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EDITED BY
Luis de la Cruz Cruz,
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REVIEWED BY
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Universidad de las Américas, Chile
Fukuan Li,
Linyi University, China

*CORRESPONDENCE
Libia Pérez-Torres
liperez@uat.edu.mx

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Allosuckling in domestic hair sheep: a rare behavior associated with multiple births and male lambs

Libia Pérez-Torres[1]*, Agustín Orihuela[2], José Herrera-Haro[3] and Angelica Terrazas[4]

[1]Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma de Tamaulipas, Ciudad, Victoria, Tamaulipas, Mexico, [2]Facultad de Ciencias Agropecuarias, Universidad Autónoma del Estado de Morelos, Morelos, Mexico, [3]Departamento de Recursos Genéticos y Productivos - Ganaderia, Colegio de Postgraduados, Montecillo, Estado de Mexico, Mexico, [4]Facultad de Estudios Superiores Cuautitlán, Universidad Nacional Autónoma de México, Cuautitlán Izcalli, Mexico

Allonursing or allosuckling is a rare but an intriguing evolutionary behavior reported in several species including mammals. Despite the energy cost of lactation, females occasionally allow alien offspring to suckle, suggesting potential adaptative, physiological, or social functions. However, information on this behavior in domestic sheep, particularly in tropical hair breeds, remains scarce. To determine the frequency and the influencing factors of non-filial suckling (NFS) in Saint Croix sheep, a total of 33 hair sheep ewes and their lambs (16 singletons, 13 twins, and 4 triplets) were observed from parturition to weaning (8 weeks of lactation). All animals were kept as a group, grazing on a paddock from 0800 to 1400 hours and penned during the rest of the day. Behavioral observations were conducted three times/week (from 0800 to 1000 and from 1400 to 1600 hours), and the suckling events (*S*) and suckling attempts (*A*) from both filial and non-filial (NF) ewe–lambs pairs and the weight gain in lambs were recorded. A total of 1,664 *A* and 6,203 *S* were observed, of which 17.0% corresponded to non-filial attempts (NFAs) and 0.6% to NFS. Of the lambs, 85% displayed NFAs, while 37% displayed NFS, at least one time. The percentage of lambs that displayed NFS was affected by the following: a) multiple births—more triplets and twins than singletons [50% (6/12) and 38% (10/26) *vs*. 25% (4/16), $p = 0.0001$]; b) the sex of the lamb—more males than females [75% (25/33) *vs*. 30% (10/33), $p = 0.0004$]; and c) the time of day context—favoring PM = pen over AM = pasture (67.2% *vs*. 32.8%, $p = 0.0075$). The age of the lamb did not affect the percentage of lambs displaying NFAs or NFS. However, NFAs were more frequent in young lambs at early lactation. All ewes received NFAs, but only 49% of them allowed NFS (100% of the ewes that gave birth to triplets, 46% bearing twins, and 37% bearing singletons). Lambs that displayed more NF activities had the lowest average weight gains at weeks 2 and 6, maintaining the same tendency throughout lactation. These results indicate that NFS occurs in hair sheep, but is infrequent and needs to be investigated in the context of nutritional stress, recognition errors, or maternal permissiveness.

KEYWORDS

allosuckling, animal welfare, lactation, maternal behavior, multiple births, non-filial suckling, Saint Croix, sheep

1 Introduction

In the majority of mammalian species, mothers exclusively nurse their own offspring (Nowak et al., 2000). However, non-exclusive or non-filial suckling (NFS) between females and offspring has been documented in several species. This behavior is referred to as "allosuckling," when a young animal seeks and suckles from a female other than its mother (Packer et al., 1992), and as "allonursing," when a female allows and provides care to alien offspring (Roulin and Heeb, 1999).

NFS has been reported in various mammalian species, including red deer (*Cervus elaphus*) (Bartoš et al., 2001), reindeer (*Rangifer tarandus*; Engelhardt et al., 2014), giraffes (*Giraffa Camelopardalis*; Gloneková et al. 2016), camels (*Camelus bactianus*; Brandlová et al. 2013), water buffalo (*Bubalus bubalis*; Murphey et al., 1995; Paranhos da Costa et al., 2000, Orihuela et al., 2024), cattle (*Bos taurus*) (Špinka and Illmann, 2015; Víchová and Bartoš, 2005; Castanheira et al., 2013), bighorn sheep (*Ovis canadensis*) (Hass, 1990), wild Argali sheep (*Ovis ammon*) (Kilgour and Dalton, 1984), and domestic wool sheep (*Ovis aries*) (Welch and Kilgour, 1970, 1972).

The biological importance of allosuckling or allonursing remains under investigation as lactation is energetically costly (Roulin, 2003). Several hypotheses have been proposed to explain its occurrence (Mota-Rojas et al., 2021). For example, the compensatory supplementation hypothesis suggests that offspring nurse from additional females to offset limited milk supply or insufficient maternal care (Víchová and Bartoš, 2005; Roulin, 2002). Another theory suggests that allosuckling in lambs may facilitate weight gain, promote growth, or improve body condition (Paranhos da Costa et al., 2000), denominated the nutritional benefit hypothesis. On the other hand, the immunological advantage hypothesis proposes that suckling from multiple females broadens the range of antibodies and immunological protection transferred to the young (Roulin and Heeb, 1999).

The NFS behavior is affected by factors inherent to the dams (Bartoš et al., 2001; Paranhos da Costa et al., 2000). For the nursing female, potential benefits include relief of udder pressure and the maintenance of mammary gland function (Roulin, 2002). However, this may decrease the milk available to its own offspring, increasing the need for complementary nutrition (Packer et al., 1992). In addition, when allosuckling is allowed, mothers may obtain health benefits through evacuating the extra milk (Roulin, 2002). However, nursing a non-filial (NF) offspring can also result in refusal to care for their own offspring (Stevens et al., 1982).

A recent review has highlighted that the allonursing or allosuckling behavior results from a variety of intrinsic and extrinsic factors. These include the female's physiological state, parity, and maternal experience, as well as the social structure, group stability, and population density. However, these factors are different for each species (Mota-Rojas et al., 2021).

On the other hand, despite this information about NFS, this is limited to domestic sheep, in particular to hair breeds. This is relevant because the NFS behavior could influence the productivity, growth, productive development, and welfare of the sheep.

Therefore, the objectives of this study were to quantify the incidence of NFS during the first 8 weeks of lactation in Saint Croix sheep and to identify the ewe and lamb characteristics associated with its occurrence and its potential effects on lamb growth performance.

2 Materials and methods

This study was strictly observational and did not involve any experimental manipulation, treatment, or interference with the animals beyond standard husbandry practices. Therefore, ethical approval from an institutional animal care and use committee was not required. A clarifying statement has been added in "*Ethical considerations*" to explicitly state this point.

This study was conducted at the Universidad Autónoma del Estado de Morelos, Mexico (18°37' N, 99°19' W, 899 m.a.s.l.). The region has a subtropical climate with an average annual rainfall of 800 mm and a mean annual temperature of 23°C (García, 2004).

2.1 Animals and housing conditions

Prior to the experiment, 60 Saint Croix ewes were synchronized using intravaginal sponges impregnated with fluorogestone acetate (30 mg; Chronogest®, Intervent/Schering-Plough Animal Health, Mexico) for 12 days, followed by the administration of 500–600 IU of equine chorionic gonadotropin (Novormon®, Virbac, Mexico) (Letelier et al., 2009). Natural mating was performed with three rams over 3 days after sponge removal. Pregnancy was confirmed 30 days post-estrus using transrectal ultrasound, and only ewes that were diagnosed pregnant were retained in the group. Only those ewes that delivered in a range 1–2 days of difference were considered for the study, resulting in 33 Saint Croix multiparous ewes with two to three previous parturitions, averaging a body condition score of 2.5 (scale from 1 to 5) (Khan et al., 1992). There were 16, 13, and 4 ewes having singletons, twins, and triplets, respectively. A total of 54 lambs were observed: 16 singletons, 26 twins, and 12 triplets.

All animals were kept as a single group in a semi-intensive management for the first 8 weeks of lactation, grazing in a paddock of 1,100 m^2 (52.8 m^2/ewe) composed of *Cynodon nlemfuensis* and *Pennisetum purpureum* from 0800 to 1400 hours and then penned the rest of the day in a roofed enclosure with a concrete floor (1.5 m^2/ewe). In the pen, ewes were supplemented with 950 g of commercial concentrate per ewe per day. This concentrate comprised 16% protein and 2.7 Mcal, and the amount offered post-estrus was adjusted weekly according to the nutritional requirements of the ewes. Water and mineral salts were provided *ad libitum*.

2.2 Experimental procedure

The sex and body weight of the lambs were recorded immediately after birth. At this time, the ewes and lambs were identified with numbers painted on their flanks using a non-toxic

paint so that they could be observed from a distance. After recording the birth weight, the lambs were weighed between 0700 and 0800 hours, every week until the end of the experiment. A digital scale was used for this purpose.

At 4 h postpartum, the establishment of the mother–lamb bond (Poindron et al., 2010) was confirmed based on the observation that all ewes allowed their own lambs to nurse. From this point, observations were performed three times per week by four trained observers during 2-h periods, from 0800 to 1000 hours in the paddock and from 1400 to 1600 hours in the pen, which led to a total of 96 h of observation during the 8 weeks. Before data collection began, the observers underwent standardized training sessions in behavioral identification. The training included reviewing the operational definitions of all suckling behaviors and jointly observing pilot sessions until agreement exceeded 85%. Inter-observer reliability was calculated using Cohen´s kappa, resulting in a value of 0.86, which indicates strong agreement among observers.

The following behaviors were recorded:

1. Suckling events (*S*): active nipple sucking by a lamb lasting >3 s.
2. Suckling attempts (*A*): efforts to reach or grasp the nipple lasting <3 s.

Each *S* and *A* event was classified according to whether it occurred between a filial or a non-filial (NFA–NFS) ewe–lamb pair.

2.3 Statistical analyses

Descriptive statistics were obtained following the means procedure of the SAS statistical package (PROC MEANS, SAS 2004). Normality tests were conducted (PROC UNIVARITE, SAS, 9.2, SAS 2004). Data that did not meet the normality requirements were normalized by $\log[x + 1]$ transformation.

The frequency of NFAs and NFS displayed was analyzed with the three-way analysis of variance *F*-ratio using the following as factors: the type of parturition (singletons, twins, or triples), the sex of the lamb (male or female), and the time of day context (AM = pasture or PM = pen), with weight used as the fixed effect and lamb as the random effect. In case of significance, Tukey's test was used as a *post-hoc* analysis. The weight gains of the lambs were analyzed using a linear mixed model (LMM) of repeated measures in the time mixed model. Values with $p < 0.05$ were considered significant, and a tendency when $p > 0.05$, but <0.1. Data are presented as the mean ± SEM from the events observed in 96 h of observation during 8 weeks of lactation (12 h/week). A two-variable regression equation and Pearson's correlation coefficient (*r*) were calculated between NFA and time, and between NFS and time, to evaluate the degree of association between these variables. Finally, the proportion of ewes that received NFAs and NFS among the parturition types was analyzed using a 2 × 3 table chi-squared test (Altman, 1997), while the Friedman test was used to compare the median values of the NFAs and NFS received (Siegel and Castellan, 1988).

3 Results

3.1 Lambs displaying non-filial behaviors

A total of 1,664 *A* and 6,203 *S* were observed, of which 17% corresponded to NFAs and 0.6% to NFS. Of the lambs, 85% (46/54) displayed NFAs, while 37% (20/54) displayed NFS, at least once during the study.

More NFAs were displayed by triplets (11/12, 91%) and twins (24/26, 92%) [$X_2(1,38) = 0.42$, p = 0.52, triplets vs. twins] than by singletons (11/16, 68%) [$X_2(1,28) = 4.13$, p = 0.04; $X_2(1,42) = 4.17$, p = 0.04]. Similarly, more NFS were displayed by triplets (6/12, 50%) and twins (10/26, 38%) [$\chi^2(1,38) = 0.76$, $p = 0.38$] than by singletons (4/16, 25%) [$\chi^2(1,28) = 6.46$, $p = 0.011$], where twin and singleton lambs displayed NFS at a frequency range of 1–5, while triplets reached >11 events ($p = 0.001$) (Table 1).

More males (20/21, 95%) than females (9/21, 43%) displayed NFAs [$\chi^2(1,42) = 15.72$, $p = 0.00012$]. Correspondingly, more males (25/33, 75%) than females (10/33, 30%) displayed NFS [$\chi^2(1,66) = 12.53$, $p = 0.0004$]. From those lambs that displayed NF activities, similar frequencies of NFAs were observed in females than in males (7.28 ± 6.57 *vs.* 5.40 ± 3.21, $p = 0.10$), with similar frequencies of NFS between both sexes (2.18 ± 3.50 *vs.* 1.44 ± 0.72 for females and males, respectively, $p = 0.52$).

The time of day favored NFS at PM = pen over AM = paddock (67.2% *vs.* 32.8% of the lambs) [$\chi^2(1,112) = 7.14$, $p = 0.0075$]. In addition, from a total of 37 NFS registered, 30 (81%) and 7 (19%) were observed at PM = pen and AM = paddock, respectively [$\chi^2(1,37) = 14.30$, $p = 0.00017$].

NFAs were more frequent in young lambs at early lactation. The percentage of NFAs tended to decrease throughout lactation ($y = 0.3x^2 - 4.6x + 31.0$; $r = -0.9$, $p > 0.05$), while the NFS tended to increase and then decrease ($y = 0.03x^2 + 0.4x - 0.1$; $r = 0.4$, $p > 0.05$), reaching its peak during the fifth week of lactation (Figure 1).

3.2 Ewes allowing non-filial behaviors

All ewes received NFAs; however, only 49% allowed NFS [100% of the ewes that gave birth to triplets, 46% of the ewes bearing twins, and 37% to ewes with single lambs, showing a trend in favor of multiple birth ewes ($p = 0.096$)]. Ewes with triplets averaged more NFS (4.3 ± 2.8) than ewes with twins (0.6 ± 0.26, $p = 0.006$) and ewes with singletons (0.8 ± 0.37, $p = 0.004$) (Table 2).

3.3 Non-filial suckling behaviors and lamb body weight performance

Lambs that displayed more NF activities (>11) had the lowest average weight gain at weeks 2 and 6 ($p = 0.0008$), maintaining the same tendency throughout lactation (Figure 2). At weaning, lambs that had more NF activities weighed less than the other lambs, whereas those that never performed NF activities weighed more than others (13.4 ± 1.2 *vs.* 18.9 ± 1.2 kg, $p = 0.002$). No difference

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TABLE 1 Number of lambs, according to the type of parturition, that were observed to display different frequencies of non-filial suckling attempts (NFA) and non-filial suckling (NFS) episodes during 96 h of observation.

Type of parturition and non-filial behavior performed	Frequency				Total events observed	Mean ± SEM events/lamb
	0	1–5	6–10	>11		
Singletons (*n* = 16)						
NFA	6	10	0	0	22	2.2 ± 1.2c
NFS	12	4	0	0	4	1.0 ± 0.0a
Twins (*n* = 26)						
NFA	2	15	6	3	145	6.0 ± 3.7b
NFS	16	10	0	0	14	1.4 ± 0.6b
Triplets (*n* = 12)						
NFA	1	4	1	6	118	10.7 ± 6.1a
NFS	6	4	0	2	19	3.1 ± 4.8a
Total lambs (*n* = 54)						
NFA	9	29	7	9	285	
NFS	34	18	0	2	37	

Values followed by the same lowercase letter did not differ significantly at $p = 0.05$. Comparisons were made within the same variable (NFA or NFS) among the different types of birth (i.e., singletons, twins, and triplets).

was found between lambs performing 1–5 and 6–10 NF behaviors (16.6 ± 0.5 and 16.4 ± 0.6 kg, respectively, $p = 0.072$).

4 Discussion

Our results showed that NFS occurs infrequently in lambs, that it is more common in ewes and lambs from multiple births, that male lambs displayed more NFS than females, and that it does not represent weight gain benefits to the lambs that performed it.

The frequency of NFS observed in the present experiment corresponded to 0.6% of the total suckling episodes and were performed by 48% of the lambs (16/33), a little over the 0.2% reported also in hair sheep (Fonsêca et al., 2016), which studied 60 multiparous Morada Nova ewe–lamb pairs (singletons and twin lambs) from lambing until 40 days after lambing in 2 years, suggesting that this behavior may not provide a significant adaptive or nutritional advantage under controlled management. This supports the idea that, in commercial sheep production systems, NFS could be by recognition errors or maternal

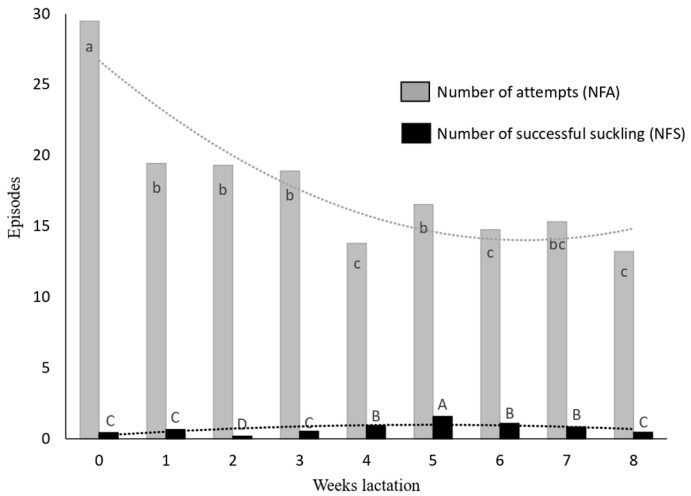

FIGURE 1
Distribution of non-filial suckling attempts (NFA) and non-filial suckling episodes (NFS) recorded in 96 h of observation during 8 weeks of lactation (12 h/week). **(a–d)** different lower-case letters indicate significant differences (P<0.05) among weeks in NFA. **(A–D)** different capital letters indicate significant differences (P < 0.05) amongweeks in NFS.

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TABLE 2 Proportion of ewes and frequency of non-filial attempts (NFAs) and non-filial suckling (NFS) received according to the type of parturition.

Type of parturition	Proportion of ewes	Average ± SEM of non-filial behaviors received/ewe	
	Nursing	NFA	NFS
Singletons	37.0 (6/16)	5.6 ± 0.6a	0.8 ± 0.4
Twins	46.0 (6/13)	9.4 ± 0.9b	0.6 ± 0.3
Triplets	100.0 (4/4)	15.2 ± 2.8c	4.3 ± 2.8

Lowercase letters denote within the same column significant differences among lines ($p < 0.05$).

permissiveness rather than as an evolved cooperative strategy (Špinka et al., 2021).

In contrast, these results differ from those reported in wild bighorn sheep (*O. canadensis*), in which NFS suckling occurred in more than 85% of the offspring, after 3 months of observation in two different locations for two consecutive years (Hass, 1990). Although the different methodologies and breeds make it difficult to compare among studies, this higher incidence in wild sheep suggests that NFS may have survival advantages that are not present in domesticated tropical sheep, or at least not in the hair breeds, therefore suggesting that this behavior may offer survival benefits under natural selection pressures, including increased access to nutrition or thermoregulatory support in unpredictable environments (Fairbanks, 1990).

Multiple birth lambs performed more NFAs and NFS than singletons, which is in accordance with the observation of sheep producers, as reported by Welch and Kilgour (1972). Multiple birth lambs are lighter than singletons and consume less milk in each suckle (Van Welie et al., 2016), perhaps due to the lack of an available teat in the case of triplets during suckling episodes and the inability of ewes to produce enough milk to satisfy their milk demands (Stevens et al., 1982). Thus, the main factor that induces NFAs is likely hunger. Consequently, lambs of multiple births develop strategies to compensate for these deficiencies (Roulin, 2002; Víchová and Bartoš, 2005; Zapata et al., 2010). Furthermore, in the present study, lighter lambs were more likely to display NFS, perhaps to compensate for the deficiency in food, as was suggested by Víchová and Bartoš (2005).

Ewes that had multiple births nursed alien lambs more frequently. These ewes may have more milk due to the higher demand of their multiple litter. This is supported by the finding that the higher frequency of NFS occurred around 5 weeks of lactation, which correlated with the peak in milk production (Freitas-de-Melo and Ungerfeld, 2016). In this case, where triplets' lambs allosuckled more and mothers of triplets allonursed more, the reciprocity hypothesis (Trivers, 1971) results particularly important. In addition, ewes with multiple offspring were more likely to permit alien lambs to suckle, potentially due to the higher milk production or the greater tolerance derived from increased maternal investment demands. This observation aligns with the "milk evacuation" and "reciprocal altruism" hypotheses, whereby ewes may allow NF lambs to nurse either to relieve udder pressure or in exchange for future benefits within the social group (Freitas-de-Melo and Ungerfeld, 2016; Trivers, 1971). In addition, the peak in NFS during the fifth week of lactation coincides with the physiological peak of milk yield (Réale et al., 1999), suggesting that endocrine and metabolic factors may facilitate greater tolerance toward alien lambs during this phase. However, this remains to be examined.

Alien lambs learn to approach an alien multiple birth mother during suckling episodes (with their own lambs), thus confusing the ewe (Figure 3). This may explain why the NFAs decreased and the NFS increased during the study. Lambs involved in NF behaviors learn by trial and error in terms of the position and time to approach the ewe in order to have a successful NFS. In addition,

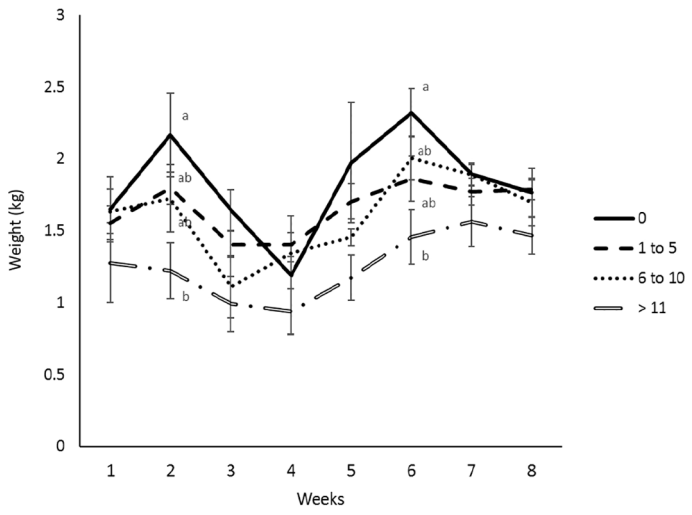

FIGURE 2
Weekly weight gains (± SEM) from lambs, according to the frequencies (0=never; 1to 5; 6 to 10, 11 or more times) of non-filial behaviors (suckling attempts and suckling bouts)displayed, during 8 weeks of lactation. (a, b) different letters within the same week indicate significant (P < 0.05) difference.

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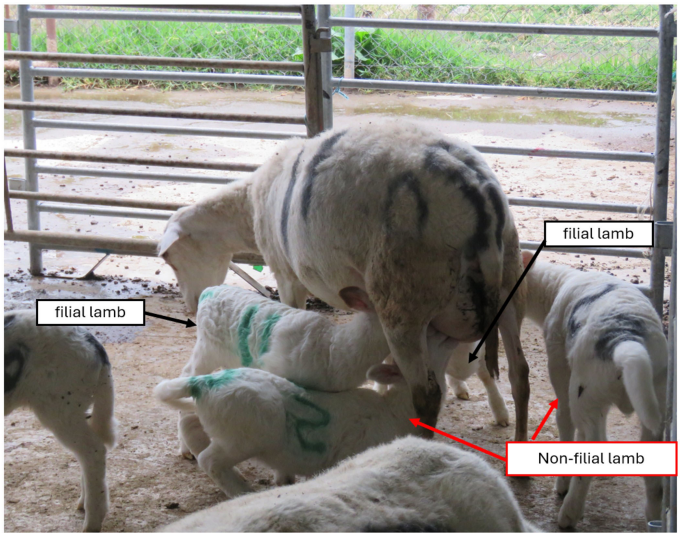

FIGURE 3
Episode of lactation. Mother of twins lambs (filial) nurse at same time a non filial lambs. The posisition the non filial avoid that the mother indentifided to alien.Non-filial lamb.

the fact that more NFS were observed at the corral than at pasture also suggests that higher animal densities facilitate NFS due to a greater likelihood of mother–offspring confusion, i.e., during encounters between lambs and ewes. This result was also noted in Mouflon sheep (Réale et al., 1999), wherein the incidence of NF behaviors increased when the size of the paddock was reduced. The above does not rule out the fact that multiple birth lambs may accidentally try to suckle from a NF ewe by failing to recognize their own mother, particularly at the early ages. Nowak et al. (1989) found that lambs can discriminate their own dams from alien mothers at a very young age, but with single lambs performing better than multiples in a two-choice situation test. Therefore, the environmental conditions also influence the occurrence of NFS. The higher frequency recorded in pens relative to paddocks supports the "misdirected parental care" hypothesis, indicating that spatial restriction and higher animal density increase the likelihood of confusion between ewes and lambs (Dwyer, 2008b). These same findings were observed in Mouflon sheep, where confinement was shown to elevate the incidence of NF interactions (Engelhardt et al., 2014). Moreover, the observed decrease in NFAs and the concurrent increase in NFS over time suggest that lambs may learn, through trial and error, the optimal circumstances for successful access to NF ewes.

Behaviors recorded at the pen were always registered during the afternoon, while those at the pasture were registered during the morning. Although the time of day may have influenced the greater frequency of NFAs and NFS in pens, it should be noted that both the change from pasture to pen and *vice versa* increased the frequency of all suckling.

Our finding that more male than female lambs showed NFAs and NFS is in contrast to that previously reported in other species such as reindeer (Engelhardt et al., 2014) and cattle (Víchová and Bartoš, 2005). Dwyer (2008a) found that lamb behavioral progress is retarded in males compared with female lambs, which could lead to some delay or a weakening in the identification of its mother, coupled with the fact that lighter lambs, such as those from multiple deliveries, which have in general lower body weights and vigor, are more involved in NFAs and NFS. These could reflect delayed behavioral and cognitive maturation in males (Víchová and Bartoš, 2005), potentially leading to less effective maternal recognition. Alternatively, it may indicate sex-specific differences in exploratory motivation or competitive behavior during early development.

We found no evidence for weight gain benefits in the lambs that performed NFS as the lambs were not able to increase their body weight through allosuckling, perhaps due to the frequency of these behaviors being very low (and therefore not much extra milk was transferred) that it does not represent a productive advantage for the lambs that practiced it, as the majority of the lambs displayed NFS less than 11 times and only two performed NFS greater than 11 times during the 8 weeks. However, there is also the possibility that, if they had not engaged in NFS, their weight gains may have been lower or even put their survival at risk. Further research is needed to determine the rates of milk consumption of alien lambs during NFS episodes and their survival rate, factors that could be very important particularly in feral animals, in which the frequency of NFS maybe more than 80%, or in domestic breeds with a very limited milk production, where NFS may facilitate the development of immune defenses (Roulin and Heeb, 1999). NFS did not result in improved body weight or growth performance, indicating that, under the studied conditions, all suckling does not confer fitness advantages. However, it is possible that such behaviors have social or developmental functions, such as improving future maternal competence or social integration, as suggested by recent ethological studies (Špinka et al., 2021; Špinka, 2021).

On the other hand, in addition to their behavioral and nutritional interpretations of NFS, the welfare implications for

both ewes and lambs are relevant. Although animal welfare was not directly assessed in this study, the higher incidence of NF behaviors in lighter lambs and those from multiple births suggests that these animals may experience increased nutritional stress or difficulties in accessing adequate milk from their mothers. Therefore, NFS may serve as a behavioral indicator of hunger or resource competition, reflecting compromised welfare, particularly during early lactation when milk intake is crucial for offspring growth and development. Although NFS did not translate into weight gain advantages under the present conditions, its association with reduced growth performance suggests that lambs engaging in frequent NF behaviors may be experiencing underlying welfare challenges. Consequently, considering management adjustments aimed at reducing competition among lambs and improving the milk availability in ewes could enhance both nutritional welfare and social stability within the group.

It is important to mention the limitations present in the study that should be considered when interpreting the results. Firstly, the research has a strictly observational design, limiting the establishment of causal relationships between the factors evaluated and the occurrence of NFS. Secondly, the housing system was confounded with the time of day as the observations in pasture were always conducted in the morning and those in the pen done in the afternoon, making it difficult to separate the effects of environment from those of the suckling behavior patterns. Thirdly, the sample size especially for triplets was limited, which may have reduced the statistical differences. In addition, the density in the pen was lower than that of the AWIN (Animal Welfare Indicators) recommendations and may have increased the frequency of NFS under confined conditions. Finally, important variables such as immunological transfer, milk production, and maternal behavior were not measured, limiting determining whether nutritional stress, recognition errors, and maternal permissiveness are factors in the display of NFS.

Therefore, there is a need for further research quantifying the milk intake or production, the immune transfer, the maternal behavior or the mother–offspring bonding, and the affiliative interactions during NFS events, which could clarify the evolutionary persistence of these behaviors in domestic and semi-natural settings.

In summary, NFS in domestic lambs is a low-frequency, context-dependent behavior influenced by birth type, body condition, and animal density (Figure 4). Although it does not appear to provide short-term nutritional benefits, its persistence may reflect ancestral cooperative mechanisms retained from wild ovine populations. Understanding these dynamics offers insights into the interplay between physiology, behavior, and social organization in domesticated ruminants.

It is concluded that NFS occurs relatively infrequently in lambs and is most common in lambs from multiple births, lighter weight lambs, and in high stock densities. NFS represents no weight gain benefits to the lambs that performed it in this study.

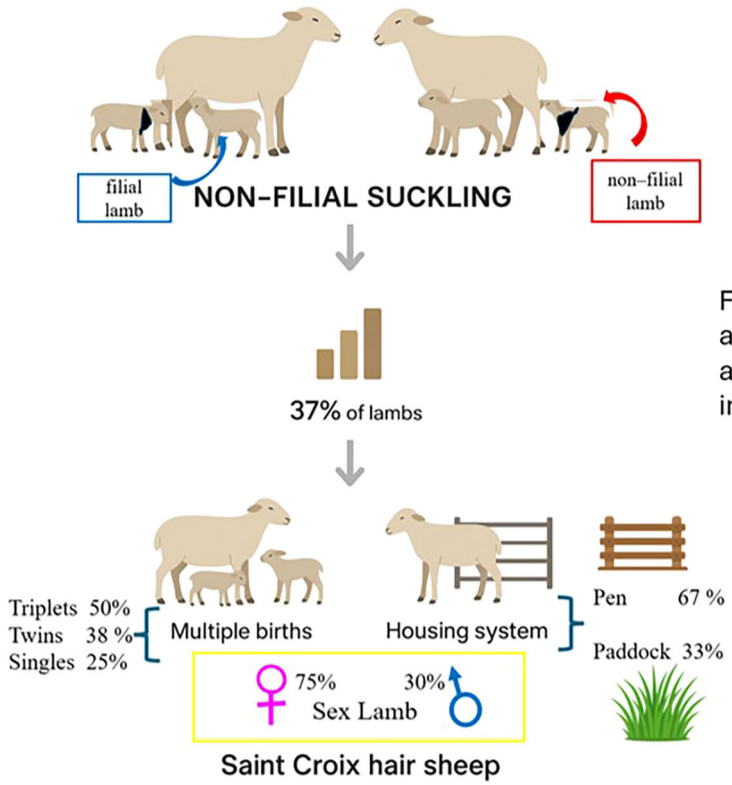

Figure 4. Factors associated with allosuclinkg behavior in Saint Croix Sheep

FIGURE 4
Factors associated with allosuclinkg behavior in Saint Croix SheepMultiple births.

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 Ethics Committee of Universidad Autónoma del Estado de Morelos. The study was conducted in accordance with the local legislation and institutional requirements.

Author contributions

LP-T: Writing – review & editing, Supervision, Conceptualization, Investigation, Methodology, Writing – original draft, Data curation. Writing – original draft, Supervision. JH-H: Methodology, Data curation, Formal Analysis, Writing – original draft. AT: Methodology, Writing – review & editing.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was used in the creation of this manuscript. The author(s) declare that Generative AI (OpenAI ChatGPT-4) was used for one building illustrative imagen (Figure 4).

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References

Altman, D. G. (1997). *Practical statistics for medical research* (London, UK: Chapman and Hall).

Bartoš, L., Vanková, D., Hyanek, J., and Siler, J. (2001). Impact of allosuckling on growth of farmed red deer calves (*Cervus elaphus*). *Anim. Sci.* 72, 493–500. doi: 10.1017/S1357729800052012

Brandlová, K., Bartoš, L., and Haberová, T. (2013). Camel calves as opportunistic milk thefts? The first description of allosuckling in domestic Bactrian camel (*Camelus bactrianus*). *PloS One* 8, e53052. doi: 10.1371/journal.pone.0053052

Castanheira, M., McManus, C. M., Paula Neto, J. B. D., Costa, M. J. R. P. D., Mendes, F. D. C., Sereno, J. R. B., et al. (2013). Maternal offspring behaviour in Curraleiro Pé Duro naturalized cattle in Brazil. *Revista Brasileira de Zootecnia*. 42, 584–591.

Dwyer, C. M. (2008a). Behavioural development in lambs: Effect of sex and birth type. *Appl. Anim. Behav. Sci.* 111, 126–138. doi: 10.1016/j.applanim.2007.06.010

Dwyer, C. M. (2008b). Genetic and physiological determinants of maternal behavior and lamb survival: Implications for low-input sheep management. *J. Anim. Sci.* 86, E246–E258. doi: 10.2527/jas.2007-0404

Engelhardt, S. C., Weladji, R. B., Holand, Ø., de Rioja, C., Ehmann, R. K., and Nieminen, M. (2014). Allosuckling in reindeer (*Rangifer tarandus*): Milk-theft, mismothering or kin selection? *Behav. Processes* 107, 133–141. doi: 10.1111/eth.12334?urlappend=%3Futm_source%3Dresearchgate.net%26utm_medium%3Darticle

Fairbanks, W. S. (1990). Allonursing and allosuckling in wild ungulates: Evolutionary and ecological perspectives. *Ethology* 85, 1–13. doi: 10.1111/j.1439-0310.1990.tb00380

Fonsêca, V. F. C., Saraiva, E. P., Arruda, M. F., Pereira, W. E., Pimenta Filho, E. C., Santos, S. G. C. G., et al. (2016). Mother–offspring relationship in Morada Nova sheep bred in a tropical semiarid environment: A perspective on maternal investment and parental conflict. *Appl. Anim. Behav. Sci.* 183, 51–58. doi: 10.1016/j.applanim.2016.07.002

Freitas-de-Melo, A., and Ungerfeld, R. (2016). Destete artificial en ovinos: Respuesta de estrés y bienestar animal. *Rev. Mexicana Cienc. Pecuarias* 7, 361–375.

García, E. (2004). *Modificaciones al sistema de clasificación climática de Köppen* (Mexico City, Mexico: Instituto de Geografía, Universidad Nacional Autónoma de México).

Gloneková, M., Brandlová, K., and Pluháček, J. (2016). Stealing milk by young and reciprocal mothers: High incidence of allonursing in giraffes (*Giraffa camelopardalis*). *Anim. Behav.* 113, 113–123. doi: 10.1016/j.anbehav.2015.11.026

Hass, C. C. (1990). Alternative maternal-care patterns in two herds of bighorn sheep. *J. Mammalogy* 71, 24–35. doi: 10.2307/1381313

Khan, K., Meyer, H. H., and Thompson, J. M. (1992). Effect of pre-lambing supplementation and ewe body condition score on lamb survival and total weight of lamb weaned. *Proc. Western Section Am. Soc. Anim. Sci.* 43, 175.

Kilgour, R., and Dalton, C. (1984). *Livestock behaviour: A practical guide* (Sydney, Australia: Granada).

Letelier, C. A., Contreras-Solis, I., García-Fernández, R. A., Ariznavarreta, C., Tresguerras, J. A. F., Flores, J. M., et al. (2009). Ovarian follicular dynamics and plasma steroid concentrations are not significantly different in ewes given intravaginal sponges containing either 20 or 40 mg of fluorogestone acetate. *Theriogenology* 71, 676–682. doi: 10.1016/j.theriogenology.2008.09.030

Mota-Rojas, D., Marcet-Rius, M., Freitas-de-Melo, A., Muns, R., Mora-Medina, P., Domínguez-Oliva, A., et al. (2021). Allonursing in wild and farm animals: Biological and physiological foundations and explanatory hypotheses. *Anim. (Basel)* 11, 3092. doi: 10.3390/ani11113092

Murphey, R. M., da Costa, M. J. P., Da Silva, R. G., and de Souza, R. C. (1995). Allonursing in river buffalo, *Bubalus bubalis*: nepotism, incompetence, or thievery?. *Animal Behaviour*. 49, 1611–1616.

Nowak, R., Poindron, P., and Putu, I. G. (1989). Development of mother discrimination by single and multiple newborn lambs. *Dev. Psychobiology* 22, 833–845. doi: 10.1002/dev.420220807

Nowak, R., Porter, R. H., Levy, F., Orgeur, P., and Schaal, B. (2000). Role of mother–young interactions in the survival of offspring in domestic mammals. *Reproduction* 5, 153–163. doi: 10.1530/revreprod/5.3.153

Orihuela, A., Bienboire-Frosini, C., Chay-Canul, A., Álvarez-Macías, A., Marcet-Rius, M., Domínguez-Oliva, A., et al. (2024). Allonursing in water buffalo: Cooperative maternal behavior in domestic Bovidae. *J. Anim. Behav. Biometeorology* 12, 2024023. doi: 10.31893/jabb.2024023

Packer, C., Lewis, S., and Pusey, A. (1992). A comparative analysis of non-offspring nursing. *Anim. Behav.* 43, 265–281. doi: 10.1016/S0003-3472(05)80222-2

Paranhos da Costa, M. J. R., Andriolo, A., de Oliveira, J. F. S., and Schmidek, W. R. (2000). Suckling and allosuckling in river buffalo calves and its relation with weight gain. *Appl. Anim. Behav. Sci.* 66, 1–10. doi: 10.1016/S0168-1591(99)00083-0

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

Réale, D., Bousses, P., and Chapuis, J. L. (1999). Nursing behaviour and mother–lamb relationships in mouflon under fluctuating population densities. *Behav. Processes* 47, 81–94. doi: 10.1016/S0376-6357(99)00051-0

Roulin, A. (2002). Why do lactating females nurse alien offspring? A review of hypotheses and empirical evidence. *Anim. Behav.* 63, 201–208. doi: 10.1006/anbe.2001.1895

Roulin, A. (2003). The neuroendocrine function of allosuckling. *Ethology* 109, 185–195. doi: 10.1046/j.1439-0310.2003.00870.x

Roulin, A., and Heeb, P. (1999). The immunological function of allosuckling. *Ecol. Lett.* 2, 319–324. doi: 10.1046/j.1461-0248.1999.00091.x

Siegel, S., and Castellan, N. J. (1988). *Nonparametric statistics for the behavioral sciences. 2nd ed* (New York, USA: McGraw-Hill).

Špinka, M. (2021). The social dimension of allonursing: Evolutionary and emotional aspects. *Front. Ethology* 2. doi: 10.3389/feth.2021.00067

Špinka, M., and Illmann, G. (2015). Nursing behavior. In *The Gestating and Lactating Sow*. C. Farmer Ed. Wageningen, The Netherlands: Wageningen Academic Publishers. 297–318.

Špinka, M., Noonan, M., and Range, F. (2021). Evolutionary perspectives on cooperative care and allonursing. *Front. Ethology* 2. doi: 10.3389/feth.2021.00045

Stevens, D., Alexandre, G., and Lynch, J. J. (1982). Lamb mortality due to inadequate care of twins by Merino ewes. *Appl. Anim. Ethology* 8, 243–252. doi: 10.1016/0304-3762(82)90207-3

Trivers, R. L. (1971). The evolution of reciprocal altruism. *Q. Rev. Biol.* 46, 35–57. doi: 10.1086/406755

Van Welie, L. A., Clews, S. A., Beausoleil, N. J., Hickson, R., Kongara, K., Kenyon, P. R., et al. (2016). The sucking behavior and milk intake of one-to three-week-old triplet lambs during natural and competitive suckling situations. *Appl. Anim. Behav. Sci.* 180, 58–64. doi: 10.1016/j.applanim.2016.04.009

Víchová, J., and Bartoš, L. (2005). Allosuckling in cattle: Gain or compensation? *Appl. Anim. Behav. Sci.* 94, 223–235. doi: 10.1016/j.applanim.2005.02.015

Welch, R. A. S., and Kilgour, R. (1970). Mis-mothering among romneys. *New Z. J. Agric. Res.* 13, 26–27.

Welch, R. A. S., and Kilgour, R. (1972). A survey of lambing practices in stud sheep flocks in New Zealand. *Proc. New Z. Soc. Anim. Production* 32, 115–122.

Zapata, B., Correa, L., Soto-Gamboa, M., Latorre, E., González, B. A., and Ebensperger, L. A. (2010). Allosuckling allows growing offspring to compensate for insufficient maternal milk in farmed guanacos (*Lama guanicoe*). *Appl. Anim. Behav. Sci.* 122, 119–126. doi: 10.1016/j.applanim.2009.12.004