

Advancing parity is associated with high milk production at the cost of body condition and increased periparturient disorders in dairy herds

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The objectives of this study were to determine the effects of parity on milk production, body condition change, periparturient health, and culling in Korean dairy herds. The data utilized included; milk yield, body condition score, cow parity, calving condition, periparturient disorders, culling, and reproductive status, which were recorded from 1290 calvings in eight dairy herds. The mean milk yield in cows over 305 days increased with increasing parity ($p < 0.01$). Cows with parities of 3, 4, and 5 or higher lost more body condition than those with a parity of 1 during month 1 of lactation ($p < 0.01$), and body condition recovery by cows with parities of 4 and 5 or higher was slower ($p < 0.01$) than recovery by cows with parities of 1, 2, or 3 until month 3 of lactation. The risk of retained placenta, metabolic disorder, and endometritis also increased with advancing parity ($p < 0.05$). Moreover, the incidence of ovarian cysts was lower in cows with a parity of one than in cows with greater parities ($p < 0.01$). Culling rate due to reproductive failure also increased with advancing parity ($p < 0.01$). These results suggest that parity increases milk yield, body condition loss during early lactation, the risk of periparturient disorders, and culling due to reproductive failure in dairy herds.

Key words: body condition, culling, milk yield, parity, periparturient disorder

Introduction

Milk is the major source of income generated on dairy farms, and over the past several decades, milk production by dairy cows has increased markedly. However, this improvement comes at the cost of higher incidences of reproductive health problems and reduced fertility [21]. Large energy requirements at the onset of lactation in high-

producing dairy cows results in a severe negative energy balance during the early lactation period [2,4], which may adversely impact postpartum health and fertility [6,28].

As a result of milk production quotas, reductions in production costs can allow dairy farms to maintain profitability. Herd replacement must be carefully managed to maintain profit margins under these conditions. Culling is a technique used to improve herds but can incur considerable costs. For example, the costs associated with raising replacement heifers have been estimated to be approximately 20% of the overall dairy herd operating cost [22]. Moreover, involuntary culling is caused mainly by reproductive failure [32]. Thus, more attention is now being given to reproductive health management; but correlations between cow parity, milk yield, nutritional status, periparturient health, and fertility require clarification in Korean dairy herds. The objectives of this study were to determine the effect of parity on milk production, body condition change during early lactation, periparturient health, culling due to reproductive failure, and reproductive performance in Korean dairy herds.

Materials and Methods

Herds and data collection

This study was performed in Holstein dairy farms located in Chungbuk province, Korea. All herds contained 50 or more cows and received regular reproductive health checkups every 2 to 4 weeks from veterinarians at the College of Veterinary Medicine, Chungbuk National University. The cows were maintained in free-stall facilities and fed a total mixed ration, based on brewer's grain, alfalfa hay, cotton seed, beet pulp, sweet sorghum, tall fescue, oat hay, and additives. Cows were milked twice daily and were observed for estrus behavior twice a day.

Data were collected from 1,290 calvings in eight dairy herds from October 2000 to May 2005. Data were collected on milk yield, body condition score, cow parity, calving condition, disease occurrence, culling due to reproductive failure, and reproductive status. Daily milk production data were collected monthly by the Korean Animal Improvement

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Association. Body condition was scored using standard procedures based on a scale of 1 to 5, as described by Edmonson *et al.* [11]. Cows were scored for body condition every 4 weeks, and once at calving.

Definitions of periparturient disorders

Abnormal partus included; dystocia (veterinary-assisted calving or pulling with extreme force), caesarean section, twins, or stillbirth [18,25]. The postpartum reproductive and metabolic disorder definitions used in this study are similar to those used in previous studies [5,9,27,35]. Retained placenta was defined as the retention of the fetal membrane for >24 h [5,25]. Metabolic disorders (abomasal displacement, milk fever, or ketosis) were diagnosed by clinical signs observed by a veterinarian and/or the farmer concerned within 4 weeks postpartum. Abomasal displacement was diagnosed by a pinging sound upon abdominal auscultation by a veterinarian, and all cases were corrected by surgery. Milk fever was diagnosed by the presence of the following clinical signs: weakness, cold skin, and a favorable response to calcium therapy. Ketosis was defined as the presence of the following clinical signs; anorexia, depression, and an odor of acetone in breath. Endometritis was diagnosed at 4 weeks postpartum by examination by the corresponding author, by the presence of the following clinical signs; cloudy discharge and an enlarged uterus observed by rectal examination with or without other clinical signs. Therefore, endometritis included cases of metritis and pyometra as well as of endometritis [12,23]. Ovarian cysts were diagnosed from 4 to 16 weeks postpartum by repeated ultrasonographic examinations at 2 to 4 week intervals (Sonoace 600 with a 5.0 MHz linear-array transducer; Medison, Korea). Ultrasonographic evaluations were based on ovarian structures of larger than 25 mm internal diameter with a wall less than 3 mm thick (follicular cyst) or with a wall greater than 3 mm thick (luteal cyst) in the absence of a normal corpus luteum [16,35]. Repeat occurrences of these conditions in a single cow were included in the analysis.

Evaluation of reproductive performance and culling

Cows diagnosed with ovarian follicular cysts beyond 8 weeks postpartum were treated with 100 µg fertirelin acetate (GnRH; Conceral, Korea) and cows diagnosed with luteal cysts were treated with 25 mg PGF_{2α} (Lutalyse; Pharmacia & Upjohn, Belgium). The cows with endometritis were treated with one intrauterine infusion of 1500 mg oxytetracycline hydrochloride solution (Metrijet 15; Intervet, U.K.) or 2% povidone-iodine solution (Korea Pharma, Korea), and retreated if necessary. The voluntary waiting period from calving to first artificial insemination (AI) established for this study was 50 days. AI was performed according to the a.m.- p.m. rule. The conception to AI ratio were determined per rectum 60 to 70 days after AI by both ultrasonographic observation and manual palpation. Reproductive performance

data were collected for a minimum of 7 months postpartum or until pregnancy or culling. Cows sold due to reproductive failure were included among culling data.

Data analysis

Parity in these herds was categorized as 1, 2, 3, 4, or 5 or higher. Statistical analyses were performed using the SAS program [33]. The relation between milk yield and parity was explored by ANOVA. Body condition score changes versus parity from calving until months 5 of lactation were also compared by ANOVA. The occurrences of periparturient disorders and culling rate among the various parities were evaluated using the chi-square test or Fishers' exact test. Intervals from calving to first service and conception were analyzed by ANOVA. For all tests, *p* values <0.05 were considered significant.

Results

During the study period, the average percentages of cows with parities of 1, 2, 3, 4, or 5 or higher were 31.1, 27.9, 20.5, 11.8, and 8.7%, respectively. Mean 305 day milk yield increased (*p* < 0.01) with increasing parity (Fig. 1); yields for parities of 1, 2, 3, 4, and 5 or higher were 8,431, 9,774, 10,191, 10,812, and 10,611 kg, respectively. Relations between body condition score and parity during lactation are shown in Fig. 2. Cows with parities of 3, 4, and 5 or higher lost more body condition (*p* < 0.01) than those with a parity of 1 during the first month of lactation. The recovery of body condition for cows with parities of 4 or 5 or higher was also more delayed than in cows with parities of 1, 2, or 3 until months 3 of lactation (*p* < 0.01), and body condition recoveries for cows with parities of 5 or higher was more continuously delayed (*p* < 0.01) than in cows with a parity

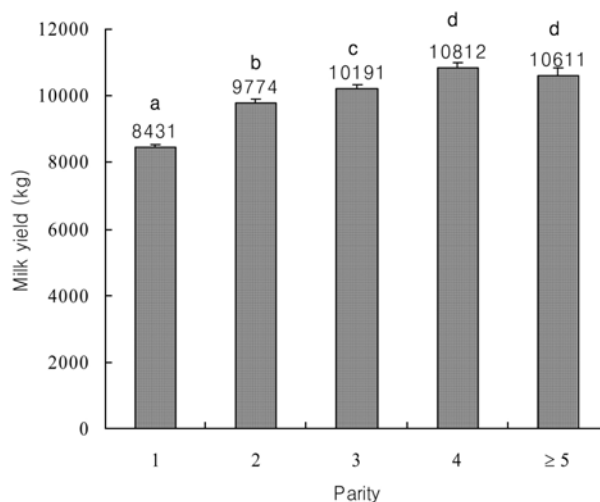


Fig. 1. The mean 305 day milk yield (kg) in cows with parities of 1, 2, 3, 4, and 5 or higher. Different letters (a-d) denote significant differences (*p* < 0.01).

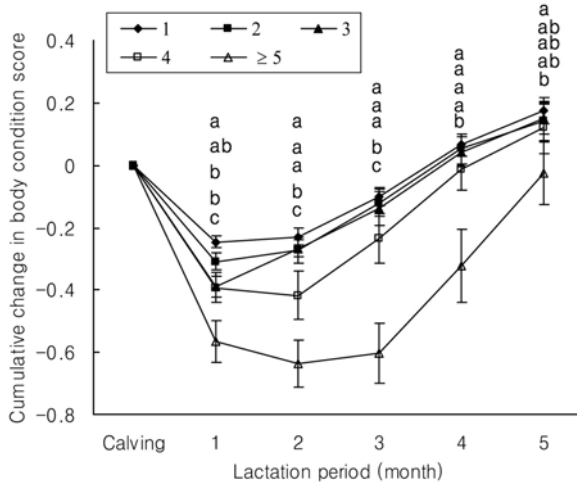


Fig. 2. Monthly changes in body condition scores during lactation in cows with parities of 1, 2, 3, 4, and 5 or higher. Different letters (a-c) denote significant differences among parities in each month ($p < 0.01$).

of 1 until month 5 of lactation. The occurrence of periparturient disorders was as compared with parity (Fig. 3). The risks of retained placenta, metabolic disorder, and endometritis increased with parity ($p < 0.05$), whereas the risk of abnormal partus was highest for cows with a parity of 4 than in cows with other parities ($p < 0.01$). The incidence of ovarian cysts was lower in cows with parity of 1 than in cows with other parities ($p < 0.01$). Moreover, the culling rate due to reproductive failure increased with parity ($p < 0.01$, Fig. 4). However, the reproductive performance of cows was not significantly different for the various parities ($p > 0.05$, Fig. 5).

Discussion

The data presented here demonstrate that advances in parity increase the risk of periparturient disorders and the incidence of culling due to reproductive failure in dairy herds. We suggest that severe loss and delayed body condition recovery due to increased milk yield during the early lactation period are responsible.

In the present study, mean 305 day milk yield increased with parity, which is consistent with previous reports [7,26]. Body condition loss during early lactation, which reflects a negative energy balance, was found to be aggravated by parity, as has been reported by others [19,36]. The inverse correlation between body condition score and increased parity during early lactation is presumed to be related to milk yield, which is also consistent with previous results [19], and demonstrates that body condition scores, which reflect the amount of fat mobilized during early lactation, decrease as milk yield increases. It has been reported that excessive lipid mobilization from adipose tissue, noted even

in clinically normal cows during early lactation, may be linked to higher incidences of periparturient health disorders [10].

Our finding of increased risks of a retained placenta and metabolic disorder in association with parity have been reported by others [13,21,30]. Metabolic disorder is influenced by increased milk yield [17] and with a severe loss and delayed recovery of body condition during early lactation [24], and these are clearly and positively correlated with parity. Moreover, the correlation between an increased risk of endometritis and advancing parity, found in the present study, is in agreement with a previous study [13] but contradicts another [30]. This latter study found that the risk of endometritis is highest in first parity cows. On the other hand, other studies have reported no relation between cow parity and the incidence of endometritis [17,21]. An increased risk of endometritis may result from over-fattening and an increased rate of stillbirth in first parity cows [29]. However, our data do not support this hypothesis, and we regard our finding of an increased risk of a retained placenta in high parity animals as an important finding. Moreover, profound periparturient impairment of neutrophil function associated with advancing parity [20] might increase susceptibility to endometritis. The increased risk of abnormal partus in cows with a parity of 4 was mainly caused by an increased occurrence of twins in this parity group, although the reason for this higher incidence was not clarified. It has been reported that the incidence of ovarian cysts is lower in cows with a parity of 1 than in other parities. Similarly, the incidence of ovarian cysts was found to increase with age [13,21]. An increased incidence of ovarian cysts in animals with a higher parity may be related to high milk yield, and a clear relationship between milk yield and the incidence of ovarian cysts has been reported on a number of occasions [3,14,23]. Taken together, these results suggest that increased milk yield and concurrent severe body condition loss during early lactation elicit a severe energy deficit, which may be related to the occurrence of postpartum reproductive (ovarian cysts) and metabolic diseases.

The major reason for involuntary culling is reproductive failure [32,34]. Our finding that culling rates due to reproductive failure increase with advancing in parity is consistent with previous studies [1,8]. Moreover, postpartum reproductive diseases can affect fertility and cause delayed conception, which may indirectly lead to culling [32]. Likewise, in our study, the increased incidence of postpartum diseases associated with parity may have a reduced fertility and led to an increased need for culling. In the report of Seegers *et al.* [34], cows culled for reproductive disorders early in their lives (parity 1 or 2) were high-yielding cows that were presumed to have had a negative energy balance during the early lactation period, a condition that is exacerbated in young and/or high-producing cows. In fact, increased culling due to reproductive failure associated with

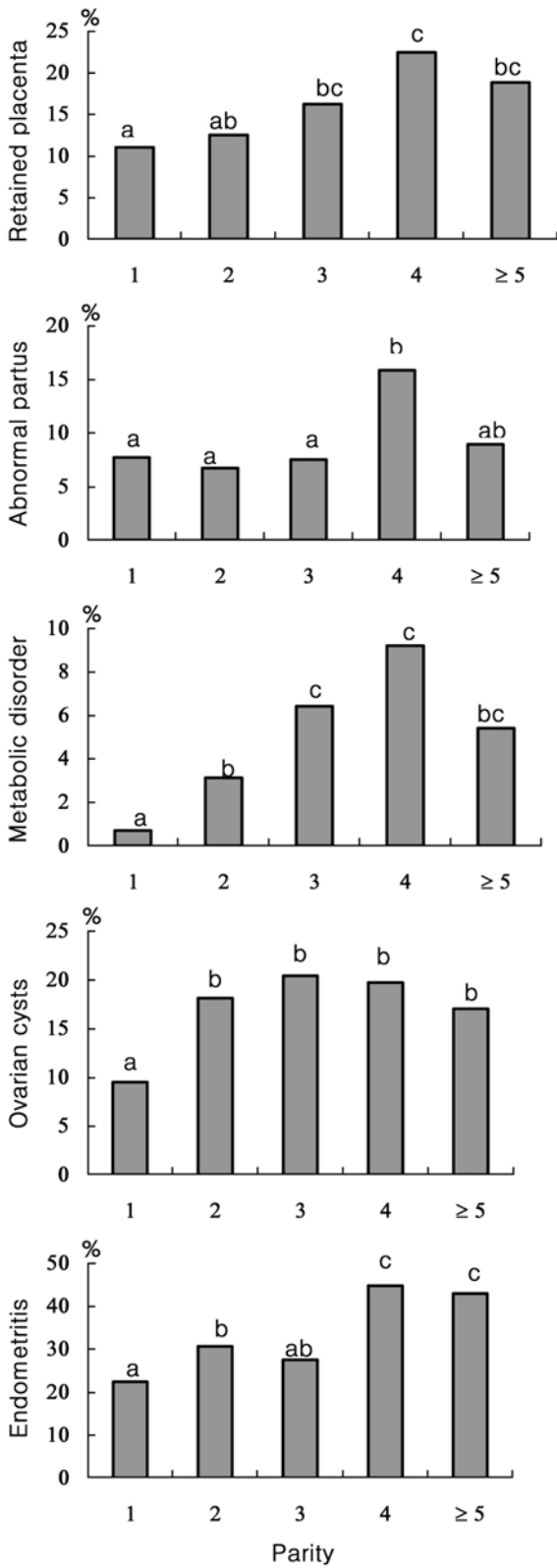


Fig. 3. Occurrence of periparturient disorders in cows with parities of 1, 2, 3, 4, or 5 or higher. Different letters (a-c) denote significant differences between parities for each disorder ($p < 0.05$).

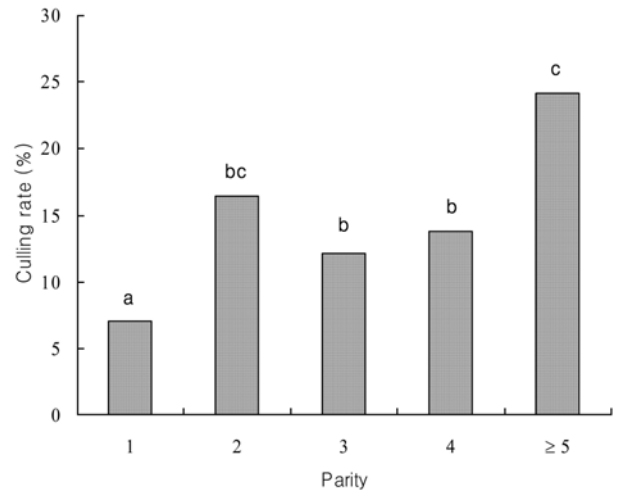


Fig. 4. Comparison of culling rates due to reproductive failure in cows with parities of 1, 2, 3, 4, or 5 or higher. Different letters (a-c) denote significant differences ($p < 0.01$).

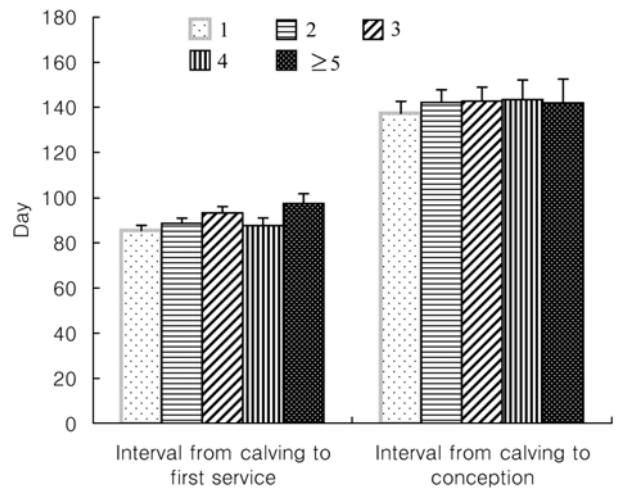


Fig. 5. Comparison of the intervals from calving to first service and conception in cows with parities of 1, 2, 3, 4, or 5 or higher. Values are means \pm SEM. No significant difference between parities ($p > 0.05$).

parity increases might be attributed to a series of body stresses including high milk yield, concurrent exaggerated body condition loss, as well as to postpartum metabolic and reproductive diseases during the lactation period.

The mean intervals from calving to first service and conception for cows with different parities were no different. However, the relationship between parity and fertility is difficult to determine because of the confounding effect of culling under farm conditions. Older cows are reportedly less likely to conceive [15,21,31], although we did not find this. Our correlation between fertility and parity may be explained by our observation that culling rates increased with parity increases. However, the reproductive performance of cows culled was not included in this study.

In conclusion, this study shows that increases in parity increase milk yield, body condition loss during early lactation, and the risk of periparturient disorders and of culling due to reproductive failure in dairy herds.

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