

Research Reflection

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Physical development, ease of integration into the dairy herd and performance of primiparous dairy cows reared with full whole-day, half-day or no mother-contact as calves

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Abstract

We investigated whether different rearing conditions affected the physical development, ease of integration into the dairy herd and performance of primiparous dairy cows and the results are reported in this Research Communication. The three rearing conditions investigated were whole-day cow-calf contact for 9 weeks (WDC), half-day contact for nine weeks (HDC) and no mother-contact (NC) with nipple-bucket-feeding (max. 2×3 l/d) and group-housing from the 8th day onward. After permanent separation from the dams (WDC and HDC), all calves had been nipple-bucket-fed and gradually weaned from week 10 to 13 of life and kept together as calves and heifers. Measures of physical development were trunk girth, height at withers and body weight. Lying behavior during the first 48 h after introduction to the dairy herd after first calving was used as an indicator of ease of integration. Performance measures were age at calving, lactation duration, milk yield and culling rates during the first lactation. No differences between WDC and HDC could be detected. Moreover, no treatment-effects on physical development or performance could be found. All treatments showed reduced lying for the first 24 h after introduction to the dairy herd. Afterward NC-heifers lay less than WDC, with HDC-heifers ranging in between. We conclude that under the conditions investigated higher weights two weeks after weaning in WDC- and HDC-calves did not carry through to the first lactation and did not lead to earlier maturity and higher performance, but that integration into the herd may be alleviated when calves have early experience of the herd and associated conditions.

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Reflections of pros and cons of the rearing of dairy calves with or without cow contact repeatedly highlight the research gaps regarding potential long-term effects (reviewed by Johnsen *et al.*, 2016). For instance, it is often expected that the usually increased growth of nursed calves might lead to earlier maturity and higher milk performance in the first lactation, because some studies point to a better development of heifers fed high amounts of milk as calves (reviewed by Khan *et al.*, 2011). Moreover, prolonged cow-calf contact may enhance social abilities of the offspring (reviewed by Johnsen *et al.*, 2016). For example, Wagner *et al.* (2012) found more submissive behavior in dam-reared heifers, which was more pronounced in whole-day compared to 2×15 min/d partial contact during the first 12 weeks of life. However, this was not confirmed by Kälber *et al.* (2014), investigating whole-day compared to no contact. In order to provide more evidence on long-term effects, the current study investigated primiparous dairy cows that had experienced full whole-day, half-day or no mother-contact during their first nine weeks of life. It was the aim to analyze potential effects of the different cow-calf contact durations per day on physical development, ease of integration into the dairy herd and performance in the first lactation.

Materials and methods

Rearing period

The study was conducted in the German Black Pied dairy herd (>90% horned cows) of the organic research farm of the University of Kassel (Germany). The calves were born in 2011/2012 in single maternity pens. Treatment conditions are described in Zipp (2018). In brief, whole-day contact calves (WDC, $n = 13$) and half-day contact calves (HDC, $n = 11$) had stayed in the maternity pen with the mother for 3 d, and the pair had then been integrated in the WDC- or HDC-group-pen. All cows were milked twice daily and during this time separated from the calf. HDC-calves were additionally separated from their dams between afternoon and morning milking (18:00–06:45) when they were locked in the calf creep. Otherwise calves had free access to the calf creep (calf-driven contact; straw-bedded group

Table 1. Lying behavior (median \pm median absolute deviation) of primiparous cows during 1–24 h and 25–48 h after the introduction to the milking herd

Lying behavior	Whole-day contact	Half-day contact	No contact
Latency until first lying	4.2 \pm 3.9 h ^A	4.9 \pm 4.9 h ^A	4.5 \pm 7.2 h ^A
Total lying duration 1–24 h	5.0 \pm 1.0 h ^{A°}	4.2 \pm 0.4 h ^A	3.5 \pm 1.3 h ^A
Total lying duration 25–48 h	6.8 \pm 0.3 h ^{A*}	6.2 \pm 0.7 h ^{A°}	4.6 \pm 0.9 h ^{B**°}
Number of bouts 1–24 h	9 \pm 2 ^A	10 \pm 2 ^A	7 \pm 2 ^A
Number of bouts 25–48 h	16 \pm 5 ^{A*}	12 \pm 1 ^{A°}	8 \pm 3 ^{B**°}
Bout duration 1–24 h	21.5 \pm 2.4 min ^A	23.1 \pm 9.8 min ^A	19.4 \pm 9.1 min ^A
Bout duration 25–48 h	25.2 \pm 5.2 min ^A	25.3 \pm 3.9 min ^A	29.8 \pm 6.5 min ^A

Cows either had full whole-day ($n=5$), full half-day ($n=5$) or no mother contact ($n=9$) during the first nine weeks of life.

^A^BDiffering capital letters: differences between rearing conditions within the row.

Two treatments with * in the same row differ with $P < 0.05$.

Two treatments with ° in the same row differ with $P < 0.1$.

igloo with fodder and water trough). No contact calves (NC, $n=14$) were separated from the mother half a day after birth, kept individually during the first week of life (igloo with outdoor area) and nipple-bucket fed (3×2 l/d). Thereafter they were group-housed and received 2×3 l/d warmed whole milk. Calves of all treatments had access to the cow's ratio (mixture of grass silage, corn silage, straw and raw potatoes), hay, concentrate and water. Permanent separation with visual contact during the first week, and gradual weaning took place from the 10th to 13th week of life. One WDC- and two HDC-calves were disbudded under anesthesia and analgesia for another project. The heifers were kept on pasture during the summer and housed in a deep litter barn during the winter period. At the cow manager's discretion heifers were admitted for natural service, depending on body weight (min 400 kg). The cow manager was blind to the treatment.

Introduction to the dairy herd

Five WDC-, five HDC- and nine NC-heifers gave birth from April to November 2014. They were kept in single maternity pens with their calves until the introduction to the dairy herd after the second afternoon milking postpartum. The herd comprised 61–91 cows (mean = 79, SD = 7). The mothers of two WDC-, three HDC- and three NC-cows were in the milking herd during the integration process. Three WDC and one NC cows were introduced as pairs, the others singly. The cow barn consisted of a deep litter pen (312.5 m^2) and a cubicle pen with 48 littered cubicles (with free passage between the two), walking and outdoor area (205 m^2), 99 feeding places and four trough drinkers (each 2 m^2). Once per day fresh feed was supplied. Additionally, the herd had pasture access (5 to 19 h/d, mean = 9.2 h/d, SD = 4.2 h/d) until October. Two NC-cows integrated in November had no pasture access.

Data collection

After the second afternoon milking in the 2×6 -herringbone-parlor, a tri-axial accelerometer (Onset Pendant G, Onset Computer Corporation, Bourne, MA) was fitted to the right or left lateral cow's hind leg (by random selection) with elastic veterinary tape for 48 h. Following the recommendations of Ledgerwood *et al.* (2010), we used a logging interval of the x- and y-axes of 30 sec; a lying bout was defined as lasting 90 s at minimum. The latency

until first lying, total lying duration, number of lying bouts and mean bout duration was calculated per animal for 1–24 h and 25–48 h after introduction to the herd.

Behavior in the feeding area and interactions with the mother were analyzed from video material. However, due to high variations in video material length per animal (pasture access and technical problems), these data are not shown.

Height at withers (folding rule), trunk girth (tape measure) and body weight (electronic scale, precision: ± 1 kg, EziWeigh2, Tru-Test Group Limited, Auckland, New Zealand) were recorded 48 h after the introduction after milking. Age at calving, milk yield until 100th days in milk, lactation duration, mean milk yield per day (lactational milk yield/lactation duration), number of culled cows and reasons were taken from the milk recording data.

Statistical analysis

Due to the small sample size, the non-parametric Kruskal-Wallis-Test was used to analyze treatment-effects on the dependent variables. If results were $P < 0.05$, Wilcoxon Rank Sum Tests were used as post-hoc tests. Cullings were compared using Fisher's Exact Test. All tests were done in R (Version 3.1.2, R Development Core Team, 2014). Results are presented as median \pm median absolute deviation ($Median(|X-Median(X)|)$). The level of significance was set at $P < 0.05$. Horn status, single/pairwise integration and amount of pasture access were checked graphically for potential effects, but not found to be influential.

Results

No differences in age at first calving (30 ± 1 months), body weight (520 ± 26 kg), height at withers (134 ± 1 cm) and trunk girth (197 ± 3 cm) could be found between rearing conditions.

Concerning the different lying parameters (Table 1), WDC and HDC did not differ, which was also the case in comparison to NC during 1–24 h after introduction. However, from 25–48 h WDC had significantly more lying bouts than NC. HDC showed a mathematical increase which was not significant. This resulted in significantly longer total lying durations of WDC and numerically longer total lying durations of HDC compared to NC ($W=9.0$, $P < 0.05$; $W=7.5$, $P=0.08$, respectively). The mean bout duration did not differ between treatments.

Effects of rearing conditions on performance parameters could not be detected. Milk yield until 100 d in milk was on average

1806 ± 248 kg ($n = 5-7$), lactation duration 256 ± 21 d ($n = 4-5$) and the mean milk yield of the lactation 14.6 ± 1.3 kg/d ($n = 4-5$). In total, two of five WDC and HDC (40% each) and five of nine NC (55.6%) left the herd before dry-off. This was not statistically different. Reasons were low milk yield ($n = 1$ WDC, 3 NC), claw disorders ($n = 1$ WDC, 1 NC), fertility problems ($n = 1$ HDC, 1 NC) and udder health problems ($n = 1$ HDC).

Discussion

In the past, some positive effects of dam or foster-mother rearing on physical development and performance of primiparous cows have been found, while other studies did not find differences (reviewed by Johnsen *et al.*, 2016). Our results do not confirm any positive long-term effects. Even though there was a growth check after permanent separation from the mother at nine weeks of age, two weeks after weaning, calves of the dam-reared treatments still weighed significantly more than NC-calves (Zipp, 2018). Presumably, management and housing after this period may overrule the outcomes. However, due to the low sample size our findings must be interpreted with caution.

The introduction of unfamiliar cows to an established group is challenging for the integrated animal, indicated by increased agonistic interactions and activity and reduced feeding and lying behavior (reviewed by Bøe and Færevik, 2003). The lying duration of the primiparous cows after introduction to the dairy herd in our study was lower compared to Boyle *et al.* (2012), but higher compared to Knierim (1999). In any case, lying and bout duration during the first 24 h were considerably reduced in comparison to expected figures of normal behavior for multiparous cows (it was half as high as reported from Hendriks *et al.*, 2019, for instance), while the number of bouts was similar. An increase of lying behavior over time after the introduction is in line with findings of Kälber *et al.* (2014). This increase was more pronounced in dam-reared cows than NC-cows, indicating an easier adaptation to the situation. This might be due to different factors, ranging from early experience of the barn and of the herd, over partly the presence of the own mother, to enhanced social abilities of the dam reared cows. Similarly to the results of Wagner *et al.* (2012), the effect of whole-day contact was more pronounced than the one of a system with less dam-contact. Again, due to low sample size, these findings of potential social effects of dam rearing should be regarded first indications that need to be followed up in further research on long-term effects of different cow-calf contact systems.

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