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Effect of Age at First Calving on Productive and Reproductive Performance in Dairy Cattle

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Abstract : This retrospective study evaluated the effect of age at first calving on the productive and reproductive performance in Holstein dairy cattle. Data were collected on 2,297 lactations from 19 dairy farms, including dates of birth, insemination, pregnancy, calving, and lactation and milk production (305-day milk yield at first lactation and lifetime milk yield). Lactation data were grouped based on age at first calving into the early (< 24 months, n = 414), moderate (24 ≤ and ≤ 28 months, n = 1,268), and late (> 28 months, n = 615) groups. The 305-day milk yield at first lactation was higher ($p < 0.005$) in the late group (8,461.9 kg) than in the early (8,130.8 kg) and moderate (8,261.9 kg) groups. Lifetime days in milk were shorter ($p < 0.01$) in the early group (1,045.7) than in the moderate (1,143.1) and late (1,110.7) groups, whereas the lifetime milk yield was higher ($p < 0.05$) in the moderate group (34,171.8 kg) than in the early group (31,791.6 kg). The second calving interval (days) differed ($p < 0.0001$) between the early (416.9), moderate (438.9), and late (455.3) groups. The culling rate at the first and second lactations tended to be higher ($p = 0.08$) in the early group (31.2%) than in the moderate group (26.0%), whereas it was intermediate in the late group (29.3%). In conclusion, dairy heifers aged 24-28 months at first calving showed a higher productive performance through an increased lifetime milk yield and a decreased culling rate.

Key words **:** dairy cows, age, first calving, productive performance, reproductive performance.

Introduction

Under the milk quota systems and an open economy, cost reduction has become inevitable to maximize herd profits in the dairy industry (3). A basic approach to reduce costs is to shorten the nonproductive period of dairy heifers (14). Age at first calving, which is one of the many factors affecting dairy farm profitability (20), is an important factor determining the length of the nonproductive period as well as affecting subsequent fertility and productivity in dairy herds (8,9,18).

A younger age at first calving reduces rearing costs due to decreased feed, labor, and farm space (5), as well as an earlier return on investment (10,15). However, first calving at a younger age may lead to difficult calving and decreased milk production at first lactation (6,8,18). On the contrary, an older age at first calving is associated with economic loss due to increased rearing costs, decreased milk production, lower fertility, and increased culling (2,3,5,9,11).

Fertility in the first lactation was best in cows calving at 23-25 months of age and worst in cows that were oldest (> 30 months) at first calving (5). Heifers calving at 24 months of age had the greater odds of survival to higher parities than heifers calving at approximately 3 years of age (2). Thus, establishment of the optimal age at first calving, which may affect subsequent milk production, productive life, reproduction, and culling, is required to maximize net returns in dairy farms. Therefore, the objective of the present study was to determine the effect of age at first calving on the productive and reproductive performance in Holstein dairy cattle.

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Materials and Methods

Animals and management

This study was conducted on 19 dairy farms in Chungcheong Province. The cows were maintained in a loose housing system, fed a total mixed ration, and milked twice daily. They received regular reproductive health checks every 2-4 weeks by veterinarians at the College of Veterinary Medicine, Chungbuk University. Virgin heifers received the first artificial insemination (AI), started from 10 months of age, variably according to the growth of heifers and farmers' breeding policy. Following parturition, the regular reproductive health checks included an examination of ovarian structures, such as the corpus luteum, follicles, or cysts, and the uterus via transrectal palpation and ultrasonography. The voluntary waiting period from calving to the first AI was 40 days. In addition to estrous detection, a herd reproductive management program was employed for cows that failed to receive AI within the 80-day postpartum interval. This included estrus synchronization using prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) or Ovsynch. Cows that exhibited estrus naturally or after estrus synchronization using $PGF_{2\alpha}$ were inseminated according to the am-pm rule, whereas cows treated with Ovsynch received timed AI. Pregnancy was diagnosed rectally 40-50 days after AI using both

ultrasonography and manual palpation.

Data collection and study design

Data were collected from 2,297 heifers, which had calved from January 2005 to September 2014, on 19 dairy farms. These data included detailed information on dates of birth, insemination, pregnancy, calving, and lactation and milk production (305-day milk yield at first lactation and lifetime milk yield). All the data were collected from the Korean Animal Improvement Association. Lactation data were grouped based on age at first calving into the early (< 24 months, n = 414), moderate (24 ≤ and ≤ 28 months, n = 1,268), and late (> 28 months, n = 615) groups. This study compared the 305-day milk yield at first lactation, lifetime days in milk (DIM), lifetime milk yield, second calving interval (days), and culling rate at the first and second lactations between the three groups.

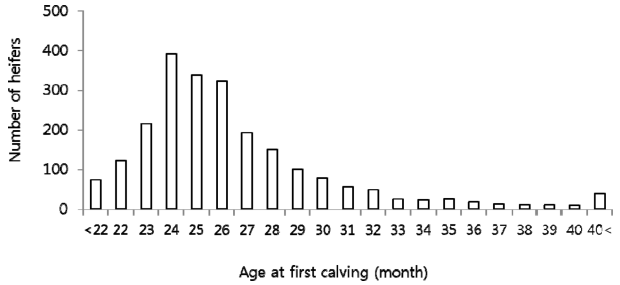

Fig 1. Frequency of age at first calving.

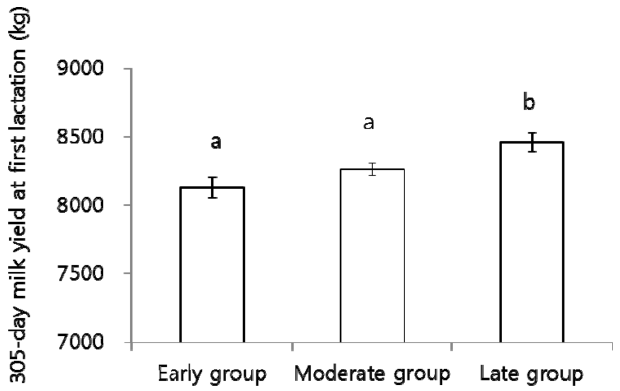

Fig 2. Comparison of the 305-day milk yield at first lactation between the early, moderate, and late groups. [a,b]means with different superscripts differ ($p < 0.005$) between groups.

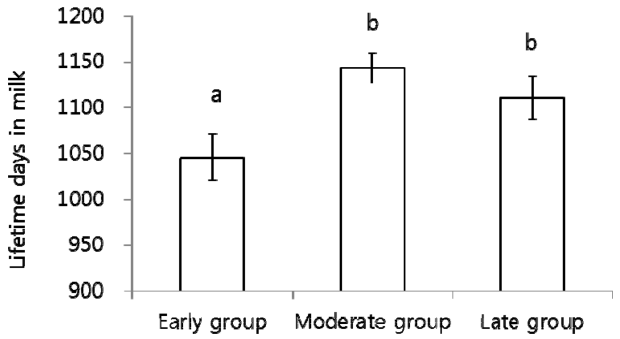

Fig 3. Comparison of the lifetime days in milk between the early, moderate, and late groups. [a,b]means with different superscripts differ ($p < 0.01$) between groups.

Statistical analysis

Results were expressed as the means ± standard error of the means. Statistical analyses were performed using the SAS program (version 9.4, SAS Inst., Cary, NC, USA). Statistical analysis of 305-day milk yield at first lactation, lifetime DIM, lifetime milk yield, and second calving interval (days) was carried out using an analysis of variance followed by Duncan's multiple range tests. The culling rate was compared using the Chi-squared test. A p-value ≤ 0.05 was con-

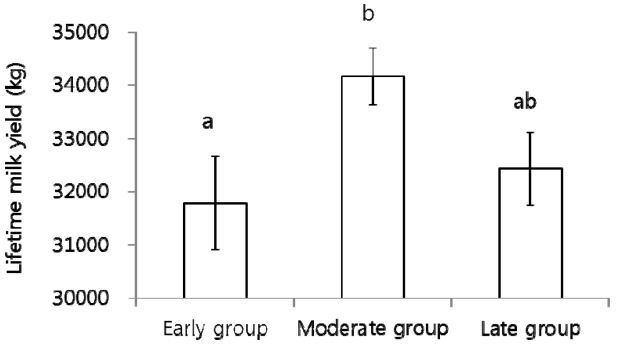

Fig 4. Comparison of the lifetime milk yield between the early, moderate, and late groups. [a,b]means with different superscripts differ ($p < 0.05$) between groups.

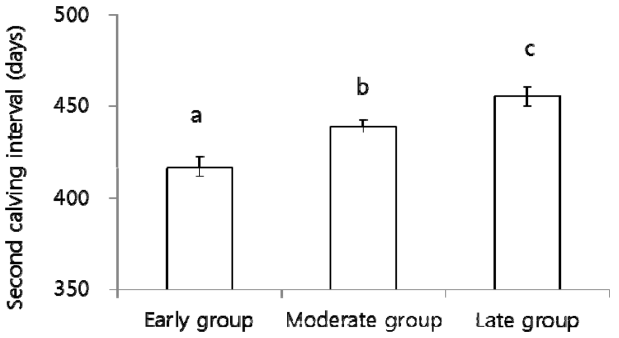

Fig 5. Comparison of the second calving interval (days) between the early, moderate, and late groups. [a,b,c]means with different superscripts differ ($p < 0.0001$) between groups.

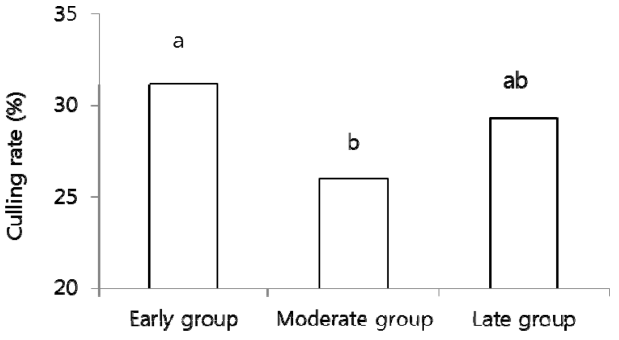

Fig 6. Comparison of the culling rate at the first and second lactations between the early, moderate, and late groups. [a,b]means with different superscripts tend to differ ($p = 0.08$) between groups.

sidered significant, and $0.05 < p < 0.1$ was considered to indicate a tendency toward significance.

Results

The distribution of heifers by age at first calving is shown in Fig 1. Most heifers calved between 23 and 28 months of age (70%), with a peak at 24 months of age. The overall mean age at first calving was 27.0 (± 0.1) months. The 305-day milk yield at first lactation was higher ($p < 0.005$) in the late group (8,461.9 ± 68.0 kg) than in the early (8,130.8 ± 71.6 kg) and moderate (8,261.9 ± 45.9 kg) groups (Fig 2). Lifetime DIM was shorter ($p < 0.01$) in the early group (1,045.7 ± 25.6) than in the moderate (1,143.1 ± 16.0) and late (1,110.7 ± 23.4) groups (Fig 3), whereas the lifetime milk yield was higher ($p < 0.05$) in the moderate group (34,171.8 ± 528.1 kg) than in the early group (31,791.6 ± 884.0 kg, Fig 4). The second calving interval (days) differed ($p < 0.0001$) between the early (416.9 ± 5.0), moderate (438.9 ± 3.3), and late (455.3 ± 5.3) groups (Fig 5). The culling rate at the first and second lactations tended to be higher ($p = 0.08$) in the early group (129/414, 31.2%) than in the moderate group (330/1,268, 26.0%), whereas it was intermediate in the late group (180/615, 29.3%, Fig 6).

Discussion

This study evaluated the effect of age at first calving on the productive and reproductive performance in Holstein dairy cattle. Cows calving at a young age (< 24 months) had a low lifetime milk yield but a shorter second calving interval, whereas cows calving at an old age (> 28 months) had a longer second calving interval than cows calving at a moderate age (24 ≤ and ≤ 28 months). These results indicate that first calving at 24-28 months of age is suggested for dairy producers, taking into consideration milk production, feed costs, and reproduction.

The overall mean age at first calving was 27.0 months in the present study. This is comparable to a previous study (16), in which the mean age at first calving of the population was 26.8 months. However, the mean age at first calving in our study was older than a previous report of 25.9 months (12) and younger than a previous report of 28.1 months (18). Variability in age at first calving might be associated with nutrition, housing, and management factors that affect the health and growth of calves and the reproductive efficiency of heifers (8,13).

The 305-day milk yield at first lactation was higher in the late group than in the early and moderate groups in the present study, which is consistent with previous studies (6,8). Other studies also showed that first calving at a younger age resulted in a reduction in the actual and 305-day milk yield in the first parity (1,15,18). Similarly, Berry and Cromie (2) showed that the first lactation 305-day milk yield decreased almost linearly by 55.5 kg for each month decrease in the age of heifers at first calving. The reason why the 305-day milk yield was lower in cows calving at a younger age than in cows calving at an older age was not clear in our study. However, a study explained that a decreased milk yield with a younger age at first calving might be related to suboptimal development of mammary tissue (19).

Lifetime DIM was shorter in the early group than in the moderate and late groups in our study, which is discordant with a previous study (5) in which animals that were younger at calving (< 26 months) achieved more DIM over 5 years. Furthermore, Zavadilová and Štípková (22) reported that the length of productive life was shorter for cows that first calved at an older age (33-46 months) than for cows that first calved at a younger age (16-24 months). On the other hand, other previous studies reported that age at first calving had no profound effect on productive life (16,21). The lifetime milk yield was higher in the moderate group than in the early group, but was intermediate in late group in the present study. This observation is not supported by previous studies (11), which reported that lifetime performance appeared to be maximized with freshening at 22.5-23.5 months of age. Cooke et al. (5) reported that cows aged < 26 months at first calving produced the most milk in their first 5 years of life. However, Ettema and Santos (8) reported that heifers in the medium age group (701-750 days) had an adjusted income value that was $138.33 and $98.81 higher than heifers in the low (≤ 700 days) and high (≥ 751 days) age groups, respectively.

Our results showed that the second calving interval (days) was shortest in the early group, and was shorter in the moderate group than in the late group, which is supported by other studies (5,22). Fertility in the first lactation was best in cows calving at 23-25 months of age and worst in cows that were oldest (> 30 months) at first calving (5). Furthermore, Zavadilová and Štípková (22) reported that days open tended to be longer in older cows (33-46 months) than in cows aged 16-24 months at first calving.

The culling rate at the first and second lactations tended to be higher in the early group than in the moderate group in our study. This is similar to a previous study (14) in which the group that was younger at first calving (≤ 749 days vs. 799-750 and > 800 days) had the highest culling rate of 41%. Similar to our results, cows calving at 25-26 months of age had the highest survival rate (9). However, Chirinos et al. (4) found that relative risk was highest for cows older than 34 months at first calving. Bielfeldt et al. (3) also reported that culling risk was higher if first calving took place when heifers were older than 3 years. On the other hand, a previous study reported that culling rates were not affected by age at first calving (8), as also observed by Ducrocq (7) and Ojango et al. (17). It has been suggested that high culling risk for heifers that are older at first calving might be related to reproductive problems (21).

Our results described above showed that cows that first calved at a young age (< 24 months) had a low lifetime milk yield, whereas cows that first calved at an older age (> 28 months) had a longer second calving interval than cows that first calved at a moderate age (24 ≤ and ≤ 28 months). Therefore, the choice of first calving at moderate age (24-28 months) may be beneficial to save expenses for replacement heifers and to increase farm incomes by increasing milk yield. For veterinary practitioners who perform reproduction consultations for dairy farms, it is recommended that the health or reproduction of virgin heifers aged older than approxi-

mately 18 months is checked during their routine veterinary visits. Furthermore, estrous induction is required for the heifers to avoid prolonged AI. Moreover, dairy producers and veterinary practitioners should keep in mind that breeding of heifers when they are too young (approximately younger than 12 months) should be avoided.

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