often fasted before being weighed at check-in because a shrunk-weight enables a greater chance for a heifer to be placed in a smaller weight class.

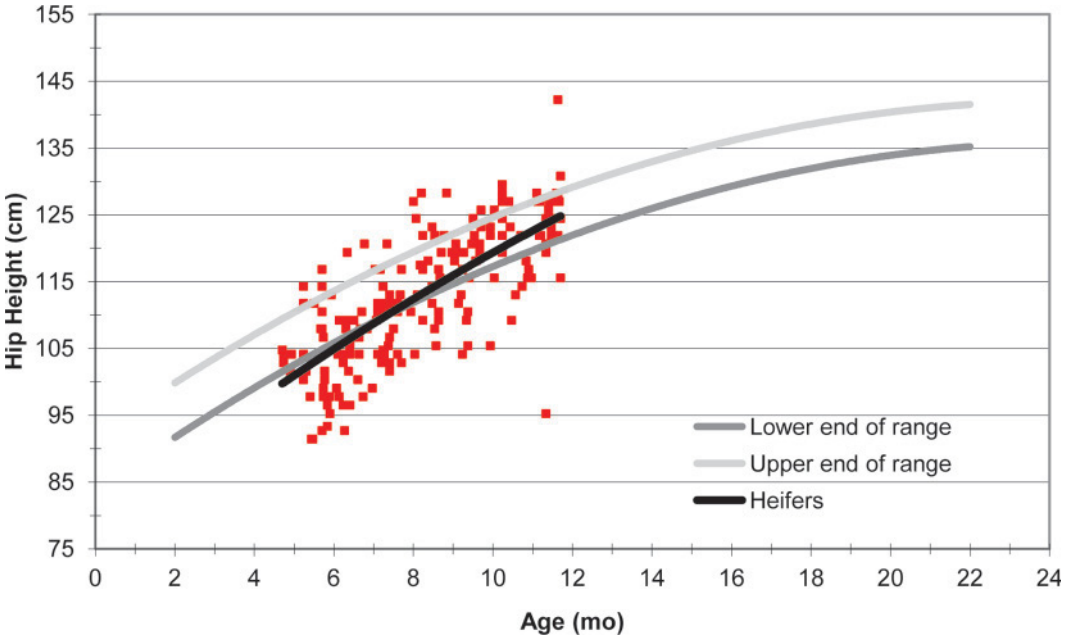

Figure 4. Hip heights compared with recommended heights at the 2010 Georgia Junior National Livestock Show (Perry, GA). Color version available in the online PDF.

Table 5. Spearman correlation coefficients between ADG, placing, weight, age, withers height, hip height, hip width, and jaw width from the 2010 GJNLS[1]

Item	Placing	Weight	Age	Withers height	Hip height	Hip width	Jaw width
ADG	−0.02	0.14	−0.87	−0.15	−0.05	0.04	0.08
(*P*-value)	(0.76)	(0.03)	(<0.01)	(0.02)	(0.42)	(0.56)	(0.22)
Placing		0.11	0.04	0.42	0.32	0.08	−0.14
(*P*-value)		(0.10)	(0.55)	(<0.01)	(<0.01)	(0.22)	(0.04)
Weight			0.09	0.27	0.26	0.20	0.03
(*P*-value)			(0.17)	(<0.01)	(<0.01)	(<0.01)	(0.65)
Age				0.22	0.07	0.02	0.00
(*P*-value)				(<0.01)	(0.31)	(0.72)	(0.96)
Withers height					0.65	0.30	−0.04
(*P*-value)					(<0.01)	(<0.01)	(0.56)
Hip height						0.34	−0.10
(*P*-value)						(<0.01)	(0.15)
Hip width							0.14
(*P*-value)							(0.04)
Jaw width							
(*P*-value)							

[1]Georgia Junior National Livestock Show, Perry, Georgia.

Each county was evaluated to determine whether their Holstein heifers were or were not achieving weight requirements. A complete list of each county's proportion of Holstein heifers meeting weight requirements is shown in Table 6. With over 25 counties showing animals through these 4 yr, a wide range of proportions existed of heifers below or meeting weight requirements. Counties that had over 85% of their Holstein heifers not meeting weight were Chattooga (87.8%), Dawson (92.3), Perry (93.1%), and Macon (95.5%). On the contrary, 5 counties proved to have over half of the Holstein heifers exhibited meet or exceed weight guidelines. Wilcox (66.2%) exhibited the highest proportion of heifers meeting industry guidelines followed by Murray (35.7%), Whitfield (60.0%), Oglethorpe (53.16%), and Putnam (52.94%).

After breaking down the differences between suggested weight and actual weights, the highest proportion of heifers that were below specifications were within 25 kg of meeting the guidelines for shows during 2007 to 2009. For the 2010 shows, the highest proportion of underweight heifers was underweight by at least 25 kg

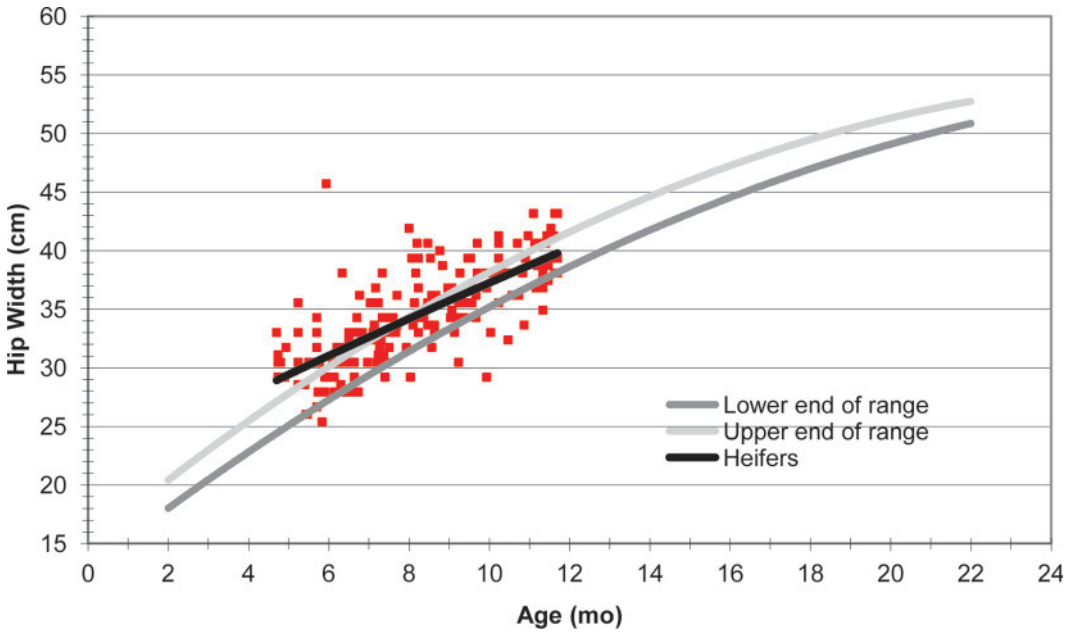

Figure 5. Hip widths compared with recommended widths at the 2010 Georgia Junior National Livestock Show (Perry, GA). Color version available in the online PDF.

Table 6. The Pennsylvania State Holstein Growth Spreadsheet: a view of each county's performance

County	No. of observations	No. of heifers underweight	% of total	No. of adequate weight heifers	% of total
Burke	29	20	68.97	9	31.03
Chattooga	41	36	87.80	5	12.20
Coweta	83	59	71.08	24	28.92
Dade	16	13	81.25	3	18.75
Dawson	13	12	92.31	1	7.69
Elbert	95	64	67.37	31	32.63
Greene	62	52	83.87	10	16.13
Houston	96	66	68.75	30	31.25
Jones	91	54	59.34	37	40.66
Lee	112	81	72.32	31	27.68
Macon	22	21	95.45	1	4.55
Madison	15	9	60.00	6	40.00
Morgan	131	71	54.20	60	45.80
Murray	14	5	35.71	9	64.29
Oconee	136	96	70.59	40	29.41
Oglethorpe	79	37	46.84	42	53.16
Peach	16	13	81.25	3	18.75
Perry	58	54	93.10	4	6.90
Putnam	102	48	47.06	54	52.94
White	77	42	54.55	35	45.45
Whitfield	15	6	40.00	9	60.00
Wilcox	71	24	33.80	47	66.20
Wilkes	80	46	57.50	34	42.50
Other[1]	35	22	62.86	13	37.14

[1]Counties with n <10 total observations from 2007 to 2010.

upwards to 50 kg underweight. For heifers that were meeting or exceeding Pennsylvania State's guidelines, the highest proportion of these heifers was within 25 kg of the benchmark. This was true for all 8 shows observed in the 4 yr observed. A breakdown of each show and the difference in actual weights from suggested weights is shown in Table 7.

The possible effects for heifers that are underweight for their age are numerous. Rate of growth has a direct effect on when a heifer becomes sexually mature (Heinrichs, 1993). Furthermore, the weight of the heifer is the main determining factor of when the onset of puberty occurs (Van Amburgh and Dalton, 1993; Sejrsen and Purup, 1997; Coffey et al., 2006; Tyler and Ensminger, 2006). For these 951 heifers that are not meeting the guidelines in this study, it is probable that the onset of puberty was delayed.

Another consequence of being underweight would be an increase in age at first calving. Rate of growth, or ADG, has a direct effect on age at first calving and productivity per day of herd life (Heinrichs, 1993). Because most of the heifers involved in the Georgia Commercial Dairy Heifer Program are leased, they are returned to their owners after the show season has been completed. For these heifers that are not meeting weight guidelines, it is possible that these heifers are calving later in their life, increasing the nonproductive period for the female and increasing the cost to raise the dairy

Table 7. Differences in suggested weight from actual weight from the Pennsylvania State Holstein Growth Spreadsheet

	Underweight (actual weight – suggested weight)			Adequate weight (actual weight – suggested weight)		
Show	<−50.00 kg (%)	−25.01 to −50.00 kg (%)	<0 to −25.00 kg (%)	0 to 25.00 kg (%)	25.01 to 50.00 kg (%)	>50.00 kg (%)
2007 UGA[1]	3.23	19.35	32.80	26.34	12.37	5.91
2007 Perry[2]	9.72	22.69	33.80	18.52	11.11	4.17
2008 UGA	18.48	16.85	27.71	23.37	9.78	3.80
2008 Perry	16.43	19.81	28.50	24.64	5.80	4.83
2009 UGA	11.18	19.08	24.34	25.00	12.50	7.90
2009 Perry	17.33	21.29	26.24	21.29	7.92	5.94
2010 UGA	19.01	26.76	23.94	15.49	9.86	4.92
2010 Perry	19.50	29.50	22.00	19.50	5.00	4.50

[1]University of Georgia Commercial Dairy Heifer Show, Athens, GA.

[2]Georgia Junior National Livestock Show, Georgia National Fairgrounds, Perry, GA.

replacement heifer (Willet, 1990; Heinrichs, 1993; Place et al., 1998; Brown et al., 2005). This can be reversed by increasing the amount of energy and protein in the dairy replacement heifer ration (Lammers and Heinrichs, 2000; Gabler and Heinrichs 2003; Brown et al., 2005). However, it may not be as efficient as during the first 6 mo of a dairy replacement heifer's life, when the cost per kilogram of BW gain is less than in any other time period (Kertz et al., 1998; Brown et al., 2005).

Holstein heifers shown in the Commercial Dairy Heifer Program were evaluated for growth and most of these heifers did not meet the industry's expectations. When looking at each county's proportion of underweight heifers, these results mirror the calculated ADG values for each county. Counties with low ADG values had higher proportions of underweight heifers. No single reason was identified as to why most of these dairy replacement heifers are underachieving. Whether the culprit is poor genetics, nutrition, environment, or other sources, people associated with the Commercial Dairy Heifer Program must be made aware of what many see in the ring anyway. However, the development of tomorrow's dairy industry, our leaders, and future producers hinge on the involvement of many within this program. Minor deviations from growth guidelines may not be as detrimental as one would think.

Whether it is to increase protein or improve environment conditions, it is important for to increase the number of heifers growing near or exceeding industry guidelines. The suggestions of 0.7 to 0.8 kg of ADG should be a priority to those associated with the Commercial Dairy Heifer Program, as well as adequate frame size, body depth, length, width, withers height, and hip height. This, in turn, will allow the owner of these heifers to reap the economic benefit of properly grown dairy replacement heifers and productive cows entering the milking herd in the future.

If calves shown in the Georgia Commercial Dairy Heifer Program are being underfed, dairy producers may be less willing to provide animals for youth participating in commercial heifer shows in the future. To ensure continued success of this activity, those involved should provide more careful weight guidelines for heifers participating in the show. Exhibitors should be better educated on proper feeding and an estimated ADG range that fits standard industry growth criteria. Growth and weight need to be better monitored.

CONCLUSIONS

When comparing commercial dairy heifers, evidence indicates no strong relationships between ADG, BW, and age with placing. An indirect relationship exists between age and ADG. After evaluating frame measurements of the heifers shown, withers height had the strongest relationship to placing within a class. Other anatomical measurements may prove to be related to placing. Because of stature's significance in evaluating dairy heifers, it is possible that withers height remains the strongest indicator of how well a dairy replacement heifer performs.

The purpose of this research was to evaluate growth of dairy replacement heifers shown in the Commercial Dairy Heifer Program. After completing this study, it is apparent that exhibitors, producers, and school personnel should strive to execute better rearing methods for these females. This could be enforced by changing the eligibility recommendations to mirror industry growth suggestions. If improved rearing methods occur, the owner may be able to increase productivity as the heifer matures. Although the withers height and other measurements were taken, the goal was to determine some measurement that could be related to and predict the placing of the commercial dairy heifer in the show. Further research may find a measurement that has a stronger relationship to placing, than withers height. These measurements may possibly help to validate age information provided by the owner, exhibitor, and or volunteer. Although it is believed that most exhibitors do report accurate ages of these heifers, if the ages were confirmed by researchers, a more detailed, accurate evaluation of heifer growth within the Commercial Dairy Heifer Show could be done.

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