Journal of Dairy Research (2016) **83** 453–455. © *Proprietors of Journal of Dairy Research 2016*
doi:10.1017/S0022029916000558

Effects of dam parity and pre-weaning average daily gain of Holstein calves on future milk production

Fatemeh Hoseyni[1], Ehsan Mahjoubi[2]*, Davood Zahmatkesh[2] and Mehdi Hossein Yazdi[2]

[1] Magsal Dairy Farm, Qazvin, Iran
[2] Department of Animal Science, Agriculture Faculty, University of Zanjan, Zanjan, Iran

Received 23 November 2015; accepted for publication 1 August 2016; first published online 29 September 2016

This research communication describes relationships between pre-weaning average daily gain (ADG) and dam parity with future productivity of dairy calves. Higher ADG before weaning has been shown to be related to greater milk production in the first lactation of Holstein calves fed milk replacer. However, data is limited on the relationship between pre-weaning ADG and first lactation performance of Holstein calves fed whole milk. Data of three hundred and thirty-two Holstein calves from 35 primiparous and 297 multiparous cows was investigated to evaluate the relationship between the dam parity and pre-weaning ADG with the first lactation performance. Results indicated that birth ($P < 0{\cdot}01$), and weaning body weight ($P < 0{\cdot}001$) were greater in calves born from multiparous cows. Neither 305 d milk production nor pre-weaning ADG differed significantly between calves born to primiparous or multiparous cows, although milk yield tended to be higher in the former and ADG higher in the latter. Correlations between 305 d milk yield and pre-weaning ADG, dam parity and birth body weight were low and non-significant, although there was a tendency for a positive correlation between ADG and milk yield.

Keywords: ADG, calf, dam parity, first lactation.

Well-grown dairy calves and heifers play an important role in the future success of all dairy farms, and the phase of growth occurring between birth and weaning may have major economic importance. Clearly, improvements in the first-lactation milk production would be the ultimate return for a greater investment in early calf rearing programs. Recent research has demonstrated that greater pre-weaning average daily gain (ADG) can have a positive effect on the future production (Moallem et al. 2010; Soberon et al. 2012; Soberon & van Amburgh, 2013), mainly due to higher growth rate during early life. However, not all studies agree and some have found there to be no effect of increasing whole milk or milk replacer intake during the neonatal period on first-lactation performance (Morrison et al. 2009; Raeth-Knight et al. 2009; Kiezebrink et al. 2015). These studies did have a few issues which should be considered, for instance, Kiezebrink et al. (2015) housed the milk-reared calves in environmentally controlled conditions, which is different from common on-farm conditions. These discrepancies call for more research in this area, particularly with the use of bigger data sets, which was the first objective of this research. In addition, there has been a positive correlation found between dam parity and calf birth weight (Elzo et al. 1987), which can affect ADG (Gregory et al. 1978). To our knowledge, nobody has evaluated this parameter in Holstein cows; therefore, the second objective of this study was to determine the effect of dam parity on future milk yield of the progeny.

Material and methods

Animal and experimental design

Growth and production parameters of 332 Holstein calves born during June to November 2012 were collected from a commercial dairy farm that had 3000 lactating cows (Magsal, Qazvin, Iran). This farm is located in a tropical area (longitude 50·31°E and latitude 36·07°N) where average daily milk production was around 37·5 kg per head. Thirty-five Holstein Friesian first lactation heifers and two hundred and ninety-seven multiparous cows were included in the dataset. All calves were managed similarly and fed whole milk, making it possible to detect

*For correspondence; e-mail: e_mahjoubi@znu.ac.ir; e_mahjoubi133@yahoo.com

Table 1. Growth and performance data on heifers' and cows' offsprings

Parameter	Dam parity: Heifer	SD	Cow	SD	*P*-value
Birth BW (kg)	35·31	0·83	37·71	0·29	0·01
Weaning BW (kg)	68·66	1·40	73·47	0·48	0·001
Age at weaning (d)	62·08	0·76	62·68	0·26	n.s.
Height at weaning	82·66	0·58	83·81	0·20	n.s.
ADG (g/d)	536·49	19·62	570·41	6·75	n.s.
Age at calving (d)	825·59	11·42	833·26	3·68	n.s.
305 d milk production (kg)	11 884·60	277·77	11 386·76	100·04	n.s.
305 d fat production (kg)	388·75	13·69	373·40	4·53	n.s.
305 d protein production (kg)	351·35	14·69	343·53	4·04	n.s.

within-herd variations related to ADG and first lactation performance.

All the calves were separated from their dam within 2 h of birth; the animals were fed 2.5.l of colostrum at each of the first 2 feedings (i.e. within 1·5 h after birth and in 12 h after the first feeding). Colostrum feeding was continued for the first 2 d of life. Calves were fed 4 l of whole milk in 2 separate feeds at 0800 and 1600 h, 4 l per day from 4 to 20 d of age, 5 l per day from 20 to 50 d of age, 2 l per day from 50 to 60 d of age, followed by milk being fed 1 l per day fed in one meal daily from 60 to 65 d of age in order to facilitate weaning. All calves were dehorned at 7 to 14 d of age using dehorning paste. Calves had unlimited access to water from day 3 onward. After weaning they were kept in groups of 12 calves per pens for 2 to 3 weeks, after which they were moved into groups of 24 calves per pen. At 3 of month of age onwards they all were kept in groups containing 80 calves per pen. All calves were offered cereal based starter from 3 d until 40 d of age, followed by which they were fed a mixed ration containing 10% alfalfa hay and 90% cereal based starter through until they were 3 months of age. Details of the diet are presented in online Supplementary Table S1.

Birth weight, weaning weight, hip height at weaning, age at weaning and age at calving were recorded for each calf. The ADG was calculated as: (weaning weight – birth weight)/days in period. Heifers were bred according to their body weight (BW; at least 360 kg) and hip height (130 cm) at 13 to 15 months of age and following. After calving, milk yield was recorded monthly. They were milked 3 times a day at 0600, 1400 and 2200. Milk fat and protein contents were analysed by CombiFoss 5000 (Foss Electric, Hillerød, Denmark). Actual 305-d milk yield as well as milk fat and protein yield were calculated from available data.

Statistical analysis

All data related to birth BW, weaning BW, age and height at weaning, pre-weaning ADG, age at calving, 305-d milk yield and milk fat and protein yield were analysed with the dam parity as independent variable in the model and data was analysed using MIXED procedures in SAS 9.4 (SAS Institute Inc., Cary, NC). To realise whether there is any relationship between early life performance and future production, regression of birth weight, weaning BW, age and height at weaning, pre-weaning ADG, age at calving and dam parity on 305-d milk yield was generated using PROC REG. Data were reported as least square means and were considered significant if $P < 0{\cdot}05$.

Results and discussion

The data on birth weight, pre-weaning ADG, hip height at weaning, age at first calving and 305-d milk yield (Table 1) was analysed. The average birth BW was 37·46 ± 4·97 kg, with a range from 21 to 55 kg. As expected, when mean birth BW was considered separately for primiparous and multiparous cows, the heifer calves from cows were 2·5 kg heavier than progeny from primiparous animals (35·31 *vs* 37·71 kg; $P < 0{\cdot}007$). Across the whole dataset, mean ADG was 566 g/d with a range of 269 to 1016. This range of ADG was narrower than reported by Soberon et al. (2012) and greater than reported by Yaylak et al. (2015). Both of these authors presented data obtained across several years. We did not collect information regarding quality of colostrum offered, and this may have influenced ADG (Faber et al. 2005), although farm management mandated offering frozen colostrum if dam colostrum was of insufficient quality. Dam parity did not significantly affect pre-weaning ADG ($P > 0{\cdot}05$), with 536 *vs* 570 g/d for progenies of primiparous *vs* multiparous cows, respectively. As a result, weaning BW also followed a similar trend and multiparous cows had heavier calves at weaning ($P < 0{\cdot}01$). Yaylak et al. (2015) reported that a one kg increase in birth BW caused an increase of 890 g in weaning weight and a decrease of 1·26 g in daily live weight gain. Kertz & Loften (2013) suggested that at increase of 680 g in ADG would double calf birth weight by the end of 2 months of age. Our data suggests that this relationship does not apply across all farms, as the calves in our study were able to more than double body weight at lower ADG. This further suggests that optimal calf growth may depend on initial body weight.

Table 2. Correlation coefficient and equations developed from linear regression of the following pre-weaning and management parameters with 305 d milk yield

Dependent variable	Derivation	Correlation coefficient	*P*-value
Birth BW	$y = 10\,272 + 31{\cdot}26x$	0·102	0·095
Weaning BW	$y = 10\,266 + 16{\cdot}07x$	0·085	0·164
Age at weaning (d)	$y = 11\,848 - 6{\cdot}46x$	−0·018	0·768
Hip height at weaning (cm)	$y = 8468{\cdot}39 + 35{\cdot}51x$	0·077	0·205
ADG (g/d)	$y = 11\,198 + 0{\cdot}43x$	0·032	0·059
Age at calving (d)	$y = 10\,191 + 1{\cdot}49x$	0·077	0·355

Hip height at weaning tended to be lower in calves from primiparous dams compared to calves from multiparous dams ($P < 0{\cdot}06$). Overall height of weaned calves (83·7 cm) was nearly 10 cm lower than that reported by Soberon et al. (2012), which may be due to different genetics and differences in mature body sizes of cows between our dataset and theirs. Similarly, the cows in our study were older at first calving compared to the data reported by Soberon et al. (2012), and may reflect the different management strategies in the two countries.

Although the actual 305-d milk yield tended to be greater in calves from primiparous dams compared to calves from multiparous dams this difference was not significant ($P >$ 0·05; Table 1). There was no difference in milk fat and protein yield between parities. Older data (Lubritz et al. 1989) using Hereford cattle, found that calves born to young dams produced more milk. The present study found a similar relationship between dam parity and milk production. Recent data (Hinde et al. 2014; Græsbøll et al. 2015) showed that milk production at first and second lactation could be affected by the sex of the calf at first calving, it appears that these kind of data should be interpreted with caution and more studies are needed to clarify the relationship between pre-weaning ADG, age of dam and calf sex on first lactation milk yield.

Milk production and pre-weaning ADG tended to be positively correlated, ($P = 0{\cdot}06$; Table 2). This observation is in agreement with Soberon & Van Amburgh (2013) and Soberon et al. (2012) who showed, in milk replacer fed calves, the higher pre-weaning ADG the more milk production in first lactation. Soberon et al. (2012) suggested that a 400 g increase in pre-weaning ADG would result in 621 kg more milk production in the first lactation and there is no plateau in response to pre-weaning nutrient intake. In contrast with the current study, more recently Kiezebrink et al. (2015) indicated that higher whole-milk feeding and, in turn, greater ADG was not translated to more milk production in first lactation. However, the calves in their study were kept under a controlled environment which is completely different from what happens in the real conditions inside the farm.

In conclusion the results of this study show that under farm conditions, the effects of pre-weaning ADG (obtained by whole milk feeding) and dam parity on future milk production are relatively small, albeit with a tendency for a positive effect of higher ADG.

Supplementary material

The supplementary material for this article can be found at http://dx.doi.org/10.1017/S0022029916000558

The authors gratefully thank Dr A. Bach for his instructive guidance in statistical analysis. We thankfully acknowledge Dr R. A. Patton and Mr Saman Jamshidi for English improvement of this paper.

References

Elzo AM, Quaas RL & Pollak EJ 1987 Effects of age of dam on weight traits in the Simmental population. *Journal of Animal Science* **64** 992–1001

Faber SN, Faber NE, McCauley TC & Ax RL 2005 Case study: Effects of colostrum ingestion on lactational performance. *Professional Animal Scientist* **21** 420–425

Græsbøll K, Kirkeby C, Nielsen SS & Christiansen LE 2015 Danish Holsteins favor bull offspring: biased milk production as a function of fetal sex, and calving difficulty. *PLoS ONE* **10** e0124051

Gregory KE, Cundiff LV, Smith GM, Laster DB & Fitzhugh HA, Jr 1978 Characterization of biological types of cattle – cycle II: I. Birth and weaning traits. *Journal of Animal Science* **47** 1022

Hinde K, Carpenter AJ, Clay JS & Bradford BL 2014 Holsteins favor Heifers, not Bulls: biased milk production programmed during pregnancy as a function of fetal sex. *PLoS ONE* **9** e86169

Kertz AF & Loften JR 2013 Review: A historical perspective of specific milk-replacer feeding program in the United States and effects on eventual performance of Holstein dairy calves. *Professional Animal Scientist* **29** 321–332

Kiezebrink DJ, Edwards AM, Wright TC, Cant JP & Osborne VR 2015 Effect of enhanced whole-milk feeding in calves on subsequent first-lactation performance. *Journal of Dairy Science* **98** 349–356

Lubritz DL, Forrest K & Robison OW 1989 Age of cow and age of dam effects on milk production of Hereford cows. *Journal of Animal Science* **67** 2544–2549

Moallem U, Werner D, Lehrer H, Zachut M, Liveshitz L, Yakoby S & Shamay A 2010 Long-term effects of ad libitum whole milk prior to weaning and prepubertal protein supplementation on skeletal growth rate and first-lactation milk production. *Journal of Dairy Science* **93** 2639–2650

Morrison SJ, Wicks HC, Fallon RJ, Twigge J, Dawson LE, Wylie AR & Carson AF 2009 Effects of feeding level and protein content of milk replacer on the performance of dairy herd replacements. *Animal* **3** 1570–1579

Raeth-Knight M, Chester-Jones H, Hayes S, Linn J, Larson R & Ziegler D 2009 Impact of conventional or intensive milk replacer programs on Holstein heifer performance through six months of age and during first lactation. *Journal of Dairy Science* **92** 799–809

Soberon F & Van Amburgh ME 2013 The effect of nutrient intake from milk or milk replacer of preweaned dairy calves on lactation milk yield as adults: a meta-analysis of current data. *Journal of Animal Science* **91** 706–7012

Soberon F, Raffrenato E, Everett RW & Van Amburgh ME 2012 Pre-weaning milk replacer intake and effects on long term productivity of dairy calves. *Journal of Dairy Science* **95** 783–793

Yaylak E, Orhan H & Daşkaya A 2015 Some environmental factors affecting birth weight, weaning weight and daily live weight gain of Holstein calves. *Turkish Journal of Agriculture-Food Science and Technology* **3** 617–622