



OPEN ACCESS

EDITED BY

Luis de la Cruz Cruz,
Metropolitan Autonomous University, Mexico

REVIEWED BY

Branimira Špoljarić,
University of Zagreb, Croatia
Ilda Fernández,
Universidad Autónoma Agraria Antonio Narro
Unidad Laguna, Mexico
Ariadna Yáñez,
Universidad Autónoma Metropolitana, Mexico

*CORRESPONDENCE

Angélica Terrazas-García
✉ garciate@unam.mx

RECEIVED 30 June 2025

ACCEPTED 26 September 2025

PUBLISHED 22 October 2025

CITATION

García-Cázares A, Cano-Suárez P and
Terrazas-García A (2025) Effects of social
hierarchy in primiparous and multiparous
goats on nursing behavior during lactation.
Front. Ethol. 4:1656480.
doi: 10.3389/fetho.2025.1656480

COPYRIGHT

© 2025 García-Cázares, Cano-Suárez and
Terrazas-García. This is an open-access article
distributed under the terms of the [Creative
Commons Attribution License \(CC BY\)](#). The
use, distribution or reproduction in other
forums is permitted, provided the original
author(s) and the copyright owner(s) are
credited and that the original publication in
this journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted
which does not comply with these terms.

Effects of social hierarchy in primiparous and multiparous goats on nursing behavior during lactation

Andrea García-Cázares, Paolo Cano-Suárez
and Angélica Terrazas-García*

Universidad Nacional Autónoma de México, Facultad de Estudios Superiores-Cuautitlán,
Departamento de Ciencias Pecuarias y Centro de Enseñanza Agropecuaria, Cuautitlán Izcalli, Mexico

Introduction: Goats are gregarious animals with a social organization differentiated by their stratification into defined social ranks. Relatively little is known about whether these social relationships affect the behavioral activity of mothers and offspring during lactation. Therefore, the objective of this study was to evaluate the effect of social hierarchy in primiparous and multiparous goats on nursing behavior during lactation.

Methods: Forty-seven multiparous and 25 primiparous French Alpine and Toggenburg goats were used. They were weighed, their body condition was evaluated during the second half of pregnancy and lactation, and the weights of their kids were measured during two months of age. To evaluate the hierarchy, a success index was calculated by recording the antagonistic interactions between animals in the second and last weeks of lactation. Furthermore nursing activities were recorded approximately 14 days postpartum and weekly until day 55 of lactation. The following behaviors were recorded: frequency of nursing episodes, episodes in which the mother accepted or rejected, and the duration of each nursing episode.

Results: Both primiparous and multiparous goats had the highest percentage at the medium dominance level (65%). This was significantly higher than those at the low dominance level (20%) and the high dominance level (15%, $P < 0.001$). Body weight and body condition scores were higher in goats with a high dominance than in those with a medium or low social hierarchy ($P < 0.05$). The body weights of the kids were not affected by the dominance of their mothers ($P > 0.05$). There were no differences among the three dominance levels in the duration of episodes, episodes accepted or rejected, or the number of total nursing episodes observed during lactation ($P > 0.5$).

Conclusion: Regardless of parity, the maternal hierarchy level significantly affected productive parameters in goats, but not offspring growth or nursing behavior during lactation.

KEYWORDS

maternal behavior, lactation, kids, dominance, behavior

Introduction

Global goat production has witnessed a growing population of over one billion heads (Chetroui et al., 2013; Miller and Lu, 2019). Asia and Africa are home to the largest concentrations of goats for meat production. Meanwhile, Europe is home to the largest concentration of dairy goat breeding (Escareno et al., 2013; Monteiro et al., 2019). Goat production is a diverse sector, ranging from subsistence to industrialized systems (Lu, 2023). The consumption of goat milk and meat is increasing due to their nutritional benefits and growing demand (Bañón et al., 2006; Miller and Lu, 2019). Therefore, the contributions of research in this species are important.

The mother–offspring relationship in goats occurs during a sensitive period that includes the first 4–6 h postpartum, in which maternal selectivity is established. This process consists of the mother learning to recognize her offspring and differentiate them from any other offspring that attempt to approach her udder (Poindron et al., 2007a). This bonding process indicates the quality of maternal behavior in small ruminants and it is important that it be established within the first 4 h postpartum (Romeyer and Poindron, 1992; Poindron et al., 2010). This process can be assessed with what is called a maternal selectivity test, in which the newly born female is exposed to the presence of a foreign kid and a strange one to assess her ability to discriminate between the two (Lévy, 2022). However, these tests may require some time. Other methods have been used to evaluate maternal motivation quickly, particularly when a large number of females are observed. One such method is the maternal behavior score, which, depending on the author, can have up to five points on the scale (Alexander et al., 1983; O'Connor et al., 1985), or three levels in which the interest of a female in her offspring is categorized (Dwyer and Lawrence, 1998). This maternal scoring system has already been applied to goats, with responses similar to those observed in sheep (Cano-Suarez et al., 2024).

Maternal motivation and the establishment of selectivity are desirable characteristics of newly delivered females. This ensures adequate care for their offspring, and consequently, their survival. However, some factors may disrupt the mother–offspring relationship in goats during the peripartum period, such as the female's nutritional status during pregnancy and maternal experience. Malnourished pregnant females have problems bonding with their offspring postpartum (Terrazas et al., 2009; Ramírez-Vera et al., 2012). Meanwhile, primiparous goats tend to be slower to care for their offspring, resulting in a delay in their kids reaching the udder compared to those born to multiparous mothers (Cano-Suarez et al., 2024).

Some lactation variables in goats are positively correlated with milk production as is the case with weight of kids (García et al., 2017; Erduran, 2023). Therefore, a positive mother–young relationship can be guaranteed with adequate milk production. In ungulates, the first few hours postpartum are an intense period of interaction between the mother and her litter. This leads to unrestricted access of the offspring to the udder and the

establishment of a lactation rhythm (Poindron et al., 2007b; Hernández et al., 2012). However, the frequency of this rhythm varies depending on the species and stage of lactation, and the exclusive mother–offspring bond (Lickliter, 1985; García et al., 2017). Furthermore others factors such as maternal hierarchy may be related to this process. A study conducted on goats in a semi-desert climate found that those with a high social rank had better productive parameters in the prepartum and postpartum period. However, these advantages were not reflected in the productive development of their offspring during lactation (Flores-Salas et al., 2025).

Social animals form ranks or hierarchies that enable their successful coexistence. The hierarchy had a substantial impact on the activity of each animal in the group. Individuals in social groups must share resources, and when these resources are scarce, they must compete actively for them. Therefore, animals may engage in agonistic encounters with conspecifics, primarily for food, mates, comfort, and protection (Craig, 1986; Seebacher and Krause, 2019). In goats, unlike other domestic herbivores, a high frequency of agonistic behavior and sometimes excessive aggression has been reported (Fournier and Festa-Bianchet, 1995; El Sabry and Almasri, 2023). Meanwhile, the social behavior of goats can be divided into affiliative and agonistic behaviors. Affiliative ones occur during various activities are likely to relax the animals involved or help reduce tension after a conflict, for example, alo-grooming. In contrast, agonistic behaviors occur when there is more tension in the group and competition for resources even leads to aggression (Górecki et al., 2020).

Similarly, this species, as well as others, has inherent characteristics that determine the level of hierarchy at which animals are aggregated. These factors include age, sex, breed, the presence of horns, health status, and body size (Shackleton and Shank, 1984; Barroso et al., 2000; Shinde et al., 2004). While several of these studies have been performed on wild goats, studies in production systems has shown that the hierarchy can have effects on the use of food, and, therefore, on the nutritional condition of the animal, as well as on the use of space and body weight (Jørgensen et al., 2007; Flores-Salas et al., 2025). In dairy goats, the dominance level of adult females during seasonal anestrus was found to influence their responses to the male effect. Medium- and high-ranking goats ovulated earlier than low-ranking goats did. Therefore, the same female goats gave birth first. The lowest percentage of ovulating females was observed in the low-ranking groups. Females in the highest hierarchy had the highest association index with males (Alvarez et al., 2003).

Therefore, it is important to conduct further studies on goats to distinguish the role of social hierarchy in mother–offspring relationships during lactation, particularly nursing activity, and its relationship with productive parameters. Therefore, in this study, we aimed to evaluate the effect of social hierarchy on nursing behavior during lactation in primiparous and multiparous goats. We hypothesized that goats with a low social status, particularly those with first parity, are less successful in nursing, which affects the development of their offspring during lactation.

Materials and methods

Animals, location, and maintenance conditions

This study was conducted in the goat unit of the Facultad de Estudios Superiores, Cuautitlán Campus, Universidad Nacional Autónoma de México. Initially, 72 adult dairy goats (25 primiparous and 47 multiparous) were used, averaging approximately 45 kg in weight and aged 2–5 years.

The goats were housed in three pens measuring 12 x 15 m. Pen 1 had 25 goats, (3 primiparous and 22 multiparous), Pen 2 had 24 goats (22 primiparous and two multiparous), and Pen 3 had 23 multiparous goats. They were kept in these pens from gestation until weaning, or until the end of the experiment. To concentrate births in a short period of days, reproduction was synchronized with a process similar to the one described by Terrazas et al. (2009). This consisted of applying vaginal sponges containing the progestogen Cronolone (20 mg, Chronogest CR[®], Intervet, France) to each goat. On day 11, a 5 mg intramuscular injection of Dinoprost-PGF2 α Tromethamine (Lutalyse[®], Zoetis, Argentina) was administered. The sponge was removed on day 12, and each goat immediately received an intramuscular injection of 350 IU of Equine Chorionic Gonadotropin (NOVORMON 5000[®], Virbac, France). The doses were subsequently exposed to sexually active males (one per pen), each fitted with a harness equipped with a colored wax marker (Raider[®], Germany) to identify the bred females. A pregnancy diagnosis was conducted approximately 65 d post-breeding using a real-time ultrasound (WellD[®] 9618, 3.5 MHz, China). All the animals were identified using tags at the time of pregnancy diagnosis.

Pregnant goats were kept in the same pen as non-pregnant goats throughout the experiment to avoid disrupting social cohesion. Therefore, the dominance level was calculated for both pregnant and non-pregnant females. Goats were fed a diet consisting of corn silage, alfalfa hay, and commercial balanced feed with a crude protein content of 18%. Animals had free access to water throughout the experiment.

Experimental process

At the first weighing of the experimental phase on approximately day 65, the goats were fitted with a SIGIGANTM brand plastic collar with a sequential number for easier identification. The same number was assigned to each goat collar throughout the experiment.

Determining the dominance level

The dominance level was determined seven days after birth. Observations were conducted during the morning feeding period, and every day, all females were observed for two continuous hours (09:00–11:00) over six consecutive days. This procedure was

repeated during the last six days of lactation. Only agonistic interactions between the animals were recorded (Table 1).

The success index was calculated using the information obtained from these behavioral interactions and their outcomes. This value was used to determine the social hierarchy or dominance level of each animal. The success index was obtained using the formula 1, following the method standardized in previous studies (Mendl et al., 1992; Alvarez et al., 2003). This index yields values between 0 and 1.0 and allows animals to be categorized into three dominance levels: low (0–0.33), medium (0.34–0.66) and high (0.67–1.0).

Formula 1. Equation used to calculate the success index of each goat.

Success index

$$= \frac{\text{number of individuals it can move}}{\text{number of individuals it can move} + \text{number of individuals that move it}}$$

Maternal motivation score

This variable was recorded two hours after birth in the mother when the kids were handled to measure their weights and body temperatures (Dwyer and Lawrence, 1998). Maternal interest was categorized into three levels.

1. Little or no interest: The mother showed no interest in handling her offspring, turned away, engaged in other activities, and did not vocalize. 2. Medium interest: The mother did not approach her offspring but followed it with her eyes and emitted maternal vocalizations. 3. When the mother followed her offspring to its location, approached it, sniffed, licked it, and vocalized continuously (O'Connor et al., 1985; Dwyer and Lawrence, 1998).

Rectal temperature and surface temperature of the kids

Two hours postpartum, when the kids were weighed, their rectal temperatures were recorded using a digital thermometer

TABLE 1 Agonistic behaviors to determine the hierarchy of animals.

Conduct	Description
Bump	When an individual hits another individual, especially with the head.
Threats	When an individual intends to hit another individual, the threat may occur with the head or the trunk of the body, but without reaching or touching it.
Push	When an individual pushes another individual with its body, but without hitting it, to move it from a certain place.
Flight	When, after being threatened, hit, or pushed, an individual decides to leave the area and flee from his opponent.
Evasion	When an individual, faced with the threat of another animal, decides to abandon the encounter or interaction.
Bite	When an individual bites the limb of another individual to displace it from its place.

(Hergom[®], Mexico). This was disinfected between uses. Their external temperatures were also taken using a digital gun thermometer (Stern[®] HER-424 Mexico), held 5 cm away from the shoulder blade and neck.

Body weight and body condition score of goats and kids

The goats were weighed and their body condition scores (BCS) were recorded as described by (Mendizabal et al., 2011) on days 65, 85, 105, and 135 of gestation and on days 6, 14, 20, 27, 34, 41, 48, 55, 62, and 69 after birth. The kids were weighed two hours after birth and on the same dates that the mothers were weighed after birth.

Nursing activity

When the kidding season began, guards were held for 14 h per day (7:00–21:00) to ensure that the births proceeded normally and that the mother–offspring bond was properly established during the sensitive period (4 h postpartum). During the guard period, when a goat was found to be in labor, a 2 x 2 m pen was designated for her, and birth and bonding with her offspring were monitored. In the pen, the goats were provided with water and food, after which the mother and offspring were released back into the herd.

After calculating the success rate and determining the hierarchy, nursing activity was recorded, starting on approximately day 14 postpartum, using a method similar to that described in a previous study (Hernandez et al., 2002). The measurements were performed with the assistance of three observers, comprising one per pen. The observers remained at the same location for most of the observation period and were stationed outside the pens in the feeding area to avoid disturbing the animals during the measurements. Observations were performed weekly on days 6, 14, 20, 27, 34, 41, 48, and 55 of lactation on the same day throughout the experiment, during two daily periods: morning (8:00 to 11:00 am) and evening (4:00 to 7:00 pm). Recordings were performed using the behavioral time interval method with spontaneous recording, noting every episode of nursing. Behaviors were recorded on a preformatted sheet and are presented in Table 2.

Statistical analysis

The Pearson's chi-square test was used to compare the proportions of animals in each social hierarchy. For the weights of the goats and kids, and the BCS of the goats, a repeated-measures ANOVA was used to determine the effects of hierarchy and parity and to evaluate the effect of sampling time. The Kruskal–Wallis and Mann–Whitney U tests were used to assess the effects of hierarchy and parity on nursing behaviors. Friedman and Wilcoxon tests were used to compare behaviors within a group over time. All the statistical analyses were performed using SYSTAT 13.0 (Chicago, Illinois USA).

Results

Distribution of goats across hierarchy levels, time of observation, and parity

Five primiparous and nine multiparous goats showed high dominance ($P = 0.28$). Meanwhile, 17 primiparous and 28 multiparous goats were categorized as having medium dominance levels ($P = 0.10$). Three primiparous and 10 multiparous goats were categorized as low-dominance goats ($P = 0.052$).

Figure 1 shows the distribution of goats across the three dominance levels according to parity, success index calculation stage, and reproductive status. As shown on the left side of Figure 1, there were no significant differences between the proportions of goats within each parity distributed in the first and second success index calculations ($P > 0.05$). There were no differences between primiparous and multiparous goats in the proportions distributed across dominance levels ($P > 0.05$). Both primiparous and multiparous goats had a higher proportion at the medium dominance level than at the high and low levels (Figure 1, $P < 0.0001$).

The right side of Figure 1 shows the numbers of pregnant and non-pregnant does at each dominance level according to parity. No differences were found in the proportion of pregnant and non-pregnant does between primiparous and multiparous animals ($P > 0.05$).

Based on the results shown in Figure 1, the data for each dominance level were averaged between the first and second measurements. This average included both pregnant and non-pregnant does, as well as primiparous and multiparous ones.

TABLE 2 Behaviors to measure suckling rhythms. Average data were recorded over 6 h of daily observation, weekly from day 6 to day 55 of lactation.

Conduct	Description
Nursing episode	Number of times in which the mother accepted nursing one or two kids, depending on the type of birth, and this lasted a minimum of 5 s.
Accepts to nurse	When the kid(s) approached the mother's inguinal area to try to suckle and the mother allowed it, this was considered acceptance when the kid suckled for more than five continuous seconds.
Refusal to nurse	When the kid(s) approached the mother's inguinal area to try to suckle and the mother rejected it, either by attacking it or simply by moving away from the kid.
Nursing duration	The total duration of each episode.

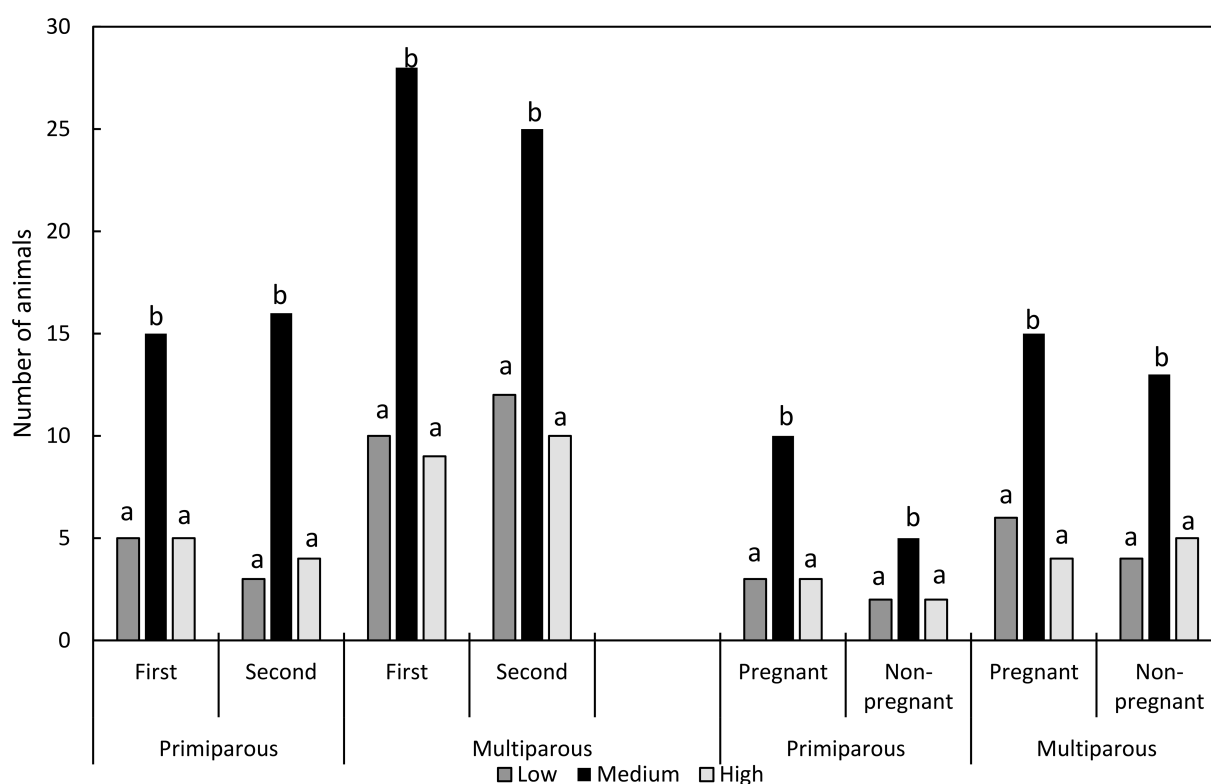


FIGURE 1

Number of goats (primiparous and multiparous) distributed across the three dominance levels. The left panel shows the first (beginning of lactation) and second measurements (end of lactation) success index calculations. The right panel shows the number of goats at each dominance level according to reproductive status. Different letters within each parity indicate differences between the three dominance levels ($P < 0.05$).

Body weight of goats

Body weight during the measurement period was affected by parity, with primiparous goats weighing less than multiparous goats ($P < 0.0001$) and by measurement time ($P < 0.0001$). The interaction between parity and time was also significant ($P = 0.013$) (data not shown).

Goat body weight was not affected by the physiological status ($P > 0.05$). However, it was influenced by the measurement time ($P < 0.0001$). A significant interaction between time and pregnancy status was also found ($P < 0.0001$), as pregnant females gained weight in late pregnancy and lost weight after parturition (data not shown).

Regardless of parity, body weight was significantly affected by the dominance level of goats ($P = 0.014$). Figure 2 shows that goats with a high dominance level weighed more than those with medium and high dominance. A highly significant effect of time ($P < 0.0001$) was also found. The weight of the goats increased as the gestation of the females progressed until delivery and then decreased. There was no significant effect of the interaction between time and dominance level ($P > 0.05$).

BCS of the goats

The BCS of primiparous goats was lower than that of multiparous goats on days 65 and 135 of gestation and on days 6,

27, and 34 of lactation ($P < 0.05$). A tendency toward higher BCS in multiparous goats than in primiparous goats was observed only on day 41 of lactation ($P = 0.092$). Data not shown.

BCS did not differ between pregnant and non-pregnant females ($P > 0.05$). However, during lactation, non-lactating females had a higher BCS than lactating females on days 6, 27, 34, 41, 48, 55, 62, and 67 ($P < 0.05$; data not shown).

Without considering parity, on day 85 of gestation and days 6, 14, 20, 41, 48, and 62 of lactation, BCS was significantly higher in goats with high dominance than in those with medium and low dominance ($P < 0.05$; Figure 3). Meanwhile, on days 65 and 135 of gestation and on day 55 of lactation, there was a tendency for high dominance goats to have better BCS than those with medium and low dominance levels ($P < 0.09$, Figure 3).

Body weight of kids

The body weights of the kids were not affected by the dominance of their mothers ($P > 0.05$). However, an effect of time was observed ($P < 0.0001$), as lactation progressed the kids at all three dominance levels increased in weight (Figure 4). Maternal parity did not affect the weights of the kids ($P > 0.05$).

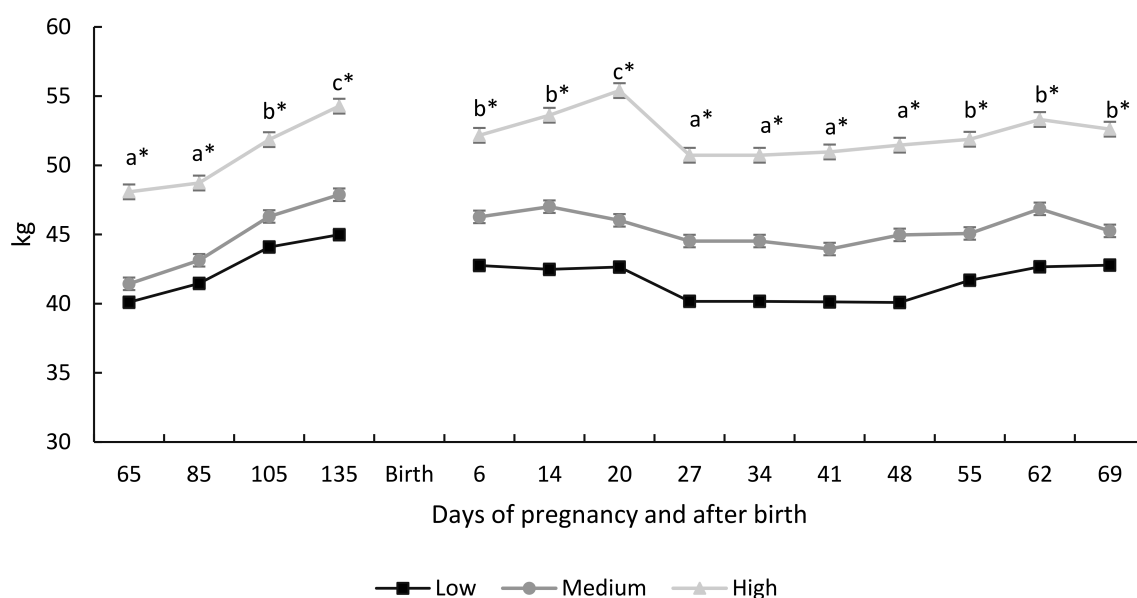


FIGURE 2

Body weight (mean $\pm$ SEM) of goats at the three dominance levels, measured from the second half of gestation until the end of lactation. Different literals indicate significant differences over time ($P < 0.0001$). Asterisks indicate differences between the three dominance levels ($*P < 0.05$).

Rectal temperature and surface temperature of the kids

The rectal temperature of the kids was affected by the maternal dominance level ($P = 0.05$, low: 39.3 ± 0.09 ; medium: 39.01 ± 0.09 ; high: 39.44 ± 0.20), with kids born to mothers with high dominance

having the highest temperature. Meanwhile, the external temperature of the kids was not affected by the maternal dominance level ($P > 0.05$; low: 28.5 ± 0.5 ; medium: 28.4 ± 0.4 ; high: 27.5 ± 1.1).

Neither the rectal nor external temperature of the kids were affected by the parity of the mothers ($P > 0.05$). Rectal temperature:

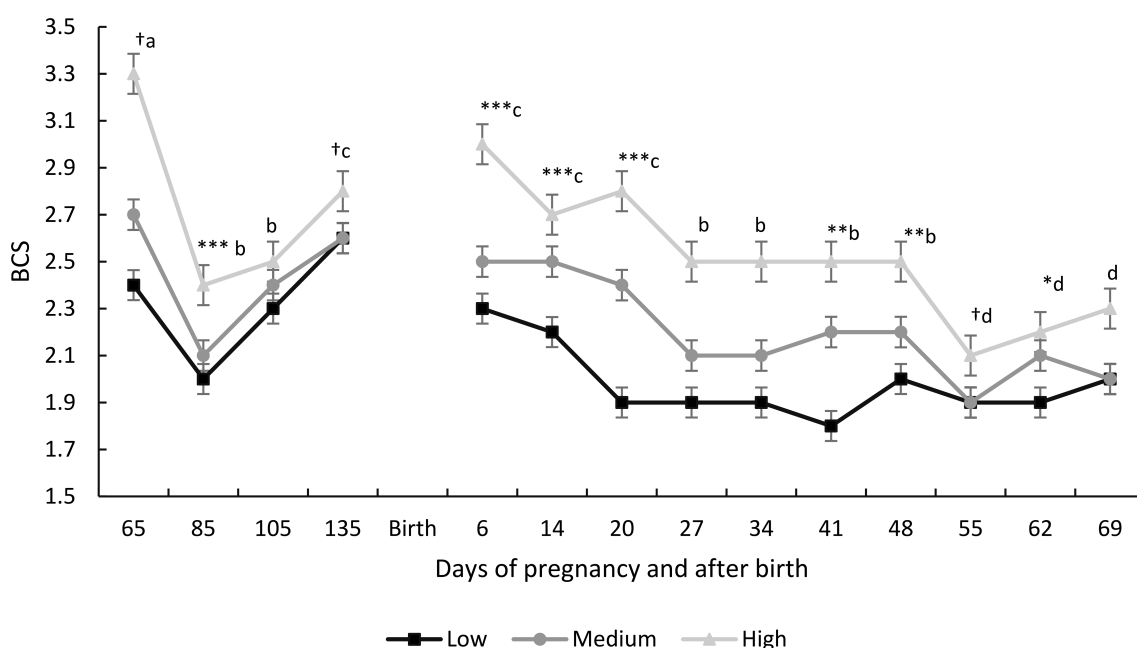


FIGURE 3

BCS (mean $\pm$ SEM) of goats at the three dominance levels, recorded from the second half of gestation until the end of lactation. Differences over time are indicated by different letters ($P < 0.05$). Differences between dominance levels are indicated by asterisks ($*P < 0.05$, $**P < 0.01$, $***P < 0.0001$), and trends, by the symbol †.

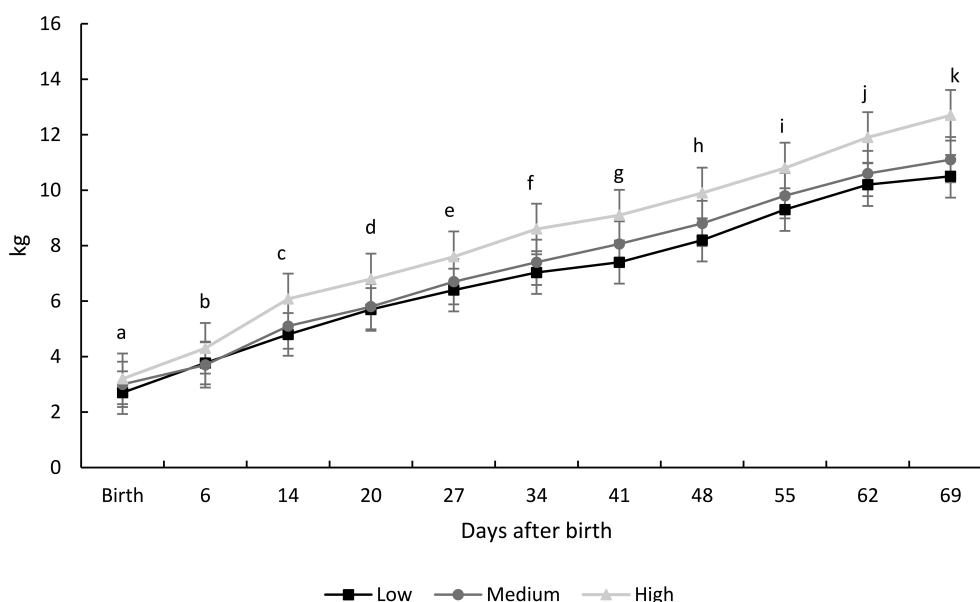


FIGURE 4

Body weight (mean $\pm$ SEM) of kids at the three maternal dominance levels, observed throughout lactation. Different letters indicate differences over time ($P < 0.0001$).

(primiparous: 39.03 ± 0.12 and multiparous: 39.2 ± 0.08). External temperature: (primiparous: 28.4 ± 0.6 and multiparous: 28.3 ± 0.4).

Maternal motivation score

The level of maternal motivation after 2 h postpartum was not affected by the dominance level of the mothers ($P > 0.05$, low: 2.28 ± 0.19 ; medium: 2.37 ± 0.12 ; high: 2.85 ± 0.14). However, a positive correlation was found between maternal motivation and success index value ($r = 0.29$, $P = 0.035$). No differences were found between primiparous and multiparous goats in this variable either ($P > 0.05$, primiparous: 2.30 ± 0.14 ; multiparous: 2.4 ± 0.12).

Nursing activity regardless of parity

Data were collected during two periods: morning (8–11 am) and afternoon (4–7 pm). No differences were found between the two shifts ($P > 0.05$). Therefore, the average of the measurements was calculated and statistically analyzed. The data presented in the figures are three-hour averages. No differences were found in behavior during lactation between primiparous and multiparous goats ($P > 0.05$). Therefore, the data for these variables are presented together for both groups.

A) Nursing episodes that were accepted by the dam

No differences were found among the three dominance levels for this behavior ($P > 0.05$). When compared over time medium dominance goats showed a higher frequency of dam-accepted

nursing episodes on days 6 and 14 of lactation than on the other days ($P < 0.05$, Figure 5). In low dominance goats, this behavior was higher on day 6 of lactation ($P < 0.05$). High dominance goats did not show significant differences in the frequency of this behavior across the weeks of measurement ($P > 0.05$).

B) Nursing episodes rejected by the dam

A trend was observed on day six of lactation: goats with high dominance tended to have a higher frequency of rejected suckling episodes than goats with medium and low dominance. ($P = 0.092$). No further differences were found among the three dominance levels during the remaining weeks of measurement ($P > 0.05$). When compared over time low dominance goats tended to show fewer nursing rejections between days 34 and 55 of lactation ($P = 0.06$; Figure 5). Neither high-nor medium dominance goats showed any difference in this behavior over the observation period ($P > 0.05$).

C) Total duration of nursing episodes

No differences were found among the three dominance levels for this behavior ($P > 0.05$). When compared over time medium dominance goats showed the longest average duration of nursing episodes that occurred on days 6 and 14 of lactation compared to the other measurement times ($P < 0.05$, Figure 6). In low dominance goats, the duration of nursing episodes decreased significantly from day 14 onward ($P < 0.05$). The high dominance goats showed no significant changes in this behavior over time ($P > 0.05$).

D) Total number of nursing episodes

No differences were found among the three dominance levels for this behavior ($P > 0.05$). When compared over time medium

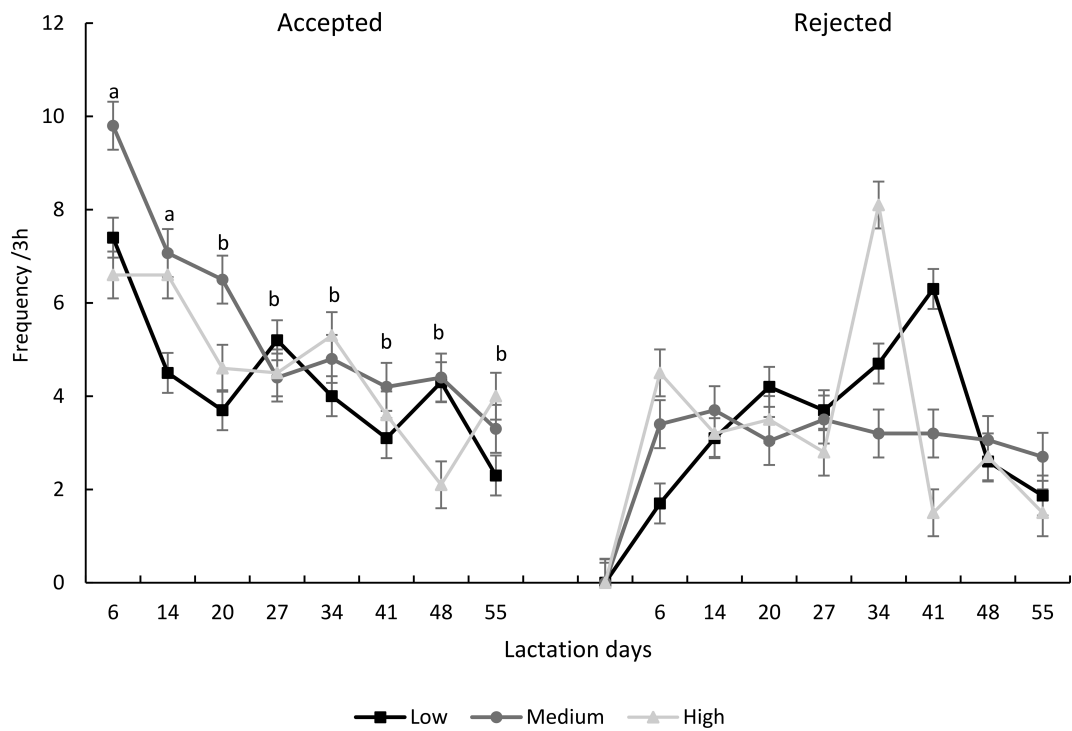


FIGURE 5
Frequency of nursing episodes (mean ± SEM) that were accepted or rejected by the dam during different stages of lactation, according to dominance level. For acceptance episodes, different letters indicate differences over time ($P < 0.05$). No significant differences were observed for rejection episodes ($P > 0.05$).

dominance goats showed the highest frequency of nursing episodes on day 14 of observation ($P < 0.05$; Figure 7). In low dominance goats, this behavior was significantly lower at week 8 than on days 6, 14, and 20 of lactation ($P < 0.05$). The high dominance goats displayed a tendency toward higher frequencies on day 34 than on days 41 and 48 ($P = 0.06$).

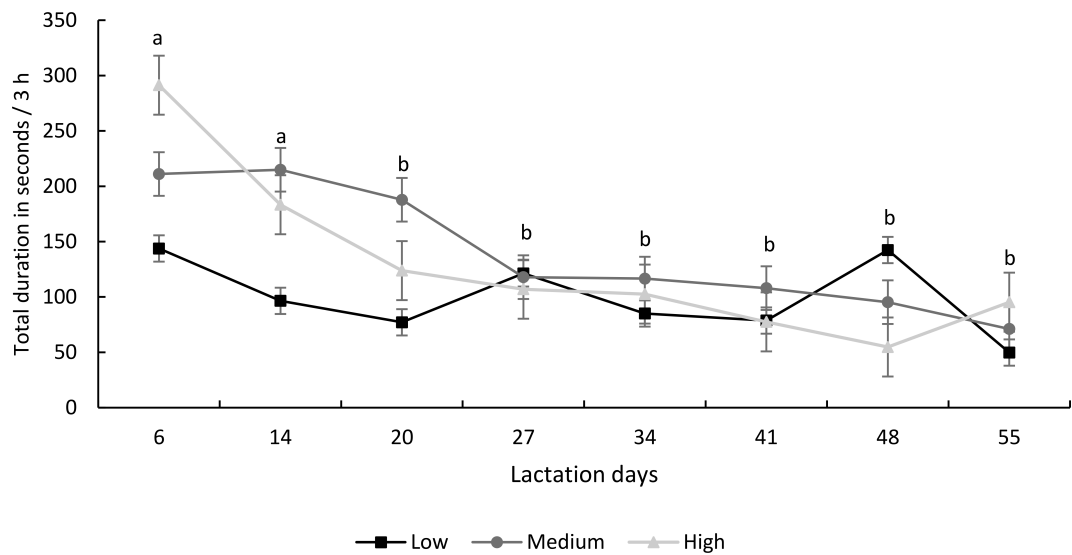


FIGURE 6
Duration of nursing episodes (mean ± SEM) during different lactation stages, according to the dominance level. Different letters indicate differences over time ($P < 0.05$).

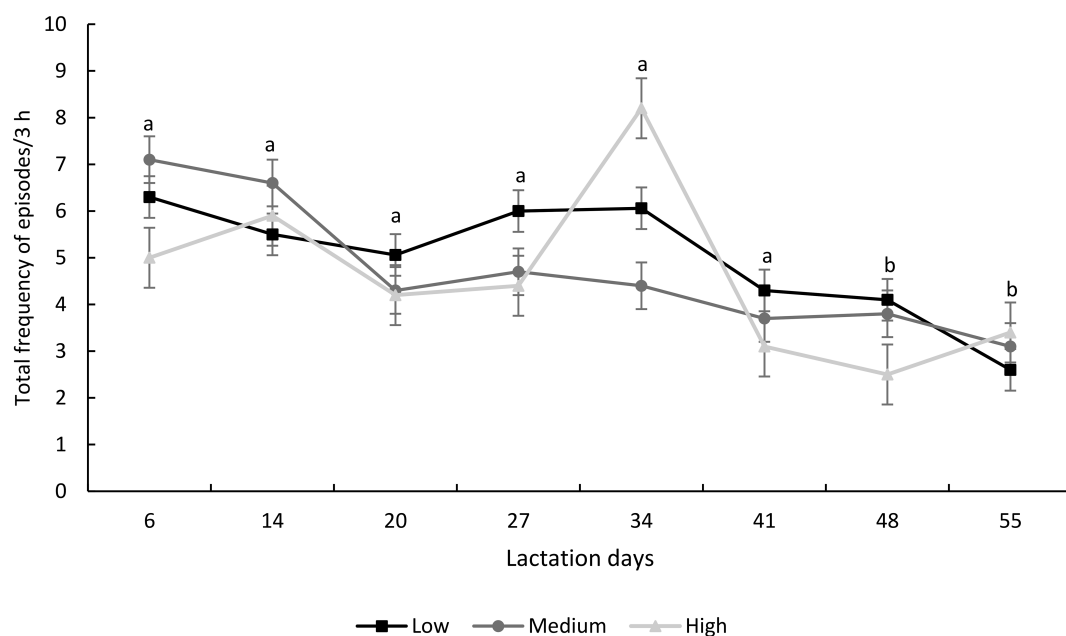


FIGURE 7

Frequency of total nursing episodes (mean $\pm$ SEM) during different lactation stages, according to the dominance level. Different letters indicate differences over time ($P < 0.05$).

Discussion

Goats were primarily concentrated in the medium dominance category. Even within parity stratification, most females (65%) were classified in medium dominance category, 20% had low dominance, and 15% had high dominance, which differed significantly. The segregation of social animals across different levels should find a balance that favors group cohesion. Therefore, most goats being both primiparous and multiparous and at the medium dominance level suggests that relationships in the group are stable and that resource availability does not induce unnecessary conflicts that lead to group instability.

These results are consistent with those reported by Barroso et al. (2000) for dairy goats in a semi-intensive system with a mixed herd of primiparous and multiparous females. Here, distributions of 50%, 27%, and 22% were reported for medium, low, and high levels, respectively. Similarly, in a study conducted with a group of 15 goats under an intensive system, found that 46% of goats exhibited medium dominance, 20% presented low dominance, and 34% presented high dominance (Fernández et al., 2007).

The animal distribution in the three dominance levels and the concentration in the medium dominance category level, both of which we found in this study, contrast with the findings by Alvarez et al. (2003). They evaluated a group of 42 dairy goats aged two to three years under an intensive system and found that only 38% of the goats were at the medium dominance category, while 35% were low and 26% were high. This discrepancy with our results may be explained by their measuring dominance success in females during the sexual resting season, or at least during periods of evident sexual inactivity. Meanwhile, our measurements were made after birth and

at the end of lactation, when most of, if not all, the females were engaged in other types of reproductive activity.

Although dominance level has been shown to influence reproduction in goats (Alvarez et al., 2007; Zuniga-Garcia et al., 2020), we found no evidence to the contrary. We did not observe other factors that could explain the different distributions of animals across dominance levels. In a study that explored the synchronization of activities and social cohesion in red deer, when the groups were mixed and unisexual, 35% of the intersex social segregation was observed (Conradt and Roper, 2000).

In our study, despite differences in age and size between primiparous and multiparous goats when comparing within each dominance level, it was found that they had an equivalent proportion of goats at the high, low, or medium levels. However, when comparing between the three dominance levels, in both parities, the highest proportion of females was concentrated at the medium level compared to the low and high levels. This result indicates that social cohesion can be preserved in goats with stable resources and low reproductive conditions.

To our knowledge, the literature has not reported comparisons of dominance levels between primiparous and multiparous goats, as most previous studies have analyzed mixed groups, including animals of both parities. However, the age ranges described in the methodologies of these studies indicate that there were goats aged two to eight years (Barroso et al., 2000; Alvarez et al., 2003). Our results and those reported in previous studies show that goats generally establish well-defined social relationships that generate hierarchical ranks that rarely change once established.

Animals in the middle hierarchy level have a greater benefit to the social structure of the herd because they do not have as many

agonistic interactions and spend less energy on fights and possible injuries. High-dominance animals constantly use energy and generate agonistic interactions to maintain their dominant position. Meanwhile, animals at low levels suffer the greatest social pressure, as they are the ones that receive aggression from dominant and middle-ranking females (Fournier and Festa-Bianchet, 1995; El Sabry and Almasri, 2023).

Regarding productive variables, primiparous females were found to weigh less than multiparous females. This is normal because of the size and age differences. Multiparous females had already reached maturity and were larger and heavier, whereas primiparous goats could continue their development (Damian et al., 2020). Body mass gain can be affected by nutritional factors and by parity at gestation. When primiparous females were administered 1 kg of concentrate/head/day feed during gestation, a greater increase in body mass was observed in primiparous females than that in multiparous females (Oyeyemi and Akusu, 2002). This suggests that there is still a distribution of nutrients required for the development of females and their products. Our results agree with those of previous studies under similar conditions, resulting in a similar weight difference between primiparous and multiparous goats (Cano-Suarez et al., 2024; Urbán Esquivel et al., 2025).

When parity was not considered, goats with high dominance were found to weigh more than those with medium or low dominance throughout the study. Those with low dominance had the lowest weight. With greater access to food resources, goats with high dominance would benefit from better weight and body condition than less favored goats, such as those with a low dominance level. These results coincide with those reported by Flores-Salas et al. (2025), who categorized goats aged 2–3 years into two hierarchical levels: high and low. They found greater body weights in high-level goats than in low-level goats. Our results also partially agree with those of Barroso et al. (2000), who indicated that high dominance animals were older and had larger body and horn sizes. In contrast, these goats produced less milk than those with medium dominance, which produced the most milk. The highest milk production in medium dominance goats was also reported by Fernández et al. (2007), after a regrouping process and once hierarchies were established. A linear relationship between the dominance level and body weight or milk production has been consistently reported in studies on domestic and stable goats. However, in the wild, animal conditions may change, since in mountain goats, there are contradictions between the best morphological characteristics and the dominant range. There is greater social instability (Fournier and Festa-Bianchet, 1995).

Body condition score was better in goats with high dominance than in those in the medium and low dominance categories. The low dominance females had a lower BCS than those in the other hierarchies, which is consistent with these females weighing less. These results are consistent with the findings regarding weight. Nutritional status is the first factor that is affected by the dominance level of animals. Goats with high dominance show more highly aggressive interactions, which give them greater access to food. However, they are also favored for access to the best food resources (Barroso et al., 2000). This allows them to have greater weights and

body conditions. Although this situation may apply when there is an interaction between older goats, when primiparous goats were compared separately, no differences in the BCS of the females between the three hierarchical levels were observed. In contrast, the general effect persisted in multiparous goats, with high dominance females displaying the highest BCS values.

Therefore, there is a relationship between the age of the animal and the dominance level, as suggested by Fournier and Festa-Bianchet (1995) for mountain goats and Górecki et al. (2020) for dairy goats. Our results regarding BCS coincide with those of Flores-Salas et al. (2025), who found that high social level goats had greater BCS than those belonging to the low dominance level. Body condition and weight are parameters that help determine the nutritional status of animals. At all dominance levels, these parameters increased from late gestation to delivery, and decreased thereafter. They also showed recovery of weight and BCS as nursing progressed. In the BCS, there was a significant interaction between the dominance level and the measurement of time, which allowed us to conclude that this parameter could be acutely altered by these factors. Therefore, it is important to focus on the nutritional status of goats of low hierarchy in stages as important as gestation and lactation, as this situation could influence milk production and offspring survival.

Regarding the body weights of the kids, when maternal parity was not considered, no significant differences were found among the three dominance levels. Within each parity, no significant differences were found in the weights of the kid among the dominance levels of their mothers. No effect of parity was observed on the weight of the kids. This indicates that the dominance level of mothers does not affect the weight of the kids, which coincides with other studies (Flores-Salas et al., 2025). This could indicate that other factors, such as sex and litter size, could affect this variable more. Our study does not show these data because it is not the objective of this investigation. However, subsequent studies may consider the correlations or interactions of these factors with the dominance level of the mother to evaluate the effect on the weight of the kids. Similarly, parity did not affect kids' weight, suggesting that it is not a factor that could affect the weight of the offspring. However, primiparous mothers were smaller in size and weight than multiparous females. This is consistent with the results of previous studies on goats (Cano-Suarez et al., 2024; Urbán Esquivel et al., 2025). In our study, kid weight was affected by age, as body weight increased over time. However, only in primiparous goats was there a tendency for an interaction between hierarchy and time. Meanwhile, kid weight increased with age, and this effect was less pronounced in kids born to low dominance mothers.

Our results coincide with those reported by López Sánchez (2013) and Flores-Salas et al. (2025), who also found no significant effect of the maternal dominance level. However, both studies reported a significant effect of time. Flores-Salas et al. (2025) reported, just as well as our own study, an interaction between the dominance level of mothers and the time of measurement. However, it is important to clarify that in their study, goats were only categorized into two levels (low and high).

The kids' growth is related to maternal milk production and depends on the nutritional status of the dam. In our study, despite the differences in maternal body weight and BCS associated with the dominance level, these factors did not affect kid growth. Nevertheless, we could not account for other factors such as litter size or kid sex, which may also influence body weight.

In contrast, our findings regarding kids' body weights differ from those reported by Barroso et al. (2000), who found that kids from medium dominance mothers were heavier than those from high and low dominance dams. The medium dominance goats were more productive in terms of milk yield, which led to greater weight gain by the end of lactation.

The rectal temperature of the kids, measured 2 h after birth, was due to the dominance level of the mothers. The offspring whose mothers had a higher dominance level had a higher rectal temperature. This implies that the level of maternal care may be higher for high dominance mothers. This could also be a consequence of the adequate nutritional status of the mother along with the quality of her colostrum, leading to the need for further research on this subject. Nevertheless, this effect was not evident for external temperature, and no effect was found on the mother's experience with these variables. Factors that affect the rectal temperature of kid and have been described in some studies are breed, sex, and environment, such as the time of day. However, most of these reports refer to studies on sheep (Dwyer, 2003; Dwyer et al., 2016) and there is relatively little information on goat kids (Habibu et al., 2022, 2023).

The level of maternal motivation at 2 h postpartum was not affected by the dominance level of the mothers. However, a positive correlation was found between maternal motivation and the success index. This indicates that the higher the success index, the higher the maternal motivation score, which could be related to the female's nutritional status. Malnourished goats show alterations in maternal behavior during gestation (Terrazas et al., 2009). Meanwhile, those supplemented with energy substrates at the end of gestation show improved maternal attention and greater kid vitality (Ramírez-Vera et al., 2012). However, the maternal motivation score is a short evaluation and may not be a fully accurate measure of maternal care quality, necessitating further studies.

Regarding nursing behavior during lactation, almost no effects of dominance level were observed in either primiparous or multiparous goats. Only one trend was found in week one, when high dominance goats rejected nursing more often than medium or low dominance goats. The main effects were associated with time: the frequency of nursing episodes accepted by the mother was greater at the beginning of lactation and then decreased. However, this difference was more pronounced in medium dominance goats. Similarly, nursing rejection decreased with age, and this effect was more evident in low dominance goats.

Regarding the total duration of nursing episodes, values were the highest at weeks 1 and 2, coinciding with the peak in nursing activity and demand of milk of the kids. Both variables decreased as the nursing program progressed. Our results regarding the time effect coincide with those of Lickliter (1985), who noted that

mother–offspring interactions are greater during the first weeks of life, although these interactions occur in short periods. Meanwhile, the young remain more concealed. A study conducted on kids showed that the frequency of nursing episodes was highest during the first seven days postpartum and then decreased from the second week of lactation onward. Meanwhile, nursing refusals increased after the second week postpartum (García et al., 2017).

The perspectives we propose for investigation include an assessment of whether maternal dominance level affects the establishment of selective bonding during the sensitive period. Further studies should be conducted with more animals grouped in the same space. It would be valuable to assess whether there is a relationship between endocrine factors regulating maternal behavior, female nutritional status at the end of gestation, and dominance level.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The animal study was approved by Comité Interno para el Cuidado y Uso de los Animales en Experimentación-CICUAEFESC of Facultad de Estudios Superiores Cuautitlán, Universidad Nacional Autónoma de México (registration number: CICUAEFESC C 23_09). The study was conducted in accordance with the local legislation and institutional requirements.

Author contributions

AG-C: Methodology, Writing – review & editing, Data curation, Investigation, Conceptualization, Writing – original draft, Visualization, Formal analysis, Validation. PC-S: Validation, Writing – review & editing, Conceptualization, Investigation, Data curation, Supervision, Methodology, Visualization, Resources, Writing – original draft, Formal analysis. AT: Supervision, Validation, Investigation, Data curation, Conceptualization, Writing – review & editing, Project administration, Funding acquisition, Formal analysis, Writing – original draft, Resources, Methodology, Visualization.

Funding

The author(s) declare financial support was received for the research and/or publication of this article. This research was mainly funded by Universidad Nacional Autónoma de México with project number: UNAM-DGAPA-PAPIIT IN224220, as well as by a complementary support made by Facultad de Estudios Superiores Cuautitlán with project number: FESC-UNAM-CI2458 and by the

Consejo Mexiquense de Ciencia y Tecnología (COMECYT) fund Mujeres Investigadoras with project number: FICDTEM-2021-068.

Acknowledgments

We would like to thank Magdalena Franco Oviedo and Martín Arana for animal care and data collection. We sincerely thank Alfredo Herrera Martinez, Laura Castillo Hernandez, Melisa Rojas Rangel, Fernanda Delgadillo, Daniel Ramos, Karen Ayala and Rocío Ibarra, who assisted with data collection.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Alexander, G., Stevens, D., Kilgour, R., de Langen, H., Mottershead, B. E., and XXXJJ, L. (1983). Separation of ewes from twin lambs: Incidence in several sheep breeds. *Appl. Anim. Ethol.* 10, 301–317. doi: 10.1016/0304-3762(83)90181-5
- Alvarez, L., Martin, G. B., Galindo, F., and Zarco, L. A. (2003). Social dominance of female goats affects their response to the male effect. *Appl. Anim. Behav. Sci.* 84, 119–126. doi: 10.1016/j.applanim.2003.08.003
- Alvarez, L., Zarco, L., Galindo, F., Blache, D., and Martin, G. B. (2007). Social rank and response to the “male effect” in the Australian Cashmere goat. *Anim. Reprod. Sci.* 102, 258–266. doi: 10.1016/j.anireprosci.2006.11.002
- Bañón, S., Vila, R., Price, A., Ferrandini, E., and Garrido, M. D. (2006). Effects of goat milk or milk replacer diet on meat quality and fat composition of suckling goat kids. *Meat. Sci.* 72, 216–221. doi: 10.1016/j.meatsci.2005.07.004
- Barroso, F. G., Alados, C. L., and Boza, J. (2000). Social hierarchy in the domestic goat: effect on food habits and production. *Appl. Anim. Behav. Sci.* 69, 35–53. doi: 10.1016/S0168-1591(00)00113-1
- Cano-Suarez, P., Damian, J. P., Soto, R., Ayala, K., Zaragoza, J., Ibarra, R., et al. (2024). Behavioral, physiological and hormonal changes in primiparous and multiparous goats and their kids during peripartum. *Ruminants* 4, 515–532. doi: 10.3390/ruminants4040036
- Chetrou, R., Călin, I., and Niculescu, C. G. (2013). “Worldwide trends and orientations of raising goats,” in *Agrarian Economy and Rural Development-Realities and Perspectives for Romania. 4th Edition of the International Symposium*. November 2013, Bucharest (pp. 100–106). Bucharest: The Research Institute for Agricultural Economy and Rural Development (ICEADR). Available online at: https://www.econstor.eu/bitstream/10419/111570/1/ICEADR-2013_p100.pdf (Accessed October 05, 2025).
- Conradt, L., and Roper, T. J. (2000). Activity synchrony and social cohesion: a fission-fusion model. *Proc. Biol. Sci.* 267, 2213–2218. doi: 10.1098/rspb.2000.1271
- Craig, J. V. (1986). Measuring social behavior: social dominance. *J. Anim. Sci.* 62, 1120–1129. doi: 10.2527/jas1986.6241120x
- Damian, J. P., Terrazas, A., Cabrera, E., Simonetti, S., Aragunde, R., and Fila, D. (2020). Growth of foetal bones and metabolic profile during gestation in primiparous ewes and multiparous ewes. *Reprod. Domest. Anim.* 55, 1180–1189. doi: 10.1111/rda.13760
- Dwyer, C. M. (2003). Behavioural development in the neonatal lamb: effect of maternal and birth-related factors. *Theriogenology* 59, 1027–1050. doi: 10.1016/S0093-691X(02)01137-8
- Dwyer, C. M., Conington, J., Corbiere, F., Holmoy, I. H., Muri, K., Nowak, R., et al. (2016). Invited review: Improving neonatal survival in small ruminants: science into practice. *Animal* 10, 449–459. doi: 10.1017/S1751731115001974
- Dwyer, C. M., and Lawrence, A. B. (1998). Variability in the expression of maternal behaviour in primiparous sheep: effects of genotype and litter size. *Appl. Anim. Behav. Sci.* 58, 311–330. doi: 10.1016/S0168-1591(97)00148-2
- El Sabry, M., and Almasri, O. (2023). Stocking density, ambient temperature, and group size affectsocial behavior, productivity and reproductivity of goats- A review. *Trop. Anim. Health Prod.* 55, 181. doi: 10.1007/s11250-023-03598-0
- Erduran, H. (2023). Effect of parturition time and photoperiod on milk production, quality, and somatic cell count traits of pure and crossbred goats in a different production system. *Trop. Anim. Health Prod.* 55, 145. doi: 10.1007/s11250-023-03560-0
- Escareno, L., Salinas-Gonzalez, H., Wurzing, M., Iniguez, L., Solkner, J., and Meza-Herrera, C. (2013). Dairy goat production systems: status quo, perspectives and challenges. *Trop. Anim. Health Prod.* 45, 17–34. doi: 10.1007/s11250-012-0246-6
- Fernández, M., Álvarez, L., and Zarco, L. (2007). Regrouping in lactating goats increases aggression and decreases milk production. *Small. Ruminant. Res.* 70, 228–232. doi: 10.1016/j.smallrumres.2006.03.008
- Flores-Salas, J. M., Castillo-Zuniga, M. S., Meza-Herrera, C. A., Calderon-Leyva, M. G., Bustamante-Andrade, J. A., Santiago-Miramontes, M. L. A., et al. (2025). Maternal social hierarchy, morphometric traits, live weight, and metabolic status as related to the offspring pre-weaning growth in crossbred dairy goats. *Anim. (Basel)*. 15, 1–12. doi: 10.3390/ani15081100
- Fournier, F., and Festa-Bianchet, M. (1995). Social dominance in adult female mountain goats. *Anim. Behav.* 49, 1449–1459. doi: 10.1016/0003-3472(95)90066-7
- García, E., Flores, J., Delgadillo, J., González, T., Fernández, I., Terrazas, A., et al. (2017). Early nursing behaviour in ungulate mothers with hidden offspring (Capra hircus): Correlations between milk yield and kid weight. *Small. Ruminant. Res.* 151, 59–65. doi: 10.1016/j.smallrumres.2017.04.014
- Górecki, M., Sochacka, J., and Kaźmierczak, S. (2020). Dominance hierarchy, milking order, and neighbour preference in domestic goats. *Small. Ruminant. Res.* 191. doi: 10.1016/j.smallrumres.2020.106166
- Habibu, B., Aliyu, A., Idris, S. Y., Buhari, H. U., Galadanchi, F. A., Abdulrahman, M., et al. (2023). Thermoregulation in periparturient rabbit does and their neonatal kits with different litter sizes during West African winter. *Anim. Biotechnol.* 34, 4357–4366. doi: 10.1080/10495398.2022.2150200
- Habibu, B., Umaru Kawu, M., Aluwong, T., and Joan Makun, H. (2022). Neonatal thermoregulation and dynamics of serum thyroid hormones in tropical breeds of goat kids. *J. Therm. Biol.* 108, 103299. doi: 10.1016/j.jtherbio.2022.103299
- Hernandez, H., Serafin, N., Terrazas, A. M., Marnet, P. G., Kann, G., Delgadillo, J. A., et al. (2002). Maternal olfaction differentially modulates oxytocin and prolactin release during suckling in goats. *Hormones. Behav.* 42, 232–244. doi: 10.1006/hbeh.2002.1812
- Hernández, H., Terrazas, A., Poindron, P., Ramírez-Vera, S., Flores, J. A., Delgadillo, J. A., et al. (2012). Sensorial and physiological control of maternal behavior in small ruminants: sheep and goats. *Trop. Subtropical. Agroecosyst.* 15 (1), S91–S102. doi: 10.56369/tsaes.1307
- Jørgensen, G. H. M., Andersen, I. L., and Bøe, K. E. (2007). Feed intake and social interactions in dairy goats. The effects of feeding space and type of roughage. *Appl. Anim. Behav. Sci.* 107, 239–251. doi: 10.1016/j.applanim.2006.10.007
- Lévy, F. (2022). The onset of maternal behavior in sheep and goats: endocrine, sensory, neural, and experiential mechanisms. *Adv. Neurobiol.* 27, 79–117. doi: 10.1007/978-3-030-97762-7_3
- Lickliter, R. E. (1985). Behavior associated with parturition in the domestic goat. *Appl. Anim. Behav. Sci.* 13, 335–345. doi: 10.1016/0168-1591(85)90013-9

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

- López Sánchez, J. M. (2013). La jerarquía social de las madres afecta la viabilidad sobrevivencia de la cría en caprinos durante la lactancia. Bachelors Thesis, Universidad Nacional Autónoma de México. Available online at: <https://ru.dgb.unam.mx/server/api/core/bitstreams/f6deab39-b5bd-4f5c-bd21-2bb59663e5a4/content> (Accessed October 05, 2025).
- Lu, C. D. (2023). The role of goats in the world: Society, science, and sustainability. *Small Ruminant Research* 227. doi: 10.1016/j.smallrumres.2023.107056
- Mendizabal, J. A., Delfa, R., Arana, A., and Purroy, A. (2011). Body condition score and fat mobilization as management tools for goats on native pastures. *Small Ruminant. Res.* 1-3, 121–127. doi: 10.1016/j.smallrumres.2011.03.029
- Mendl, M., Zanella, A. J., and Broom, D. M. (1992). Physiological and reproductive correlates of behavioural strategies in female domestic pigs. *Anim. Behav.* 44, 1107–1121. doi: 10.1016/S0003-3472(05)80323-9
- Miller, B. A., and Lu, C. D. (2019). Current status of global dairy goat production: an overview. *Asian-Australas. J. Anim. Sci.* 32, 1219–1232. doi: 10.5713/ajas.19.0253
- Monteiro, C., Cardoso-Cruz, H., and Galhardo, V. (2019). Animal models of congenital hypoalgesia: Untapped potential for assessing pain-related plasticity. *Neurosci. Lett.* 702, 51–60. doi: 10.1016/j.neulet.2018.11.045
- O'Connor, C. E., Jay, N. P., Nicol, A. M., and Beatson, P. R. (1985). Ewe maternal behaviour score and lamb survival. *Proc. New Z. Soc. Anim. Product.* 45, 159–162. Available online at: <https://www.nzsap.org/system/files/proceedings/1985/ab85037.pdf> (Accessed October 05, 2025).
- Oyeyemi, M. O., and Akusu, M. O. (2002). Response of multiparous and primiparous West African Dwarf goats (*Capra hircus*, L.) to concentrate supplementation. *Veterinarski. Arhiv.* 72, 29–38. Available online at: <https://hrcak.srce.hr/78391> (Accessed October 05, 2025).
- Poindron, P., Lévy, F., and Keller, M. (2007a). Maternal responsiveness and maternal selectivity in domestic sheep and goats: The two facets of maternal attachment. *Dev. Psychobiol.* 49, 54–70. doi: 10.1002/dev.20192
- Poindron, P., Otal, J., Ferreira, G., Keller, M., Guesdon, V., Nowak, R., et al. (2010). Amniotic fluid is important for the maintenance of maternal responsiveness and the establishment of maternal selectivity in sheep. *Animal* 4, 2057–2064. doi: 10.1017/S1751731110001126
- Poindron, P., Terrazas, A., Montes de Oca M. de, L., Serafin, N., and Hernandez, H. (2007b). Sensory and physiological determinants of maternal behavior in the goat (*Capra hircus*). *Hormones. Behav.* 52, 99–105. doi: 10.1016/j.yhbeh.2007.03.023
- Ramírez-Vera, S., Terrazas, A., Delgadillo, J. A., Flores, J. A., Serafin, N., Vielma, J., et al. (2012). Inclusion of maize in the grazing diet of goats during the last 12 days of gestation reinforces the expression of maternal behaviour and selectivity during the sensitive period. *Livestock. Sci.* 148, 52–59. doi: 10.1016/j.livsci.2012.05.006
- Romeyer, A., and Poindron, P. (1992). Early maternal discrimination of alien kids by post-parturient goats. *Behav. Proc.* 26, 103–111. doi: 10.1016/0376-6357(92)90006-Y
- Seebacher, F., and Krause, J. (2019). Epigenetics of social behaviour. *Trends Ecol. Evol.* 34, 818–830. doi: 10.1016/j.tree.2019.04.017
- Shackleton, D. M., and Shank, C. C. (1984). A review of the social behavior of feral and wild sheep and goats. *J. Anim. Sci.* 58, 500–509. doi: 10.2527/jas1984.582500x
- Shinde, A. K., Singh, N. P., and Verma, D. L. (2004). Milk yield and composition of Marwari goats maintained under different production systems. *Indian J. Anim. Sci.* 74, 333–335. Available online at: <https://epubs.icar.org.in/index.php/IJAnS/article/view/38414> (Accessed October 05, 2025).
- Terrazas, A., Robledo, V., Serafin, N., Soto, R., Hernández, H., and Poindron, P. (2009). Differential effects of undernutrition during pregnancy on the behaviour of does and their kids at parturition and on the establishment of mutual recognition. *Animal* 3, 294–306. doi: 10.1017/S1751731108003558
- Urbán Esquivel, K., Damián, J. P., Díaz Sánchez, V. M., Rojas Maya, S., Cano Suárez, P. C., Ramírez Espinosa, J. J., et al. (2025). A comparison of behavioral and biochemical changes associated with pain, between primiparous and multiparous goats around parturition. *Austral J. Vet. Sci.* 57, 1–14. doi: 10.4206/ajvs.57.03
- Zuniga-García, S., Meza-Herrera, C. A., Mendoza-Cortina, A., Otal-Salaverri, J., Perez-Marin, C., Lopez-Flores, N. M., et al. (2020). Effect of Social Rank upon Estrus Induction and Some Reproductive Outcomes in Anestrus Goats Treated With Progesterone + eCG. *Anim. (Basel)*. 10, 1–18. doi: 10.3390/ani10071125