

Case Report

Associations of Eliminating Free-Stall Head Lock-Up during Transition Period with Milk Yield, Health, and Reproductive Performance in Multiparous Dairy Cows: A Case Report

Sushil Paudyal ^{1,*} , Juan Piñeiro ^{1,2}  and Logan Papinchak ¹¹ Department of Animal Science, Texas A&M University, College Station, TX 77843, USA² Texas A&M AgriLife Research and Extension Center, Amarillo, TX 79106, USA

* Correspondence: sushilpaudyal@tamu.edu

Abstract: The objective of this retrospective case study was to understand the effects of eliminating free-stall lock-up time during 21 days postpartum on milk yield, reproductive performance, and health events at a large dairy herd. A group of 200 cows were selected as the treatment (TRT) group, which did not receive a lock-up time during early lactation, and a separate group of 200 cows served as the control (CON) group, which received on average 2 h/day of lockup time. The TRT group had greater milk yield (mean \pm SE) on the third monthly milk test day (33.1 ± 0.75 vs. 29.9 ± 1.22 ; $p = 0.04$) and tended to have greater milk yield on the second test day (38.3 ± 1.55 vs. 39.1 ± 0.79 ; $p = 0.06$) compared to the CON cows. Milk fat% (mean \pm SE) was greater in the TRT group than in the CON group on the first monthly milk test (3.65 ± 0.06 vs. 3.31 ± 0.12 , $p = 0.01$). The TRT group had lower linear somatic cell scores on the first monthly milk test day compared to the CON group (2.6 ± 0.24 vs. 3.2 ± 0.11 ; $p = 0.01$). Cows in the TRT group had lower days in milk at first breeding (DIMFB) (66.2 ± 3.7 vs. 76.7 ± 2.9 ; $p = 0.02$) and were confirmed pregnant earlier as indicated by smaller days in milk to pregnancy (DIMPREG) (96.9 ± 12.32 vs. 112.1 ± 5.5 ; $p < 0.01$). Cows in the TRT group also had fewer incidences of all health events combined (13% vs. 30.5%; $p < 0.001$), lameness (3% vs. 9.5%; $p = 0.01$), and mastitis (3% vs. 16%; $p < 0.001$). We conclude that eliminating the stall lockup may have contributed to the increased milk yield, health, and reproductive performance of dairy cows in this dairy herd. Future prospective cohort studies are needed to further assess the potential effect of eliminating lock up time on cow performance.



Citation: Paudyal, S.; Piñeiro, J.; Papinchak, L. Associations of Eliminating Free-Stall Head Lock-Up during Transition Period with Milk Yield, Health, and Reproductive Performance in Multiparous Dairy Cows: A Case Report. *Dairy* **2023**, *4*, 215–221. <https://doi.org/10.3390/dairy4010015>

Academic Editors: Burim Ametaj and Sven Dänicke

Received: 15 January 2023

Revised: 22 February 2023

Accepted: 7 March 2023

Published: 9 March 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords: dairy; head lock-up; free-stall

1. Introduction

The use of self-locking feed stanchions provides ease of work and reduces the handling time of cattle dairy barns with free stalls. Head locks at the feed bunk of free-stall barns allow dairy farm personnel to restrain cows and facilitate routine herd procedures. These stanchions are utilized during on-farm tasks such as health checks, pregnancy diagnosis, vaccinations, and artificial insemination. Although with a high initial investment cost, headlocks at the free-stall feed bunk also provide labor efficiency, ease of use, and worker safety during the routine on-farm activities [1]. Lock-up stanchions help to reduce competition and aggression among cows at the bunk by ensuring that each animal in the pen receives the minimum feed bunk space in front of them [2]. Therefore, using head locks to restrain the cows in a feed bunk is a widespread practice on dairy farms and lasts for approximately 2–4 h per day. The daily head lock-up time varies across dairy farms and between cows within an individual farm depending on the size of the pen, the routine tasks performed, the number of employees and their skills to perform the tasks, and the cows' arrival order at the feed bunk. There are reported negative impacts of longer lockup times on milk production, reproduction performance, disease events, heat stress conditions, lameness events, and the overall behavior of cattle [3] (Papinchak et al., 2022). Overall,

the use of headlocks at the feed bunk is a widespread practice on dairy farms, but their prolonged use can have negative impacts on cow welfare and productivity. This study seeks to determine if eliminating this practice during the transition period can lead to improved outcomes for the cows. Our hypothesis was that eliminating free-stall head lock-up during the early stages of lactation would increase milk yield, health, and reproductive performance. Consequently, the objective was to evaluate the association of eliminating stall lock-up during the transition period of dairy cows (21 days after parturition) on milk yield, reproductive performance, and health events.

2. Materials and Methods

This retrospective case study was conducted at a commercial dairy farm in Texas, USA from August 2020 to November 2020. All data used in this study were collected retrospectively from on-farm software, thus no Institutional Animal Care and Use Committee approval was required. All cows were housed in free stall barns with sand-bedded stalls and had free access to feed and water. The farm milked around 2500 Holstein cows with a rolling herd average of 8600 kg. Cows in both of the study groups were fed a total mixed ration two times a day to meet or exceed the nutritional requirements for a lactating Holstein cow producing 30 kg/d of milk with 3.5% fat and 3.1% true protein based on NRC, (2001) [4]. The study cows consumed a diet consisting on average of 24.5 kg DM and consisted of corn silage (14 to 17.5%); wheat silage (13 to 20%); a premix containing soybean, soy hulls, corn, wheat, and minerals and vitamins (47.5 to 50.5%); sorghum silage (3.0 to 4.5%); alfalfa hay (12 to 16%); and grass hay (0 to 3%). Cows were bred based on heat detection using tail chalk after a voluntary waiting period of 45 days. Cow tailheads were painted daily with colored chalk and checked for signs of estrus by the removal of tail chalk. If identified to be in estrus, cows were artificially inseminated in the morning.

The study cows were randomly selected as treatment (TRT; $n = 200$) or control groups (CON; $n = 200$) blocked by parity and by the period of the enrollment. The CON group was restrained at the head locks for approximately 2 h per day for 21 days postpartum, while the TRT cows were not restrained. After the intervention period was over, both groups were managed using routine headlocks as they exited the fresh cow pen after the transition period. The cows were tested monthly by DHIA and followed the a.m./p.m. scheme where cows were tested either in the morning or afternoon milking session by trained DHIA technicians. Milk was collected in DHIA sample vials and submitted to the Texas DHIA lab in Canyon, TX. The laboratory used the Bentley 2000 mid-infrared method (Bentley Instruments Inc., Chaska, MN, USA). The study cows were followed up until the end of current lactation and farm records including monthly test-day milk yield, test-day milk fat%, test-day milk protein%, monthly test-day linear somatic cell score (LSCC), days in milk at first breeding (DIMFB), days in milk to pregnancy diagnosis (DIMPREG), and incidence of diseases, were obtained from the farm management software (PCDART[®]). Herd data were exported to Microsoft Excel[®] spreadsheets and analyzed using SAS ver.9.4[®]. The continuous variables were analyzed using a mixed model (PROC MIXED) with the cow as a random effect variable in the model. The models included Milk production, fat%, protein%, LSCC, DIMPREG, and DIMFB as outcome variables and DIM, month of test as predictor variables. The frequencies of diseases and pregnancies per AI were evaluated using Chi-squared tests (PROC FREQ). The statistical significance was tested at $p < 0.05$ level.

3. Results and Discussion

The study cows comprised all multiparous lactating cows with the mean (\pm SD) parity of 3.16 (\pm 0.12) and 4.1 (\pm 0.14) for the TRT and CON groups, respectively. A total of 17 cows in the CON group and 10 cows in the TRT group received assistance during calving. Overall, the CON cows produced 33.1 kg per day whereas the TRT cows produced 31.2 kg per day during the study period. Cows on the TRT group had significantly greater milk yield on the third test day (33.1 ± 0.75 vs. 29.9 ± 1.22 ; $p = 0.04$), and numerically greater milk

yield on second test day (38.3 ± 1.55 vs. 39.1 ± 0.79 ; $p = 0.06$), but numerically lower milk production on the first, fourth and fifth monthly test days compared to the CON cows (41.4 ± 1.37 vs. 39.9 ± 0.64 , $p = 0.31$; 26.1 ± 1.06 vs. 24.6 ± 1.51 , $p = 0.45$; and 27.36 ± 2.12 vs. 22.76 ± 4.56 , $p = 0.38$; Figure 1).

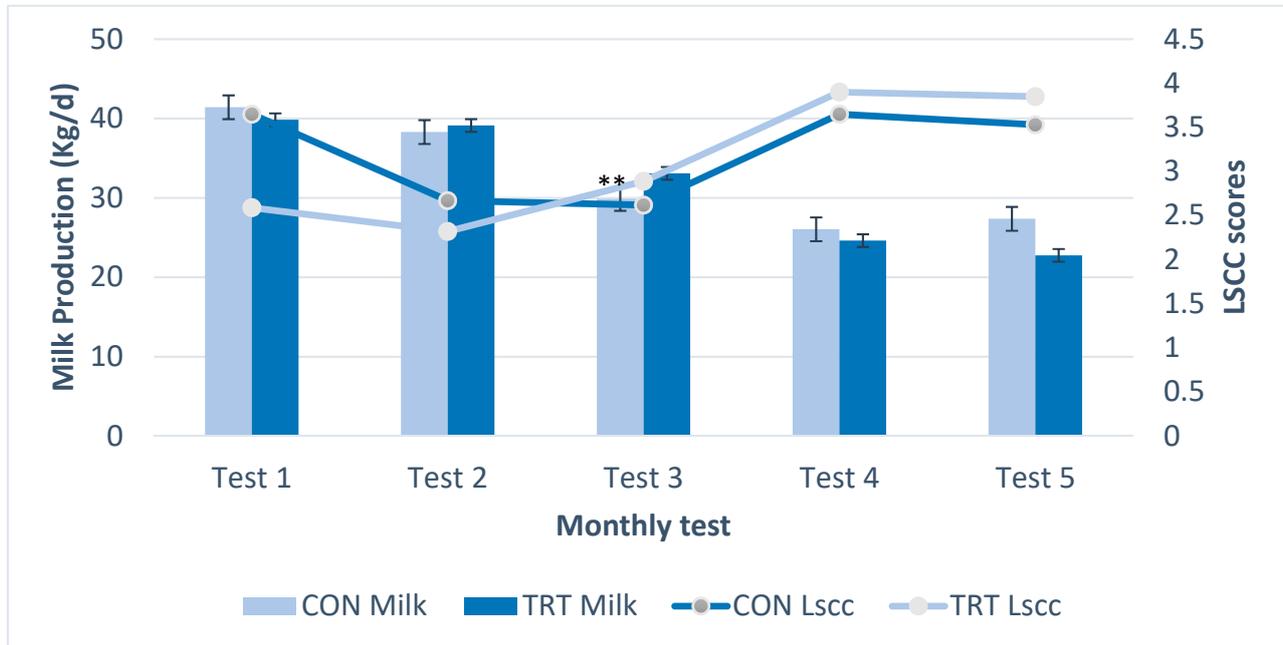


Figure 1. Distribution of milk production and linear somatic cell score (LSCC) across the monthly milk test days among cows in treatment (TRT; no headlocks) and control (CON; regular headlock) groups. ** denotes a statistically significant difference.

Milk fat% (mean \pm SE) was significantly greater in the TRT than in the CON group on the first monthly milk test (3.31 ± 0.12 vs. 3.65 ± 0.06 , $p = 0.01$) (Figure 2). Milk protein% was very significantly greater only on the third test (3.32 ± 0.05 vs. 2.98 ± 0.05 , $p < 0.001$). There was no significant association between milk protein% and lock-up time. Similarly, there was no significant difference between the TRT and CON groups when evaluating the LSCC.

Of the total cows enrolled, 117 cows were pregnant by the fifth monthly test day in the CON group, and 101 cows were pregnant in the TRT group. Although with fewer pregnancies, more cows were reported to be in estrus in the TRT group and they consequently demonstrated a greater pregnancy% per AI. It is possible that cows in the TRT group had a less exacerbated negative energy balance for a shorter period after parturition and might have returned to cyclicity and express estrus earlier than the CON cows which would explain the reduced DIMFB (66.2 ± 3.7 vs. 76.8 ± 2.9 ; $p = 0.02$). In turn, this may explain why the TRT cows were confirmed to be pregnant significantly earlier, as indicated by the reduced DIMPREG (86.9 ± 12.3 vs. 112.1 ± 5.5 ; $p < 0.01$). Overall, the percentage of cows pregnant per AI was greater in the TRT than in the CON group for all inseminations (Table 1). During the lactation, the TRT group reported two abortions, and the CON group had one reported abortion.

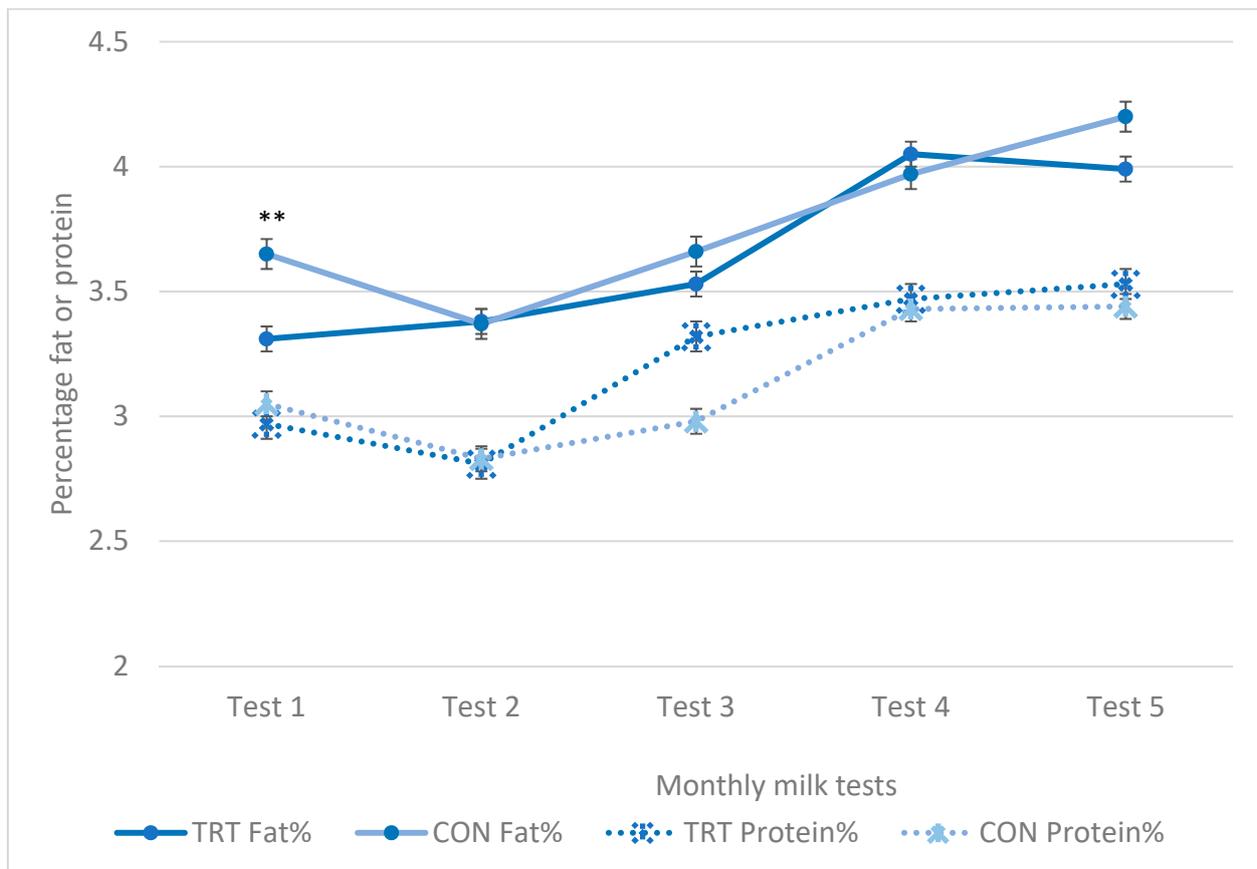


Figure 2. Distribution of milk fat% and milk protein% across the monthly milk test days among cows in the treatment (TRT; no headlocks) and control (CON; regular headlock) groups. ** denotes a statistically significant difference.

Table 1. Distribution of pregnancy per AI and cumulative frequency of diseases among the cows in treatment (TRT = no headlocks) and control groups (CON = regular headlock).

	CON (n)	TRT (n)	p-Value
Pregnancy per AI			
1	14.5% (26)	36.7% (44)	$p < 0.001$
2	25.6% (37)	46.8% (30)	$p < 0.001$
3	20.66% (19)	50.0% (15)	$p = 0.001$
4	34.78% (24)	64% (9)	$p = 0.001$
5	33.3% (11)	60% (3)	$p = 0.001$
Disease events			
Lameness	9.5% (19)	3% (6)	$p = 0.01$
Milk fever	0.5% (1)	2% (4)	$p = 0.17$
Metritis	5.5% (11)	3% (6)	$p = 0.13$
Mastitis	16.5% (33)	3% (6)	$p < 0.001$
Respiratory	3.5% (7)	2.5% (5)	$p = 0.29$
All health events combined	30.5% (71)	13% (26)	$p < 0.001$

Cows in the TRT group had lower incidence of lameness compared to CON (3% vs. 8.5%; $p = 0.01$, $x^2 = 8.21$). Similarly, TRT group reported reduced incidence of milk fever (0.5 vs. 2%; $p = 0.37$, $x^2 = 1.82$), mastitis (3% vs. 16%; $p < 0.001$, $x^2 = 20.71$), and respiratory diseases (2.5% vs. 7%; $p = 0.29$, $x^2 = 0.34$).

The study evaluated monthly test day milk production and milk components in cows restrained through head locks on a daily basis and cows without exposure to head locks.

Overall, the TRT group had a greater milk yield on the third monthly test day and reduced incidence of the common dairy cattle health disorders.

The repeated daily exposure to stressors such as head lock-up in free-stall housed dairy cows makes it difficult for them to adapt to the stress, which ultimately alters the physiological response to stress [5]. The long duration of repeated free-stall head lock restraint is associated with forced standing, leading to decreased feed intake which induces altered-energy metabolism. Forced standing has been associated with the reactivity of brain (HPA axis), thus indicating an overall impact on the animal [6,7]. Although there are limited studies investigating the dose-dependent relationship between free-stall lock-up time with markers of chronic stress, there are studies that suggest that longer lock-up time exposes animals to significant stressful conditions and represents one of the neglected issues in the dairy industry that needs to be addressed.

Studies have demonstrated that the use of headlocks with dairy cattle influences glucocorticoid secretion which ultimately leads to a high level of cortisol in the blood [8]. This effect is primarily due to restrictions in accessing water and resting areas when locked up [9], reduced lying time, and increased human presence. An altered time budget leading to reduced lying time has been associated with reduced sleeping for animals [7], leading to the overall disruption of the daily rhythm of dairy cows. As cows are predominantly routine animals, this alteration in dairy time budget leads to overall discomfort and a negative impact upon milk production. Time spent in lockup at the feed bunk can be compensated for 1–2 h of lying time but the prolonged lockup in association with other stressors such as overstocking will impede the cow's ability to compensate [10].

We detected a 0.83 kg/day and 3.2 kg/day increase in daily milk production on the second and the third monthly milk test day in cows that did not receive a head lock-up. Treatment cows also produced 0.35% higher percent fat and 1.06 units lower linear somatic cell scores. Exposure to cortisol for long periods of time has the potential to decrease overall milk yield, and the chronic activation of the stress response due to restraint in head-lock was previously found to have an impact on milk yield, as well as the quality of milk including milk fat percentage, the number of somatic cells, and dry matter intake [11–14]. Cows that were not deprived of feeding and lying for more than 4 hours have demonstrated reduced milk yield by 2 L/day that lasted for 3 days [14]. Milk protein percentage was found to decrease in cows that were restrained, i.e., it has been shown to drop from 3.27 to 3.19% [11]. However, as we observed the effect only on a few monthly tests, we cannot conclude the effect is entirely due to the treatment. There are several factors including diet, cow health, and reproductive performance that contribute to milk yield and components. Therefore studies considering these and other variables including seasonality, weather, and daily cow activity should be considered.

We observed that cows without provision to lock-up had three times less prevalence of lameness, five times less prevalence of mastitis, and three times less prevalence of all diseases combined. However, previous studies failed to detect significant associations with mastitis or other health issues [11]. A longer lock-up time forces the cows to deviate from the normal daily time budget, contributing to variability in lying time and lying bouts that predispose cows to lameness [15]. Cows that were deprived of lying down become restless and engaged in stomping, repositioning, butting, and weight shifting behaviors. Cows deprived for 4 h also exhibit more sniffing and head rubbing behaviors compared to those deprived for 0 or 2 h [14].

Dry matter intake is extremely critical during the transition period because of the negative energy balance conditions due to unique physiological energy metabolism at this stage and this effect could be further exacerbated by increased stress caused by the prolonged lock-up time. As transition cows are more likely to receive restraint at head lockups for fresh cow checks and other health monitoring, the response from these animals would be further altered. Therefore, stressors presented to the transition cow should be minimal and lock-up management routines could be a strategy to closely monitor the impacts of altering the transition cow's time budget and cow comfort. Restricting access to

the feed available at the bunk through prolonged lockup time at one stall can exacerbate the negative energy balance and stress levels in cows, leading to reduced dry matter intake and further health issues. It is important to manage the lockup routine in a way that minimizes stress and maximizes cow comfort to maintain a healthy and productive transition period for dairy cows.

Free-stall head lock-up systems are designed to provide a comfortable and stress-free animal environment for dairy cattle while still ensuring efficient and effective management. Properly designed and maintained headlock units should be comfortable and safe for cows, allowing them to rest and move around freely when not locked. Farmers and dairy workers should monitor cows for signs of discomfort or distress during head lock-up and adjust head lock-up times and systems as necessary to ensure the cows' health and well-being. It is important to manage farm operations adequately to minimize the restraint time to less than 4 h per day, especially during late morning and afternoon hours of the summer months, to prevent these negative effects on dairy cows [3].

Although we were able to report some effects of eliminating lockup time in early lactation, these changes may also be due to many other factors including nutrition, season, and other farm management practices. The limitation of this case study is the lack of external validation due to limited data to evaluate many variables considered. The small sample size and frequency of the diseases may have led us to miss some significant differences that may exist. Although the disease presentations during the transition period impacted the overall lactation performance, the effect of eliminating lockup in early lactation could have a less direct impact on the fourth or fifth test day. However, the goal was to report the observations from this single-farm case evaluation to derive hypotheses for future exploration. To confidently state that the effect observed is entirely due to the elimination of the lock-up of cows, further prospective studies utilizing a robust design with higher control of the confounding variables should be conducted.

4. Conclusions

In conclusion, eliminating lock-up time in early lactation may have contributed to improvements in the milk production, health, and reproductive performance of lactating dairy cows under these farm management conditions. Future controlled research is needed to confidently determine the impact on cow performance and to further explore the most effective and practical strategies for improving animal welfare in the dairy industry.

Author Contributions: S.P.: conceptualization, methodology, software, validation, formal analysis, investigation, resources, writing original draft preparation, visualization, project administration. J.P.: conceptualization, methodology, validation, resources, supervision, project administration, writing-review and editing. L.P.: Software use, data acquisition, investigation, data curation, formal analysis. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study due to the use of historical retrospective farm data.

Data Availability Statement: Data supporting documents can be provided on request to the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Bewley, J.; Palmer, R.W.; Jackson-Smith, D.B. A comparison of free-stall barns used by modernized Wisconsin dairies. *J. Dairy Sci.* **2001**, *84*, 528–541. [[CrossRef](#)] [[PubMed](#)]
2. Serrenho, R.C.; Church, C.; McGee, D.; Duffield, T.F. Environment, nutrition, and management practices for far-off, close-up, and fresh cows on Canadian dairy farms—A retrospective descriptive study. *J. Dairy Sci.* **2022**, *105*, 1797–1814. [[CrossRef](#)] [[PubMed](#)]
3. Papinchak, L.; Paudyal, S.; Pinerio, J. Effects of prolonged lock-up time on milk production and health of dairy cattle. *Vet. Q.* **2022**, *42*, 175–182. [[CrossRef](#)] [[PubMed](#)]

4. National Research Council (NRC). *Nutrient Requirements of Dairy Cattle*, 7th ed.; National Academy of Sciences: Washington, DC, USA, 2001; pp. 65–67.
5. Trevisi, E.; Bertoni, G. Some physiological and biochemical methods for acute and chronic stress evaluation in dairy cows. *Ital. J. Anim. Sci.* **2008**, *8*, 265–286. [[CrossRef](#)]
6. Fisher, A.D.; Verkerk, G.A.; Morrow, C.J.; Matthews, L.R. The effects of feed restriction and lying deprivation on pituitary–adrenal axis regulation in lactating cows. *Livest. Prod. Sci.* **2002**, *73*, 255–263. [[CrossRef](#)]
7. Tucker, C.B.; Jensen, M.B.; de Passillé, A.M.; Hänninen, L.; Rushen, J. Invited review: Lying time and the welfare of dairy cows. *J. Dairy Sci.* **2021**, *104*, 20–46. [[CrossRef](#)] [[PubMed](#)]
8. Arave, C.W.; Bolinger, D.; Shipka, M.P.; Albright, J.L. Effect of extended lock-up of lactating cows on milk production, feed intake, and behavior. *J. Anim. Sci.* **1996**, *74*, 43.
9. Rulquin, H.; Caudal, J.P. Effects of lying or standing on mammary blood flow and heart rate of dairy cows. *Ann. Zootech. INRA/EDP Sci.* **1992**, *42*, 101. [[CrossRef](#)]
10. Cook, N.B. Time budgets for dairy cows: How does cow comfort influence health, reproduction and productivity. In Proceedings of the Penn State Dairy Cattle Nutrition Workshop, Harrisburg, PA, USA, 16–18 April 2008; pp. 12–13.
11. Bolinger, D.J.; Albright, J.L.; Morrow-Tesch, J.; Kenyon, S.J.; Cunningham, M.D. The effects of restraint using self-locking stanchions on dairy cows in relation to behavior, feed intake, physiological parameters, health, and milk yield. *J. Dairy Sci.* **1997**, *80*, 2411–2417. [[CrossRef](#)] [[PubMed](#)]
12. Smith, J.F.; Harner, J.P.; DeFrain, S.E.; Brouk, M.J. Effect of headlocks on milk production and feed intake of dairy cattle. *Kans. Agric. Exp. Stn. Res. Rep.* **2001**, *0*, 14–17. [[CrossRef](#)]
13. Gwazdauskas, F.C. Stress, management induced, in dairy cattle. Effects on health and Milk production. In *Encyclopedia of Dairy Sciences*; Fuquay, J.W., Ed.; Academic Press: London, UK, 2002; pp. 2604–2611.
14. Cooper, M.; Arney, D.; Phillips, C. The effect of temporary deprivation of lying and feeding on the behaviour and production of lactating dairy cows. *Animal* **2008**, *2*, 275–283. [[CrossRef](#)] [[PubMed](#)]
15. Ito, K.; von Keyserlingk, M.A.G.; LeBlanc, S.J.; Weary, D.M. Lying behavior as an indicator of lameness in dairy cows. *J. Dairy Sci.* **2010**, *93*, 3553–3560. [[CrossRef](#)] [[PubMed](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.