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PREVALENCE AND ECONOMIC CONSEQUENCES OF UMBILICAL LESIONS IN LIVESTOCK FARMING

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ABSTRACT: The aim of this study is to determine the incidence of umbilical lesions in calves within livestock enterprises and to assess the economic losses they incur. The analysis is based on clinical data from 815 umbilical lesion cases recorded over a 17-year period, supplemented by findings from a Delphi survey conducted with expert veterinarians. The results indicated that umbilical lesions predominantly occur in March and April, and 53% of affected calves are younger than one month old. It was observed that 72.8% of umbilical lesions occurred in Simmental calves. Additionally, umbilical urachus fistula was more commonly diagnosed in females, while omphalitis was more prevalent in males. The incidence rate of umbilical lesions was calculated at 38.6%, with a surgical success rate of 73.9%. Postoperative complications were observed in 28.9% of cases, and 53.8% of the calves were culled due to growth retardation or further complications. The estimated cost of surgical intervention and postoperative treatment for umbilical lesions was determined to be $101.3 per calf. However, this cost increased to $245.6 in cases complicated by postoperative complications and developmental delays. Despite the fact that umbilical lesions can be largely prevented through simple postnatal hygiene measures, their incidence remains high, leading to substantial economic losses in Türkiye.

Keywords: Calves, Delphi survey, Economic losses, Hygiene measures, Postnatal infections, Surgical intervention.

INTRODUCTION

Ensuring the healthy birth and postnatal development of calves is a critical factor for the sustainability and profitability of livestock enterprises. In particular, adequate colostrum intake and the implementation of early hygiene protocols significantly reduce mortality and morbidity rates while also enhancing growth performance, milk yield, and reproductive efficiency, thereby contributing to long-term economic gains in both the dairy and beef cattle sectors (Godden et al., 2019; Avcioğlu et al., 2024; Keller et al., 2024).

In recent years, the expansion of cattle farming in Türkiye has led to a notable rise in the number of calves admitted to veterinary clinics (Demir and Gültekin, 2024). Among the most common health issues in newborn calves are umbilical lesions, including omphalitis, umbilical abscess, urachal fistula, omphalophlebitis, umbilical hernia, omphaloarteritis, and umbilical eventration (Guerri et al., 2020). These conditions are reported to be highly prevalent among calf surgical diseases (Ganga et al., 2011; Hayat et al., 2019; Yurdakul et al., 2021).

The etiology of umbilical lesions is influenced by both hereditary and environmental factors. Key environmental contributors include improper umbilical cord cutting and sanitation, poor housing conditions, compromised general health, insufficient colostrum intake, and inadequate postnatal care and feeding (Sağlıyan et al., 2016; Ayvazoğlu et al., 2020; Avcioğlu et al., 2024).

Beyond the direct financial burden associated with treatment costs and calf mortality, umbilical lesions can lead to developmental delays and reductions in meat, milk, and reproductive efficiency. These losses not only affect individual farm profitability but also have broader implications for the livestock sector. This study was conducted with the aim of estimating the incidence of umbilical lesions in calves and the economic loss incurred.

MATERIALS AND METHODS

In this study, data from 815 calves of different breeds and sexes, admitted with complaints of umbilical lesions to the Department of Surgery at Kafkas University Veterinary Clinic in Kars during the period 2007–2023, were utilized. The data were categorized based on anamnesis information provided by animal owners.

In the analysis of the obtained data, frequency tables and descriptive statistics were employed. The statistical relationships between umbilical lesion diagnoses and categorical variables were determined using the chi-square test, Mann-Whitney U test, and Kruskal-Wallis test. The Bonferroni test was used as the Post-Hoc test in determining which

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groups the difference was derived from The IBM SPSS Statistics 20 software package was utilized for all statistical analyses. Furthermore, expert opinions regarding umbilical lesions were collected through a face-to-face Delphi survey conducted with 25 expert veterinarians working in the region. The survey questionnaire included items related to technical and economic parameters. Based on the data obtained from the Delphi survey, three distinct scenarios (optimistic, pessimistic, and expected) were established.

The estimated economic loss associated with umbilical lesions in calves was calculated using a combination of technical and economic parameters derived from both field data and expert opinions. The technical and economic data, as well as the formulas used for determining the estimated economic losses, are presented in the Table 1 (1USD$= 32.4 TL in 17.04.2024 - TCMB).

Table 1 - Key Parameters Used in the Estimation

Parameters	Value (Min-Max)	References
1. Number of calf in Türkiye	5.950.181	TURKSTAT (2024)
2. Total number of calf in Kars province	164.894	TURKSTAT (2024)
3. Average market price calf ($)	577.0 (420-775)	TURKSTAT (2024)
4. Morbidity Rate of Newborn Calves (%)	24.7	Ayvazoğlu Demir et al. (2019)
5. Mean incidence rate of umbilical lesions in calves (%)	38.6 (5.0-70.0)	Expert opinion
6. Surgical intervention cost ($/head)	34.9 (16.4-81.9)	Expert opinion
7. Treatment and medication cost ($/head)	27.9 (10.9-54.6)	Expert opinion
8. Economic loss due to reformed (culled) animals ($)	144.25 (105-194)	Expert opinion
9. Postoperative additional care and nutritional expense ($/day/head)	1.64 (1.02-3.16)	Calculation
10. Duration of postoperative recovery (Days)	23.5 (9-40)	Expert opinion

Estimated Loss=(NUL×PUL×ROp×RRef×CRef)+(NUL×PUL×COp+T)+(NUL×PUL×SOp×TRec×CEC)
NUL = Total number of calves diagnosed with umbilical lesions; PUL = Proportion of calves affected; ROp = Probability of surgical intervention; RRef = Proportion of animals culled post-treatment due to complications; CRef = Cost associated with reformed (culled) animals; COp+T = Combined cost of surgical intervention and postoperative medical treatment; SOp = Success rate of the surgical procedure; TRec = Average recovery period following surgical intervention (days); CEC = Additional daily cost of postoperative care and nutrition per calf;
Estimated Loss (No Surgery)=(NUL×MRate×CCalf)+(NUL×RRef×(1−MRate)×CCalf/4)
NUL = Total number of calves diagnosed with umbilical lesions; MRate = Mortality rate due to untreated umbilical lesions; CCalf = Market value of a calf; RRef= Proportion of calves culled due to disease-related complications.

RESULTS AND DISCUSSION

In neonatal calves, the umbilical cord typically undergoes closure by the fifth day post-birth under normal conditions, provided no complications arise (Hides and Hannah, 2005; Yurdakul et al., 2021). However, in instances where appropriate care and nutritional management are not ensured, umbilical lesions become an unavoidable consequence. Umbilical infections constitute a significant proportion of surgical conditions observed in neonatal calves and represent one of the most frequently encountered health issues in this age group.

The annual distribution of calves presenting with umbilical lesions at Kafkas University Veterinary Faculty Research Hospital is illustrated in Figure 1, which indicates that between 2007 and 2015, the number of calves admitted with umbilical lesions fluctuated between 20 and 30 cases per year. However, a notable increase was observed after 2016. This trend may be linked to the sharp rise in red meat prices in Türkiye since 2016, which has led to increased livestock valuation by producers and heightened attention to animal health (Aksoy et al., 2018).

In this study, the diagnostic distribution of umbilical lesions was as follows: 46.5% of cases were identified as umbilical hernia, 38.5% as omphalitis, 10.9% as umbilical abscess, and 4.1% as urachus fistula. Regarding lesion types, the majority of diagnosed cases consisted of umbilical hernia and omphalitis, findings that are in agreement with those of Yurdakul et al. (2021). However, some studies have suggested a higher prevalence of omphalitis and urachus infections (Moscuzza et al., 2014; Marchionatti et al., 2016). The frequent occurrence of omphalitis is likely due to insufficient postnatal umbilical care, inadequate colostrum intake, and substandard shelter hygiene (Ayvazoğlu Demir et al., 2019; Yurdakul et al., 2021). The association between calf sex and the occurrence of umbilical lesions is summarized in Table 2, which reveals that 31% of the calves admitted to the veterinary hospital were female, while 69% were male. Among these, 72.7% of female calves were diagnosed with urachus fistula, and 71.3% of male calves with omphalitis, indicating a statistically significant association between sex and umbilical lesion type ($P<0.01$). This association was further supported by the Mann-Whitney U test, which confirmed a significant difference between sex and lesion type ($U = 45.419$, $P = 0.03$, $P<0.05$).

In this study, it was determined that a notable proportion of the affected calves were male (69%), and this difference was statistically significant, aligning with previous studies that also reported a higher frequency of umbilical lesions in

male calves (Ayvazoğlu Demir et al., 2019; Sağlıyan et al., 2016). Similarly, Kharb et al. (2021) found that 66.7% of umbilical lesion cases occurred in male calves, while Fazili et al. (2013) reported that umbilical hernias were more common in males, suggesting a potential sex-related predisposition. The higher susceptibility observed in male calves may be attributed to anatomical factors, particularly the close proximity of the umbilical cord to the urethra, which increases the likelihood of urinary contamination and subsequent infection. An analysis of the breed distribution of umbilical lesions revealed that 72.8% of the affected calves were Simmental, 13.1% Montofon, 8.3% Simmental crossbreds, and 5.8% indigenous breeds. The prevalence of umbilical lesions by breed is detailed in Table 3.

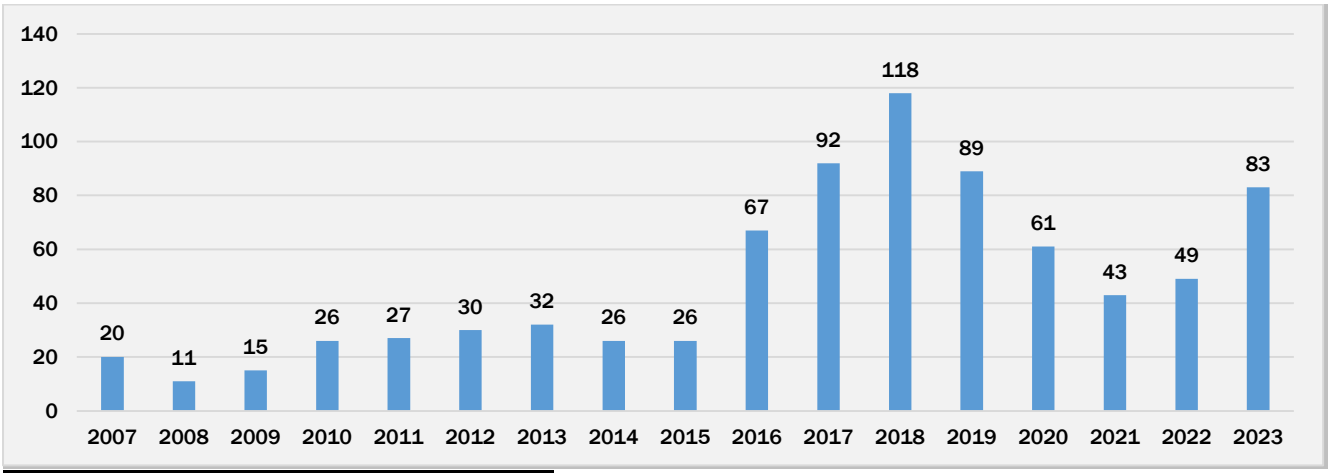

Figure 1 - Distribution of umbilical lesions by years.

Table 2 - Occurrence of umbilical lesions by sex

Diagnosis \ Sex	Female	Male	Total
Omphalitis	90 (28.7%)	224 (71.3%)	314 (38.5%)
Hernia	112 (29.6%)	267 (70.4%)	379 (46.5%)
Abscess	27 (30.3%)	62 (69.7%)	89 (10.9%)
Urachus fistula	24 (72.7%)	9 (27.3%)	33 (4.1%)
Total	253 (31.0%)	562 (69.0%)	815 (100%)

X^2 =28.032; P =0.002; P <0.01

Table 3 - Ratio of umbilical lesions by calf breeds

Breeds \ Diagnosis	Omphalitis	Hernia	Abscess	Urachus fistula	Total
Simmental	232 (39.1%)	281(47.4%)	55 (9.3)%	25 (4.2%)	593 (72.8%)
Simmental crossbred	21 (30.9%)	37 (54.4%)	9 (13.2%)	1 (1.5%)	68 (8.3%)
Montophone	38 (35.5%)	44 (41.1%)	22 (20.6%)	3 (2.8%)	107 (13.1%)
Local breed	23 (48.9%)	17 (36.2%)	3 (6.4%)	4 (8.5%)	47 (5.8%)
Total	314 (38.5%)	379 (46.5%)	89 (10.9%)	33 (4.0%)	815 (100%)

X^2 =21,094; P =0,012; P <0,05

According to Table 3, Simmental and Simmental crossbred calves exhibited a higher incidence of umbilical hernia, while omphalitis was more frequently diagnosed in indigenous breeds, and umbilical abscess was more common in Montofon calves. Chi-square analysis revealed a statistically significant difference in lesion distribution across breeds (P<0.05). Breed-based analysis revealed that 72.8% of the calves presenting with umbilical lesions were of the Simmental breed. This result is consistent with previous studies by Ayvazoğlu Demir et al. (2019) and Yurdakul et al. (2021), which reported umbilical lesion rates of 50–55% in Simmental calves. The high prevalence of umbilical lesions in Simmentals may be attributed to their increasing population in Türkiye as well as their greater susceptibility to disease compared to indigenous cattle breeds.

The monthly distribution of umbilical lesion cases recorded between 2007 and 2023 is illustrated in Figure 2, which shows that the incidence of umbilical lesions peaked in March and April, coinciding with the calving season. Seasonal analysis revealed that 40.5% of cases were reported in spring, 23.5% in winter, and 20.7% in summer. These findings

align with expert opinions collected through the Delphi Survey, where veterinarians consistently reported an increase in umbilical lesion cases during March and April. This observation is consistent with other studies reporting the highest incidence of umbilical lesions between February and April (Aydemir et al., 2022; Avcı et al., 2024). Similarly, another study observed that calves born in unhygienic environments during the calving season were more susceptible to umbilical infections, highlighting the importance of proper management during this critical time (Kharb et al., 2021). The seasonal distribution of umbilical lesions is presented in Table 4, which shows that omphalitis, hernia, and abscess cases were more frequently diagnosed in spring, whereas hernia and abscess were prevalent in autumn and summer. Urachus fistula was most commonly observed in winter. The statistical analysis confirmed a significant relationship between seasonality and lesion diagnosis ($P<0.01$). Similarly, the Kruskal-Wallis test yielded a statistically significant association between season and lesion type ($K=9.794$, $P=0.02$, $P<0.05$).

Age-based analysis revealed that 53.0% of the affected calves were younger than 30 days, 20.5% were between 31-60 days old, and 26.5% were older than 60 days. The correlation between age and umbilical lesion prevalence is presented in Table 5, which indicates that omphalitis was predominantly observed in calves younger than 30 days (47.7%), while umbilical hernia was more frequently diagnosed in those older than 90 days (72.3%). Abscesses were more common in calves aged between 30-60 days and those older than 90 days. The statistical analysis revealed a significant difference between age groups and lesion type ($P<0.05$). Additionally, the Kruskal-Wallis test confirmed a statistically significant association between age and umbilical lesions ($K=27.630$, $P=0.00$, $P<0.01$).

Regarding treatment outcomes, 89.6% of the calves admitted with umbilical lesions recovered successfully, while 10.4% experienced postoperative complications. The relationship between disease diagnosis and surgical success is illustrated in Table 6, which demonstrates that the complication rates for omphalitis, hernia, abscess, and urachus fistula were approximately 10%. However, chi-square analysis did not indicate a statistically significant relationship between lesion type and prognosis ($P>0.05$).

Further evaluation of clinical severity revealed that 7.6% of affected calves exhibited mild symptoms, 84.5% had moderate symptoms, and 7.9% presented with severe symptoms. The association between disease prognosis and surgical success is summarized in Table 7, which indicates that 89.6% of calves underwent successful surgical intervention. Statistical analysis revealed no significant correlation between disease severity and surgical success ($P>0.05$). To estimate the economic losses associated with umbilical lesions, the results of the Delphi Survey conducted with expert veterinarians are provided in Table 8.

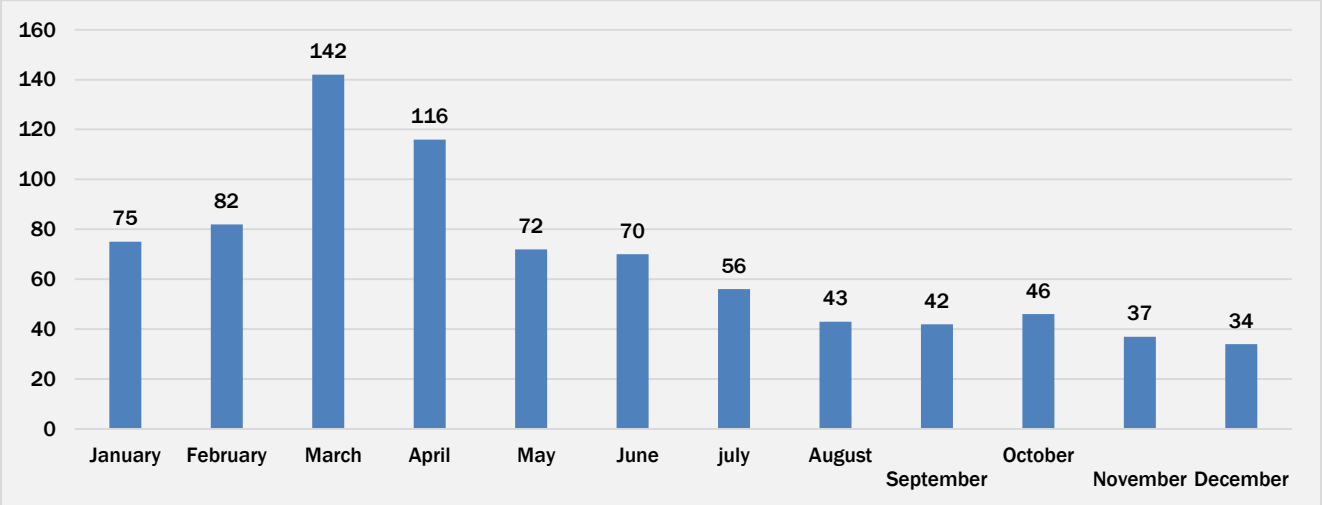

Figure 2 - Distribution of umbilical lesions by months

Table 4 - The rates of umbilical lesions by seasons

Season \ Diagnosis	Omphalitis	Hernia	Abscess	Urachus fistula	Total
Winter	75 (39.3%)	79 (41.4%)	22 (11.5%)	15 (7.9%)	191 (23.5%)
Spring	143 (43.3%)	155 (47.0%)	27 (8.2%)	5 (1.5%)	330 (40.5%)
Summer	56 (33.1%)	83 (49.1%)	23 (13.6%)	7 (4.1%)	169 (20.7%)
Autumn	40 (32.0%)	62 (49.6%)	17 (13.6%)	6 (4.8%)	125 (15.3%)
Total	314 (38.5%)	379 (46.5%)	89 (10.9%)	33 (4.0%)	815(100%)

$X^2=22.777$; $P=0.007$; $P<0.01$

Table 4 - The rates of umbilical lesions by seasons

Day \ Diagnosis	Omphalitis	Hernia	Abscess	Urachus fistula	Total
<30 day	206 (47.7%)	169 (39.1%)	34 (7.9%)	23 (5.3%)	432 (53.0%)
31-60 day	66 (39.5%)	68 (40.7%)	28 (16.8%)	5 (3.0%)	167 (20.5%)
61-90 day	30 (28.8%)	61 (58.7%)	11 (10.6%)	2 (1.9%)	104 (12.8%)
>90 day	12 (10.7%)	81 (72.3%)	16 (14.3%)	3 (2.7%)	112 (13.7%)
Total	314 (38.5%)	379 (46.5%)	89 (10.9%)	33 (4.0%)	815 (100%)

X^2 =74.039 P =0,00 P <0.01

Table 6 - Success of the operation with the diagnosis of the disease of the calves

Diagnosis \ Success of the operation	Success	Complication	Total
Omphalitis	282 (89.8%)	32 (10.2%)	314
Hernia	340 (89.7%)	39 (10.3%)	379
Abscess	79 (88.8%)	10 (11.2%)	89
Urachus fistula	29 (87.9%)	4 (12.1%)	33
Total	730 (89.6%)	85 (10.4%)	815

X^2=0,190 P=0.979 P>0.05

Table 7 - The success of the operation with the prognosis of the disease of the calves

Prognosis \ Success of the operation	Success	Complication	Total
Slight	57 (91.9%)	5 (8.1%)	62 (7.6%)
Middle	613 (89.0%)	76 (11.0%)	560 (84.5%)
Severe	60 (93.8%)	4 (6.2%)	64 (7.9%)
Total	730 (89.6%)	85 (10.4%)	815 (100%)

X^2 =1,834 P=0,400 P >0.05

Table 8 - Technical parameters of the economic losses due to umbilical lesions in Türkiye

Variable	Mean (Min-Max)
Mean umblical lesions rate in calf (%)	38.6 (10-60)
Live weight loss in calves due to umbilical lesions (%)	16.6 (10-50)
Rate of growth retardation in animals due to umbilical lesions (%)	46.6 (10-90)
Mortality rate of calves in case of untreated disease (%)	67.8 (30-90)
Recovery rate of calves in case of untreated disease (%)	12.5 (5-50)
Probability of operation for calves with umbilical lesions (%)	92.6 (80-98)
Operation success rate in calves (%)	73.6 (50-98)
Postoperative recovery time (Day)	23.5 (9-40)
Probability of return of the calf after the operation (%)	71.6 (50-95)
Recovery time of the calf after the operation (Month)	1.5 (1-2)
Probability of any postoperative complication (%)	28.9 (5-70)
Recurrence rate of the disease within 1 year after treatment (%)	10.7 (0-20)
Rate of reformed calves after navel operation (%)	53.8 (10-70)

Table 9 - Estimated cost of operations performed due to umbilical lesions in Kars Province ($)*

Variable	Loss per calf ($/calf)	Estimated average loss	(%)	Optimistic scenario	Pessimistic scenario
Reformed animal loss	144.3 (105-195)	1.129.791	45.98	161.772	1.716.769
Operation cost	34.9(16.39-81.97)	508.072	20.68	252.519	1.030.942
Post-operative medication cost	27.9 (10.93-54.65)	406.167	16.53	168.397	687.336
Extra postoperative care cost	38.5 (9.18-86.4)	412.943	16.81	138.606	543.329
Total	-	2.456.973	100.00	721.295	3.978.375

* The umbilical lesion rate was calculated as 38.6%.

According to the survey findings, the incidence of umbilical lesions average prevalence of 38.6% (10%- 60%). Consistent with these findings, prior studies have reported prevalence rates ranging between 1.3% and 66.15% (Pamuk et al., 2009; Hayat et al., 2019; Avcı et al., 2024). Notably, comparative analyses have demonstrated a higher prevalence of umbilical infections in Türkiye relative to European countries (Svensson et al., 2003; Wieland et al., 2016; Yanmaz et al., 2017). Expert veterinarians reported that 95.6% of the calves diagnosed with umbilical lesions underwent surgical intervention. The success rate of these procedures was recorded at 73.9% (ranging from 50% to 98%), with an average recovery period of 23.5 days. Approximately 71.6% of calves recovered fully within 30-60 days.

Although medical treatment options exist for umbilical lesions, their efficacy remains limited. The Delphi survey results indicated that the recovery rate of untreated calves was as low as 12.5%, while the mortality rate reached 67.8%. Given these findings, surgical intervention remains the most definitive treatment approach, particularly for umbilical hernias (Yanmaz et al., 2017; Yurdakul et al., 2021).

The study further revealed that 53.8% of affected animals were culled due to complications. In the absence of treatment, umbilical lesions, including omphalitis, omphalophlebitis, omphaloarteritis, urachus fistula, umbilical abscess, and umbilical hernia, may lead to severe systemic complications through hematogenous dissemination, potentially affecting vital organs such as the lungs, kidneys, joints, and other tissues (Marchionatti et al., 2016; Yurdakul et al., 2021). Notably, umbilical infections can lead to pyemia, resulting in conditions such as arthritis and septicemia, thereby increasing treatment costs and contributing to economic losses due to mortality in non-responsive cases.

Economic analyses based on survey data estimated the average cost of surgical intervention for umbilical lesions in Kars at $101.3 per calf. However, in cases complicated by postoperative complications and developmental delays, this cost may rise to $245.6 per animal. According to birth statistics, an estimated 164.894 calves were born in Kars in 2023, of which approximately 15.721 were affected by umbilical lesions. Consequently, the annual economic loss attributable to the treatment of umbilical lesions in Kars was calculated at approximately $2.46 million, with variations ranging from $721.295 in the most optimistic scenario to $3.98 million in the pessimistic case (Table 9).

Furthermore, in the absence of treatment, economic losses were projected to increase dramatically to $6.88 million, factoring in a 67.8% mortality rate and an estimated 32.2% reduction in the value of affected breeding stock. When the same methodology was applied at the national level, it was estimated that 567.302 of the 5.950.181 calves born in Türkiye in 2023 may have developed umbilical lesions. Accordingly, the total economic burden associated with surgical intervention was estimated at $88.66 million. In scenarios without intervention, this figure could rise substantially to $248.28 million, due to increased mortality and productivity losses.

Taken together, these findings emphasize that umbilical lesions in neonatal calves constitute a significant source of economic loss, both in terms of direct treatment expenditures and indirect losses associated with impaired growth and early culling. Notably, a review of the literature revealed a lack of previous studies that quantitatively assessed the economic burden of umbilical lesions, further underlining the relevance and contribution of the current study.

CONCLUSION

The findings of this study demonstrate that umbilical lesions in calves impose a significant burden on the livestock sector, affecting both animal health and economic sustainability. While surgical intervention helps mitigate financial losses to some extent, umbilical lesions continue to generate substantial costs due to treatment expenses, postoperative care, complications, transport costs, labor inefficiencies, and production losses. However, these lesions can be largely prevented through simple and cost-effective management strategies. Raising awareness among livestock owners regarding preventive measures, ensuring that affected animals receive timely treatment at specialized veterinary centers, and refraining from using calves with congenital umbilical hernia for breeding purposes can substantially reduce the economic losses associated with umbilical lesions in the Turkish livestock industry. Implementing these strategies can enhance both animal welfare and the overall profitability of livestock enterprises.

DECLARATIONS

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Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Authors' contribution

P. Demir Ayvazoğlu, and E. Aydın: designed the research, supervision, writing, and editing. U. Aydın and U. Yıldız: investigation, collecting the data. Ö. Aksoy: writing, and review.

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Competing interests

The authors have not declared any competing interests.

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