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Behavioral and Morphological Traits of Nellore Cattle That Can Influence Calf Survival and Performance from Birth to Weaning

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Abstract: This study aimed to identify behavioral and morphological traits of Nellore cattle that can influence calves' survival and pre-weaning performance. It was performed in two units of a large-scale cow–calf operation farm located in the Central-West region of Brazil, with 975 cow–calf dyads, by scoring cows' maternal protective behavior, body condition, horns, udder suspension (US), teat size (TS) and calves' vigor. TS was used to determine teat symmetry (TSm). The production unit where calves were born, their birth date, sex, and birth (BW) and weaning weights were also recorded. Cow ages at calving and production units were used to categorize the cows into twelve classes (Cage). The Shapiro–Wilk test alongside tables of frequencies were used to determine if continuous and categorical variables followed a normal distribution, respectively. Two datasets were considered in statistical analyses: (i) 975 dyad records were used to identify potential factors influencing calf survivability and (ii) 936 records of weaned calves were used to assess pre-weaning performance. Generalized linear models were used to assess the effect of target traits on the calves' weight adjusted for 210 days of age (W210, kg) and pre-weaning average daily gain (preADG, kg/day). Tukey's test was used to compare W210 and preADG means. Pearson's correlation coefficients were estimated between BW, W210 and preADG. Cage, US and the TSm significantly affected pre-weaning calf performance ($p < 0.01$). Older cows (independently of the production unit) and those with intermediate US and symmetrical teats weaned heavier calves. As expected, positive and significant correlation was observed between BW and preADG (r = 0.35), which, in turn, was highly correlated with W210 (r = 0.99). We concluded that none of the behavioral and morphological traits influenced calf survivability, but cow age, US and TSm impacted pre-weaning performance, with 8- to 11-year-old cows and those with intermediate US and symmetric teats leading to better calf performance at weaning.

Keywords: animal welfare; predators; maternal protective behavior; udder and teat morphology; calf vigor

Citation: Paranhos da Costa, M.J.R.; Menezes, J.V.d.T.; Fernandes, L.d.S.; Valente, T.S. Behavioral and Morphological Traits of Nellore Cattle That Can Influence Calf Survival and Performance from Birth to Weaning. *Ruminants* **2023**, *3*, 347–359. https://doi.org/10.3390/ruminants3040029

Academic Editors: George P. Laliotis and Linda Majdoub-Mathlouthi

Received: 23 September 2023
Revised: 23 October 2023
Accepted: 25 October 2023
Published: 1 November 2023

1. Introduction

It is well-known that the first week of life is the most critical period for beef calves, because it is when the risk of death is highest [1,2]. The reason for calf mortality is largely multifactorial [3], involving traits specific to the calves (e.g., birth weight and vigor), cows (e.g., maternal ability and behavior, udder and teat morphology), and the environment (e.g., air temperature, precipitation, and predators). Birth weight is one of the main factors

for calf survival and performance from birth to weaning, as it is directly related to its vigor and ability to stand up [4] and ingest the colostrum within the first hours of life [5].

According to Paranhos da Costa et al. [6], the success of the first suckling depends on factors associated with both calves and cows, among which the following stand out: calf vigor [7], expression of maternal behavior (related to calf acceptance by the cow and nursing behavior), as well as morphological conformation of udder [8] and teats. For instance, cows with big udders with pendular suspension and thick or long teats make it difficult or can even prevent calf access to colostrum [6,9], which has been reported to be one of the factors that can cause calf death [2,10] or poor pre-weaning performance [11].

Besides feeding their calves, cows must be able to protect them against potential predators or other sources of threats, characterizing what is known as maternal protective behavior (MPB). Thus, MPB can be used as an indicator of bonding between the cow and her calf, playing an important role in the success of calf survival [12,13] and is characterized by an increased level of the cow's aggressiveness towards potential predators (including cowhands) when in the presence of her calf [14]. In this sense, a cow's reaction towards cowhands when handling their newborn calf can be assessed and used as an indicator of MPB [15,16], assuming that, under such context, apathetic (those which do not react) and fearful cows (those which try to escape) indicate low maternal investment in their calves, which can probably lead to a higher risk of calf death [17,18].

In addition to MPB and the morphological and functional aspects of udder and teats, the presence of horns also has the potential to play an important role on calf protection and survival, attributing, for example, advantages in combating predators and competing for resources [19]. For example, Pitman et al. [20] reported that keeping aggressive cattle in the herd (especially those with horns) can reduce or prevent calf predation by jaguar (*Panthera onca*) and puma (*Puma concolor*), which are the main predators of calves kept under extensive conditions in the region where the study was carried out. Other characteristics of cows, such as age or maternal experience [12,21–23] and nutritional status [8,24], can also directly influence calf survival and performance, as they affect calf birth weight and vigor [25,26].

Individuals involved in cow–calf operation aim to achieve more than just preventing calf mortality. They are also looking for ways to ensure the production of a healthy calf with a good weight at weaning [27], which positively impacts the farm profitability. To achieve that, it is necessary to understand which factors increase the risk of calf death and negatively impact its pre-weaning performance. Thus, this study aimed to identify behavioral and morphological traits of Nellore cows that can influence calves' survival and pre-performance.

2. Materials and Methods

The study was carried out following the protocols determined by the National Council for the Control of Animal Experimentation, and was approved by the Committee of the Ethical Use of Animals of the Faculty of Agricultural and Veterinary Sciences, São Paulo State University, Jaboticabal-SP, Brazil (Certified n. 4864/20).

Behavioral and morphological data collection was carried out during 2019 calving season (July and August) on a private cow–calf operation farm located at the Juruena municipality, state of Mato Grosso, Brazil. In this farm, Nellore cattle were kept on pasture and systematically submitted to phenotypic evaluations by recording calves' weights at birth, weaning and yearling age, scoring body condition and maternal protective behavior of the cows soon after calving. Nellore cattle are recognized for their robustness, characterized by the resistance to the environmental challenges present in the intertropical region, high vigor of the calves, and by intense expressions of maternal protective behavior from the calving cows [28].

The farm was divided into five production units, three of them dedicated strictly to cow–calf operation, as described by Costa et al. [16]. Animal assessment and data collection were carried out in only two units, in which second and third parity cows (U2) and those

with three or more parity (U4, multiparous) were kept. Each one of these production units had its own facilities and cowhand team.

2.1. Newborn Calf Handling Procedures

During calving season, a cowhand team inspected the maternity pastures twice (early in the morning and late afternoon), then in the next morning, moved newborn calves (~1 d old) with their respective dams to the maternity handling area (MHA) to be processed. These MHA (~2500 m^2) were fenced with smooth wire and subdivided into two or four pens, with a covered area that was fenced with boards in the middle, where the first newborn handling procedures were carried out, including weighing (using digital hanging scales), ear tattooing, navel dipping, and injecting a subcutaneous antiparasitic medicine.

After housing the cows and calves inside the MHA, the newborn calf handling procedures (usually carried out by four cowhands) start by moving each calf individually to the covered area. One of the cowhands, on horseback at the time, was responsible for roping and holding the calf, while another cowhand, on foot, was responsible for driving it to the covered area, where two cowhands received the calf and were responsible for finalizing the handling procedures, as described below. The mounted cowhand was also responsible for protecting his counterpart (working outside of the covered area) from cows' attacks.

At the end of handling, each calf was released into another pen where its mother was placed. Subsequently, management groups were formed, made up of calves of the same sex, born from cows in the same category (number of births), and with a maximum interval of 30 days between births. These calves remained in the same management group until weaning (approximately 210 days of age).

2.2. Weaning Procedures

Calves were kept with their mothers on pasture (*Brachiaria brizantha*) until they reached approximately 7 months of age, where they had free access to water and mineral supplements. Each calf management group was weaned on the same day and by the abrupt weaning method. On a specified day, cows and calves were driven to the corral and sorted. While the calves were weighed (using the working chute scales), the cows were driven back to the pasture. At the end of weighing, calves were driven to another pasture far away from their mothers.

2.3. Training by Cowhands and Data Collection

Two cowhands (one from each farm unit) systematically scored cow body conditions (BCS) and maternal protective behavior (MPB). Before starting data collection, training was carried out with the cowhands aiming to obtain good intra and inter reliability rates. The training procedure was divided into two stages. Firstly, the cowhands watched videos illustrating each one of the MPB scores that was to be applied, followed by practical training, when a cowhand and one of the researchers simultaneously assigned the MPB while the other cowhands handled the cow–calf dyads. This practical training was carried out during the routine handling of newborn calves, and it was carried out for two days in each production unit before starting data collection. Cohen's kappa coefficients were estimated to check the inter-rater reliability, and all cowhands achieved a good result, with kappa coefficients of 90%.

Two researchers and one cowhand were responsible for data collection, resulting in data from 975 cows and their respective calves (n = 511 females and 464 males). The two researchers positioned themselves within the covered area so that their presence would not interfere with the cows' and calves' behavior and not influence the cowhands' work. MPB assessments were carried out using direct observation and focal sampling technique, starting when the cowhand (on foot) walked through the corral, towards the calf and cow, and ending when he placed the calf inside the covered area.

2.4. Assessment of Cow Body Condition, Behavior, and Morphological Traits

One of the previously trained cowhands scored MPB and BCS of each cow, as defined in Table 1, while the researchers assigned visual scores for horns (HS), udder suspension (US) and teat size (TS), as defined in Table 2. TS scores were assigned to each one of the teats, characterizing them as anterior left, anterior right, posterior left, and posterior right. After assigning scores to each teat, two categories of teat symmetry (TSm) were created: (i) symmetrical teats, when all teats received the same score, and (ii) asymmetrical teats, when at least one of them received a different score.

Table 1. Description of body condition (BCS, adapted from [29]) and maternal protective behavior (MPB, adapted from [30,31]) scores.

Scores	Descriptions
Body condition score	
1	Extremely lean. No detectable fat on the spinous vertebral processes and transverse processes, and on the hip bones and ribs. The tail set and the ribs are very prominent.
1.5	Very thin, but the tail set and the ribs are less projected. The spinous processes remain prominent, but some tissue coverage is noted over the vertebral column.
2	Thin. The ribs are still individually noticeable, but not as sharp to the touch. There is palpable fat over the spine, over the insertion of the tail, and some covering over the hip bones.
2.5	The ribs' individualization is less obvious. The spinous processes can be identified by touch, but they are more rounded. There is some fat on the ribs, transverse processes and pelvic bones.
3	Good general appearance. The fat over the ribs feels spongy to palpation and the areas on either side of the tail set have palpable fat.
3.5	Firm pressure must be applied to the spine to feel the spinous processes. There is a lot of palpable fat over the ribs and around the tail set.
4	Looks fat and carries a lot of fat. An evident spongy covering is felt over the ribs and around the insertion of the tail.
4.5	Very fat. It is almost impossible to palpate the spinous processes. The animal has large deposits of fat on the ribs, at the insertion of the tail and below the vulva. Thick and spongy fat cover with likely patchiness.
5	Obese, with the appearance of a block. Thick and spongy fat cover with likely patchiness. The bone structure is not apparent and is difficult to feel. The animal's mobility is compromised by excess fat.
Maternal protective behavior	
1	Cow indifferent when the calf is handled, may stand still, not paying attention to her calf or turn away from the calf when the cowhand approaches.
2	The cow stays far from her calf, keeping her attention on it.
3	The cow remains calm, attentive, and close to her calf. She does not threaten the cowhand.
4	The cow moves continuously, shows head and tail movements, vocalizes and/or snorts, and threatens the cowhand.
5	Very agitated cow, showing vigorous head and tail movements, vocalizes and/or snorts. Attacks the cowhand.
6	Cow runs all the time, trying to escape. Throw herself on the fence or jump the fence.
7	The cow abandons her calf.

Table 2. Description of horn, udder suspension and teat size scores.

Scores	Descriptions
Horns	
1	Hornless or smurs (loosely attached small horns).
2	Small horns, up to 5 cm.
3	Intermediate/moderate horns, from ~6 to 20 cm.
4	Big horns, from ~21 to 30 cm.
5	Very big horns, bigger than 30 cm.

Table 2. *Cont.*

Scores	Descriptions
Udder suspension *	
1	Small udder, very firm and compact, very pronounced median suspensory ligament.
2	Firm and compact udder, with the pronounced median suspensory ligament.
3	Udder of intermediate size, median suspensory ligament slightly pronounced.
4	Large and loose udder, weak median suspensory ligament.
5	Udder is too loose and pendular, the median suspensory ligament is too weak and very loose.
Teat size *	
1	Very small, up to ~3 cm.
2	Small, from ~4 to 8 cm.
3	Intermediate/moderate, from ~8 to 12 cm.
4	Big, from ~13 to 20 cm.
5	Very big, >20 cm, balloon shaped.

* Adapted from Cundiff et al. [32].

2.5. Assessment of Calf Traits

The following traits were recorded from the calves: birth (BW, kg) and weaning (WW, kg) weights, sex, and calf vigor (CVg). CVg was assessed shortly after the end of processing each calf (when returned to its mother) considering the following scores: CVg = 1, the calf has difficulty standing up and maintaining the standing posture, and there is clear evidence that colostrum was not ingested (abdomen not "full"); CVg = 2, the calf moves with difficulty, and it is not clear whether colostrum intake or not; and CVg = 3, active calf, with good body condition, without difficulty in movement and with clear evidence that colostrum was ingested ("full" abdomen). The weaning weight adjusted to 210 days of age (W210, kg) and average pre-weaning daily gains (preADG, kg/day) were calculated for each calf.

2.6. Statistical Analyses

Initially, data quality control and consistency analyses were implemented, and descriptive analyses of all variables included in the present study performed. Categorical variables were evaluated using the SAS FREQ procedure (SAS Inst. Inc., Cary, NC, USA), and the Shapiro–Wilk test was used to test the normality of variables with continuous distribution.

Statistical analyses were performed considering two datasets: (i) records from 975 cow–calf dyads, used to verify differences between calves that survived and those that died before weaning; and (ii) records of 936 cow–calf dyads of weaned calves, used to assess the role of the cows and calves independent variables on the pre-weaning performance. Cow age at calving and production unit was used to categorize the cows into twelve classes (Cage) because there was an overlap of cows that were 5 years old between the two production units. The production unit with second and third parity cows (U2) included three classes of cow age (ranging from 3 to 5 years old), and the unit with multiparous cows (U4) included nine classes (ranging from 5 to 13 years old).

Generalized linear models were used (PROC GLM of SAS) to assess the effect of the independent variables on preADG and W210. For the calves' variables, the model included month, sex, and Cage, the interaction between sex and Cage as fixed effects, and calf birth weight as a covariate with linear effect. For the cows' variables, the model included body condition score, maternal protective behavior, Cage (comprised by cow age at calving and production unit), and udder and teat symmetry scores as fixed effects. Adjusted means for preADG and W210 were compared using Tukey's test considering $p \leq 0.05$ as a significant effect and $0.05 < p < 0.10$ as a trend. Pearson's coefficients of correlation were estimated between birth weight, weight adjusted at 210 days of age, and pre-weaning average daily gain (PROC CORR of SAS).

3. Results

A total of 975 cow–calf dyads were evaluated. Regarding age at calving, most of the cows kept in the U2 production unit (n = 362; 83%) were between three and four years old, while 15% of them were five years old. In turn, the majority (81%) of the U4 cows were between five and seven years old (n = 435), 23% of them were between eight and ten years old (n = 123), and only 8% between eleven and thirteen years old (n = 45). Most cows were in good body condition after calving, with 78% of them receiving a BCS between 2.5 and 3.5. Half of the cows (50%) had an udder suspension score of 2, 37% and 13% were scored as 1 and 3, respectively. Regarding TS assessments, 45% of cows showed intermediate teat size and most cows (71%) had all teats symmetrical. Among the calves, 511 were females and 464 were males, and most of them (96%) showed good vigor at birth (score 3, indicating that they were able to stand up and move around easily); only 0.2% and 3.8% received a score of 1 and 2, respectively.

None of the 975 evaluated cows were scored as 6 for MPB, showing that the reaction of running around the pen and trying to escape was not expressed. In addition, no calf was abandoned (MPB = 7) by its mother during the evaluation period. Therefore, these scores were not considered in the statistical analyses. It was observed that the majority of Nellore cows (45%) remained calm, attentive, and close to the calf during the handling procedure, not being aggressive towards the cowhands. However, considering that 4% of the cows reacted aggressively towards the cowhands during the handling procedure, it is imperative to handle them carefully to avoid animal welfare-related issues and/or labor accidents (Figure 1).

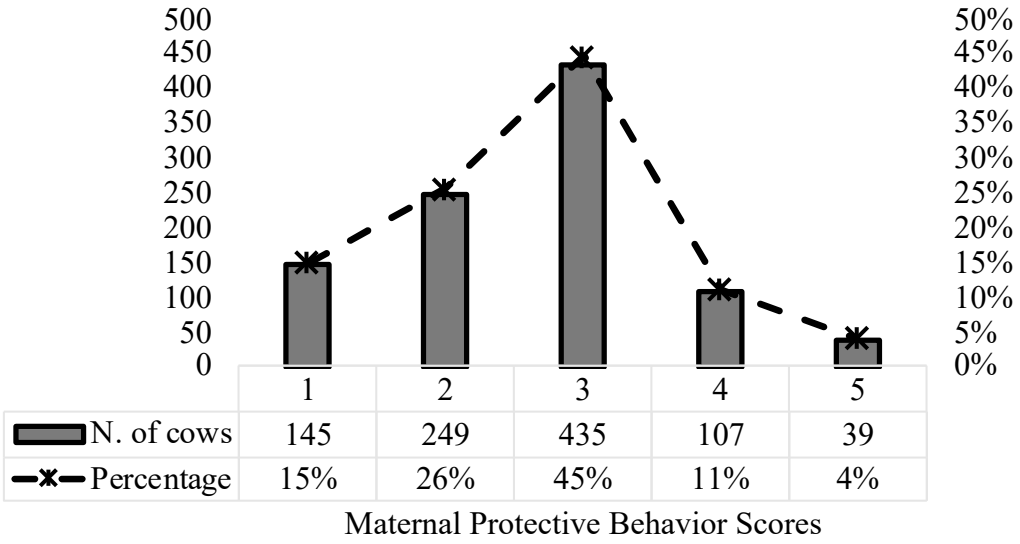

Figure 1. Absolute and relative frequencies (%) of the maternal protective behavior scores (from 1 to 5). No cow scored 6 or 7 for maternal protective behavior.

Approximately half of the cows (47%) had a horn score equal to 3 (medium horns), while about a third of them (32%) scored 2 (small horns), 12% scored 4 (big horns), and the scores 1 (hornless or smurs) and 5 (very big horns) were each represented by 5% of the cows.

3.1. Effects of Calf Traits on Their Survival and Performance

The pre-weaning mortality rate was 4% (n = 39) and none of the variables considered in this study significantly affected calf death between birth and weaning. On the other hand, all the independent variables considered in the model, including month, sex and Cage (and the interaction between sex and Cage), and birth weight, showed significant effects ($p < 0.001$) on preADG and W210 (Table 3).

Table 3. Summary of statistical analysis of weight adjusted for 210 days of age (W210) and pre-weaning average daily gain (preADG) considering the effects of calf month of birth, birth weight, sex, and classes of cows age (comprised by cow age at calving and production unit), and the interraction between sex and classes of cow age (Sex-Cage).

Sources of Variation	preADG			W210		
	F Values	DF	*p* Value	F Values	DF	*p* Value
Month of birth	15.83	1	<0.0001	15.83	1	<0.0001
Sex-Cage	33.24	1	<0.0001	33.24	1	<0.0001
Birth weight	15.23	1	<0.0001	81.59	1	<0.0001

There was a significant interaction between calf sex and Cage on preADG and W210 (Table 4), and a positive and significant correlation was observed between BW and preADG (r = 0.35, $p < 0.0001$) which, in turn, was highly correlated with W210 (r = 0.99; $p < 0.0001$).

Table 4. Adjusted means (±SD) for birth weights (BW, kg), weight adjusted for 210 days of age (W210, kg) and pre-weaning average daily gain (ADG, kg/day) for the interaction between calf sex and classes of cows age (Sex-Cage).

Sex-Cage	BW	W210	preADG
Female-U2	28.59 ± 3.27 b	134.13 ± 24.93 c	0.50 ± 0.11 c
Female-U4	31.42 ± 3.54 a	167.95 ± 18.43 b	0.65 ± 0.08 ab
Male-U2	31.10 ± 3.79 a	161.20 ± 24.30 b	0.62 ± 0.11 b
Male-U4	34.74 ± 4.02 a	180.12 ± 23.46 a	0.69 ± 0.11 a

Different lower-case letters indicate a significant difference between means.

3.2. Effects of Cow's Traits on Calf Survival and Performance

There was no significant effect of cow traits on calf survival. On the other hand, there were significant effects ($p < 0.05$) of cow age at calving, udder score and teat symmetry score on preADG and W210 (Table 5).

Table 5. Summary of analysis of variance for weight adjusted for 210 days of age (W210, kg) and pre-weaning average daily gain (preADG, kd/day) considering the effects of cow traits, where: Cage = classes of cow age by production unit, US = udder suspension, TSm = teat symmetry, BCS = body condition score, and MPB = maternal protective behavior score.

Sources of Variation	W210			preADG		
	F Values	DF	*p* Values	F Value	DF	*p* Values
Cage	13.21	11	<0.0001	11.94	11	<0.0001
US	13.46	4	<0.0001	12.97	4	<0.0001
TSm	8.06	1	0.0046	9.72	1	0.0019
BCS	0.52	4	0.86	0.51	4	0.87
MPB	1.19	6	0.31	1.04	6	0.38

There was a significant effect of Cage on calves' preADG and W210. Regardless of the production unit where the animals were born, it was noted (Figure 2) that an increase on preADG and W210 as a function of cow age. It is also noteworthy that there is a tendency to reduce W210 of calves mothered by cows over 11 years old. However, cows older than 11 years showed higher W210 means when compared to younger cows. The lowest means of W210 and preADG were observed for 3-year-old cows (138.23 and 0.519 kg, respectively) located at U2 production unit.

Regarding udder suspension, it is important to highlight that cows with poor udder quality and those with udder problems are normally culled [11]. Thus, among all assessed cows, US equal to 4 and 5 were not observed. Even so, a significant effect of US on W210 and preADG was observed and the larger the US, the greater the calves' W210 and preADG

(Figure 3a). Most cows showed symmetrical teats (n = 691), and their calves had higher preADG and consequently higher W210 when compared to those showing asymmetrical teats (Figure 3b).

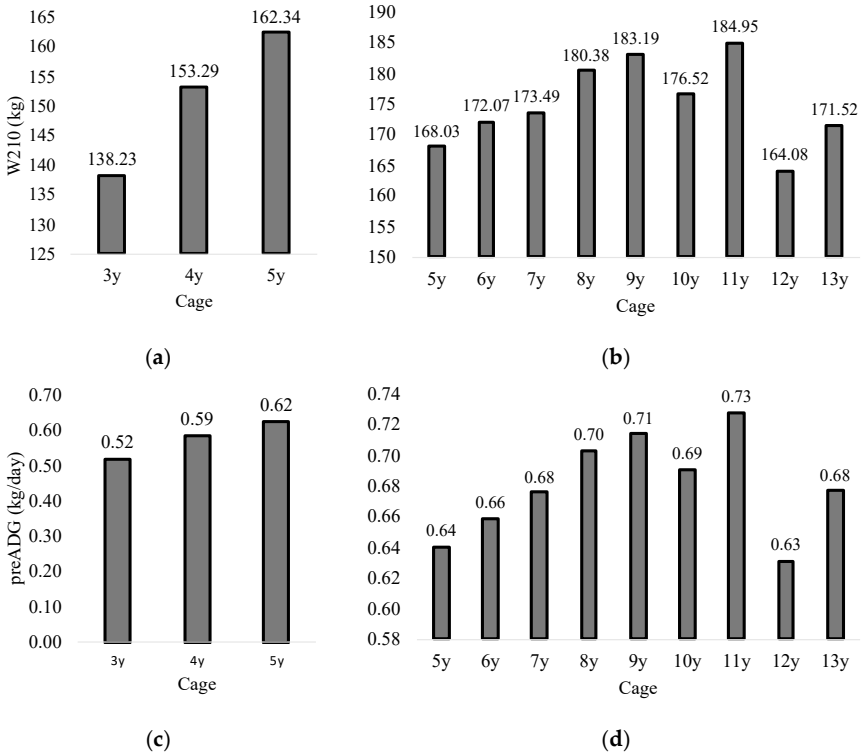

Figure 2. Adjusted means of weight adjusted for 210 days (W210, kg) of age and pre-weaning average daily gain (preADG, kd/day) as a function of the cow age classes (Cage) for each production unit, in which U2 = (**a**) and (**c**), respectively, and U4 = (**b**) and (**d**), respectively.

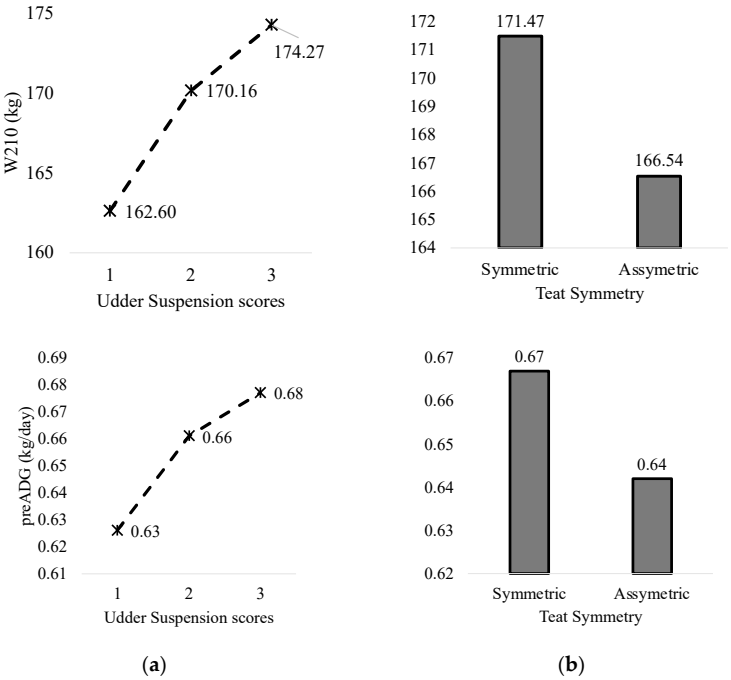

Figure 3. Adjusted means for weight adjusted for 210 days (W210, kg) and pre-weaning average daily weight gain (preADG, kg/day) according to udder suspension scores (**a**) and teat symmetry (**b**), respectively.

4. Discussion

The mortality rate observed in the present study (4%) was the same as was reported by Magalhães Silva et al., [33] and lower than the values reported by Bunter et al. [2] and Nascimento et al. [34] for a similar beef cattle production system (9.5% and 8%, respectively). Given the low mortality rate observed and the high proportion of calves evaluated with the highest score for vigor (96.2%), no association was found between these variables in the present study. Additionally, no association was observed between birth weight and the occurrence of pre-weaning mortality.

As expected, male calves had higher birth weights (33.07 and 30.17 kg, respectively) and W210 than female calves (171.36 and 152.73 kg, respectively), resulting in a mean difference of 18.63 kg at weaning. For W210 and preADG, there was a significant effect of the interaction between calf sex and Cage. Female calves born from young cows (U2) had the lowest W210, while male calves born from older cows (U4) showed the highest; these outcomes corroborate the results of Cobuci et al. [35], who reported that older cows have superior milk production that can be translated into superior performance of their offspring. In addition, female calves whose dams were older did not show any difference in W210 ($p > 0.05$) when compared to males born from younger cows.

Maternal protective behavior did not influence calf survival or performance. Seventy per cent of the cows showed desirable MPB, which is characterized by cows that remain calm and attentive to their calves during handling. On the other hand, 15% were indifferent to the calf, 10% of them showed resistance concerning the newborn calf handling and threatened the cowhands, and 4% attacked them, resulting in a real risk of labor accidents and impoverishment of cattle welfare and human well-being. No cows abandoned the calf or tried to escape from the handling area.

There is a consensus in the literature that cows scored with extreme MPB values, like those that abandon their offspring or are very aggressive towards the cowhands, show a higher risk of the death of their calves or a higher risk of accidents with their calves, cowhands, and themselves [17,18]. Sandelin et al., [36] in a study on maternal protective behavior in six groups of taurine breeds, showed that this behavior had a significant influence on the survival of their calf until weaning. Scores 1 (very aggressive), 2 (very attentive), 3 (indifferent) and 4 (apathetic) had calf survival percentages of 93, 86, 77 and 60, respectively, indicating that cows that are more attentive at birth provide increased survivability of their offspring, caused by protection from predation or other factors that might have been involved. Therefore, the selection of animals with intermediate MPB scores was recommended to promote animal welfare and labor safety, especially in production systems where the contact between cattle and humans is not very frequent [12,37,38].

Regarding cow nutrition, it is known that during the gestational period, it is of fundamental importance that the animals are well-fed and maintain good body condition, as cows with a prolonged nutritional deficit can result in a longer period of postpartum anestrus. Additionally, protein and energy deficiencies during the gestation phases have negative effects on the growth and muscle development of the fetus, negatively affecting calf birth weight and performance from birth to weaning [39]. However, in the present study, no significant effect of cow body condition score on calf birth weight and performance were observed. Our hypothesis is that this happened, most likely because there was low variability in body condition scores among all evaluated cows in this commercial herd.

Despite the low data variability, it was possible to observe significant effects of Cage, US and TSm on preADG and W210. When comparing 3- and 11-year-old cows, calves born from older animals had higher W210 and preADG, reaching a difference of 46.72 and 0.210 kg, respectively. Calf weight at weaning is largely determined by the amount of milk consumed [40], and the results of several studies have shown that older cows produce more milk than younger ones and, consequently, wean heavier calves [40–43]. According to Pimentel et al. [43], multiparous Hereford cows produced a total of 242.89 kg more milk than primiparous cows. Similar results were reported by Clutter and Nielsen [44], who found a difference of 380 kg of milk produced (in 205 days) by crossbred taurine cows aged

between two and five years old. This can be explained by the physiological dynamics of their reproductive development, as younger cows need to divide the supply of nutrients between their own growth and milk production [35].

The conformation of the mammary apparatus showed a significant effect on the performance of Nellore calves. In general, cows with intermediate udders and symmetrical teats produced calves with higher preAGD and W210. Regarding US, 492 cows scored 2 and 126 cows scored 3; these cows respectively produced calves seven and eleven kilograms heavier than the 357 cows with a US score equal to 1. Considering the cows scored as 2 and 3 for US, this difference in W210 multiplied by the number of evaluated calves represented 4830 kg more of live weight when compared to cows that received score 1. Despite these results which indicate that the larger the udder size, the better the performance of their calves, it is worth mentioning that no cows were found with very large and pendulous udders. Goonewardene et al. [45] brought similar results, in which cows with medium-sized or large, well-fixed udders end up weaning heavier calves, compared to cows with very small, well-adhered udders. Furthermore, according to Ventorp and Michanek [46], very large or pendulous udders are not desirable because they are difficult or even prevent the performance of the first suckling.

Although teat size (TS) was recorded for each single cow, greater attention was placed on the symmetry among the four teats of each cow. Teat symmetry also significantly affected calf performance from birth to weaning, with cows with asymmetric teats (with at least one teat different from the others) producing calves 4 kg lighter than cows with symmetric teats (all four are teats with the same size). Thus, an association between non-uniform teats and very pendulous udders or very small and compact udders may result in lighter calves at weaning age. Therefore, it is imperative to prioritize the selection of intermediate udders that have a good milk production capacity, to the detriment of very small and compact udders and very large and pendulous udders. This agrees with the results of Sapp et al. [47], who reported that Pearson's correlations between predicted values of teat score and udder suspension with average daily weight gain of calves indicated that cows with very large teats or hanging udders produce more milk, but that the calf may have problems accessing it. On the other hand, cows with very small teats or tight udders produce less milk, sometimes not enough to support calves' maintenance and growth. Thus, to improve the performance of Nellore cow–calf operations, it is necessary to dedicate attention to and assess the conformation of the mammary apparatus, with special attention being paid to udder suspension and teat symmetry/size. As an alternative, we recommend including these traits in genetic improvement programs, considering that they have moderate to high heritability estimates, as reported in some papers [2,47–49].

5. Conclusions

We concluded that none of the behavioral and morphological traits considered in this study influenced the calf's survivability, but some of them (cow age at calving, udder suspension and teat symmetry) impacted calves' performance from birth to wean, with cows aged between 8 and 11 years, cows with udder suspension scores of 3 (intermediate udder size, intermediate median suspensory ligament) and cows with symmetric teats all weaning heavier calves.

Author Contributions: Conceptualization, M.J.R.P.d.C. and T.S.V.; methodology, M.J.R.P.d.C., J.V.d.T.M., L.d.S.F. and T.S.V.; formal analysis, T.S.V.; investigation, M.J.R.P.d.C., J.V.d.T.M., L.d.S.F. and T.S.V.; resources, M.J.R.P.d.C.; data curation, L.d.S.F. and T.S.V.; writing—original draft preparation, M.J.R.P.d.C. and J.V.d.T.M.; writing—review and editing, M.J.R.P.d.C., J.V.d.T.M., L.d.S.F. and T.S.V.; visualization, M.J.R.P.d.C., J.V.d.T.M., L.d.S.F. and T.S.V.; supervision, M.J.R.P.d.C. and T.S.V.; project administration, M.J.R.P.d.C.; funding acquisition, M.J.R.P.d.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was carried out following the protocols determined by the National Council for the Control of Animal Experimentation, being approved by the Committee of the Ethical Use of Animals of the Faculty of Agricultural and Veterinary Sciences, São Paulo State University, Jaboticabal-SP, Brazil (Certified n. 4864/20).

Informed Consent Statement: Not applicable.

Data Availability Statement: Data subject to third party restrictions.

Acknowledgments: We are grateful to the manager and staff of Fazenda São Marcelo for their attention and support during data collection.

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

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