

Abortion in Dromedary Camels (*Camelus dromedarius*) in Algeria: A Cross-Sectional Study

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Abstract. Abortions represent a major challenge for dromedary breeding in Algeria due to their economic, sanitary, and zoonotic implications. A cross-sectional study was conducted in El Oued province (southeastern Algeria) between 2022 and 2025 to investigate reproductive losses and associated risk factors in dromedary herds. The survey included 75 herds comprising 4460 females. Overall, 80% of the surveyed herds reported abortion cases. Among the affected herds, 8.3% (5/60) showed high abortion rates, 40% (24/60) showed frequent abortions, and 51.7% showed (31/60) sporadic cases. Stillbirths were also reported in 60% of these herds. The overall abortion rate was 8.52%, ranging from 7.8% to 10% in primiparous females and from 8.53% to 9.36% in multiparous females. Most abortions (90%) occurred during mid to late gestation, with a seasonal peak between August and November. Most breeders (88.3%) buried aborted fetuses and placentas, whereas 10% discarded them in the open environment and 1.7% used incineration. Following abortion events, 75% of breeders took no specific action, while only 25% sought veterinary assistance. Among the investigated risk factors, only the presence of domestic cats and dogs was significantly associated with abortion occurrence ($P < 0.05$). This study highlights a high frequency of abortions in Algerian dromedaries, accompanied by a notable proportion of stillbirths. To better elucidate the underlying etiological determinants as well as the associated risk factors, further studies combining epidemiological, clinical, pathological, and laboratory diagnostic approaches are required.

Introduction

In Algeria, the population of camels (*Camelus dromedarius*) plays a central role in livestock production systems (Faye, 2020). The dromedary is perfectly adapted to desert climates and extreme living conditions, thanks to its ability to efficiently utilize limited nutritional resources and convert them into edible products. It plays a key role in the national economy by providing essential products such as meat, milk and hides (Djeddou-Benabid et al., 2025; Djeddi et al., 2024). These animals play a crucial role in food security, providing a major source of animal protein, particularly for the populations of the arid regions of Algeria (Djeddou-Benabid et al., 2025).

Abortions constitute one of the most commonly observed problems in veterinary practice in camelids. Indeed, the birth rate generally does not exceed 40% in nomadic herds and 70% in intensive herds (Tibary et al., 2006). In addition to these low birth rates, camel herds experience significant neonatal losses, sometimes reaching epidemic proportions (Nawaz et Tharwat, 2025). The understanding of the incidence and etiology of abortions in camelids remains limited. Among the contributing factors, infectious, traumatic, and toxic agents appear to play a predominant role

(Tibary et al., 2006; Tibary et al., 2005).

Reproductive losses are mainly associated with abortion and early embryonic mortality, often linked to various infectious and parasitic agents involved in reproductive disorders. These losses may be exacerbated by unfavorable environmental conditions, particularly prolonged drought periods (Eggimann et al., 2024). Furthermore, dromedaries play an important role in the transmission of certain diseases to other livestock species as well as in the circulation of zoonotic diseases (Khan et al., 2003; Sazmand et al., 2019; Houssou et al., 2025). Abortion rates linked to infectious diseases range from 10% to over 70% in certain regions (Eggimann et al., 2024; Tibary et al. 2006).

Furthermore, abortion diagnosis remains challenging for both livestock producers and veterinarians, especially during the early stages when clinical signs are often absent or difficult to detect. Common indicators include the presence of placental tissues protruding from the vulva, the discovery of a dead fetus, or the unexpected return of estrus behavior (Fowler, 2011; Kandeel et Al-Mubarak, 2022).

To date, epidemiological data regarding reproductive losses in dromedary camels in Algeria, particularly abortions and stillbirths, remain very limited. The present study represents the first

large-scale retrospective investigation conducted in the Algerian Sahara to assess the extent of these reproductive disorders in camel herds.

The aim of this study was to conduct a comprehensive assessment of the magnitude of abortions and stillbirths in dromedary camel herds of the Algerian Sahara and to identify factors associated with the occurrence of these reproductive losses under local husbandry conditions. The specific objectives were to:

- estimate the prevalence of abortions and stillbirths at the herd level;
- describe their spatial and temporal distribution within the investigated herds;
- characterize the main zootechnical and reproductive parameters associated with these reproductive losses;
- identify potential risk factors involved in the occurrence of abortions;
- provide baseline data useful for improving health management and reproductive performance of dromedaries in the Algerian Saharan regions.

Materials and Methods

Ethical Approval

This study was based on a cross-sectional questionnaire and did not involve any experimental procedures, invasive sampling, or manipulation of animals. Therefore, ethical approval from an animal care and use committee was not required. Prior

informed consent was obtained from all herd owners before data collection.

Study Area

The study was conducted in El-Oued Province, located in southeastern Algeria (33°21'21" N, 6°51'47" E). Covering an area of 44 586.80 km², El-Oued is one of the largest administrative regions in the country, occupying a strategic position and serving as a major center for camel breeding and supply. It is bordered by Khenchela to the north, Tébessa to the northeast, Biskra to the northwest, Touggourt and M'ghair to the west, Ouargla to the south, and Tunisia to the east, with approximately 300 km of shared borders. The climate is Saharan according to the Köppen classification, characterized by very hot summers and mild winters. Annual temperatures range from an average minimum of 21.8°C to a maximum of 39°C, with a mean relative humidity of 24.3%. Rainfall is scarce, averaging between 80 and 100 mm per year and occurs mainly from November to February as moderate showers, occasionally accompanied by intense downpours (Fig. 1).

For the purpose of the analysis, the study area was stratified into two geographical zones based on administrative and spatial proximity criteria: a northern zone and a southern zone. The northern zone included the municipalities of Reguiba, Magrane Beni Guecha, Hassi Khalifa, Tayeb Larbi, Bayadah Nakhla, and El Oglia. The southern zone comprised

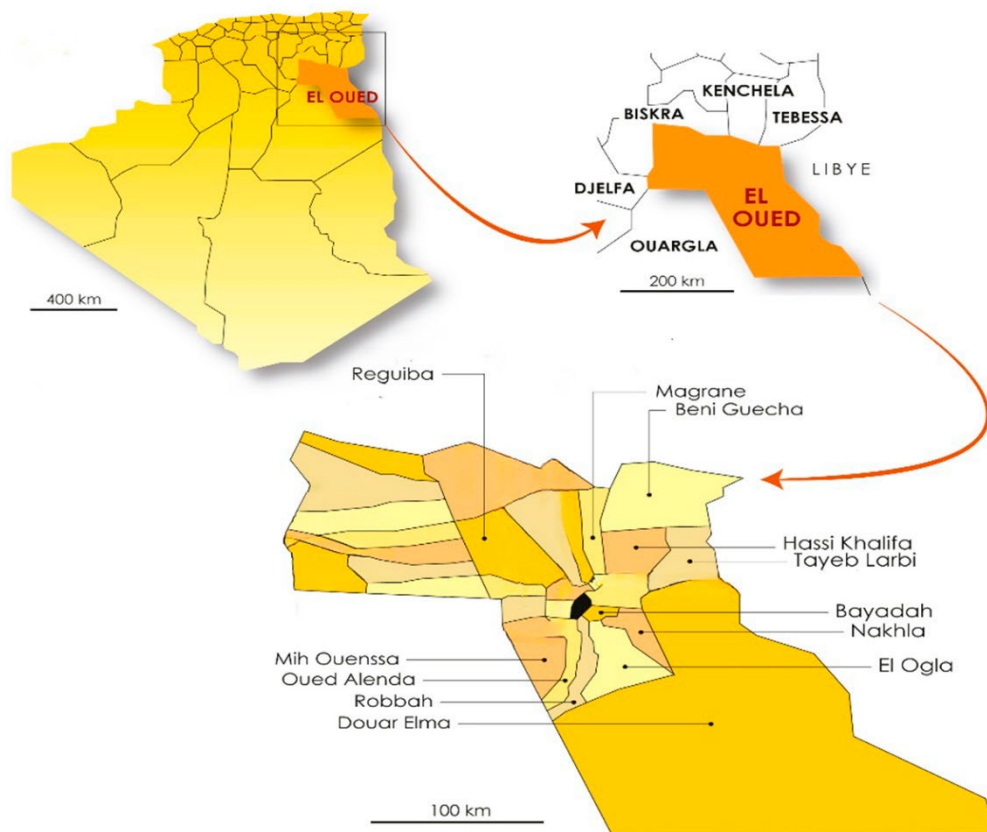


Fig. 1. Geographical distribution of the municipalities in El Oued province where the questionnaire survey was disseminated (Algeria Map)

Mih Ouensa, Oued Alenda, Robbah, Douar Elma, Bayadha, Nakhla, and El Oglia. This stratification was applied to assess potential geographical variation in abortion occurrence across the study area.

Sample Size and Herd Selection Procedure

The sample size was defined considering the number of dromedary camel herds available during the study period, with the aim of obtaining an adequate representation of abortion occurrence in the investigated region. Herds were selected from different geographical areas of the Algerian Sahara to ensure representative spatial coverage. A random selection procedure was applied based on the available herd lists, thereby ensuring an objective selection of the study units. The surveyed animals were adult female dromedaries of reproductive age (5 to 18 years), selected based on their available reproductive history and their presence within the herds included in the study.

A questionnaire was developed to collect information on reproductive events and potential factors associated with the occurrence of abortions in dromedary camel herds. An epidemiological survey was conducted among 75 camel breeders from 13 municipalities in El Oued Province. The questionnaire was administered through direct interviews with herd owners during field visits. The information provided by the respondents was recorded and subsequently used for epidemiological analysis.

Questionnaire Survey

An epidemiological cross-sectional survey was conducted in El Oued Province using a semi-structured questionnaire designed to collect standardized and detailed information. The questionnaire was structured into three main sections. The first section focused on herd characteristics, including herd size (female camels, male dromedaries, and young stock), husbandry system (extensive, intensive, semi-intensive), and herd replacement strategy (purchase, self-replacement, or mixed). The second section addressed reproductive performance, including herd-level abortion occurrence and stillbirths recorded during the periods 2022/2023 and 2024/2025. Information collected included the number of births and abortions per herd, parity status (primiparous and multiparous females), timing of abortion, gestational period (first, second, third and fourth gestational stages), type of expulsion (complete or incomplete), and management actions taken following abortion (none, isolation, or veterinary consultation). The third section recorded the presence of other domestic species (cattle, sheep, and goats), as well as the presence of cats and dogs within or around the herd environment.

In addition, open-ended questions were included to document clinical observations reported by breeders in aborted animals, the fate of the placenta and fetus,

and breeders' perceptions regarding possible causes of abortion. Herds were selected randomly within the study area.

Statistical Analysis

The questionnaire survey data were entered and coded using Microsoft Excel (Microsoft Corporation) and subsequently analyzed with SPSS software (version 27.0). A descriptive analysis was first performed to summarize the main characteristics of the studied variables.

Abortion frequency was calculated as the proportion of females that experienced abortion among the total number of pregnant females in each herd. Since no specific classification thresholds have been established for dromedary camels, abortion frequency categories were adapted from criteria previously applied in cattle (Givens and Marley, 2008) and classified as rare (< 2%), frequent (2–5%), or high (> 5%).

Herd-level abortion prevalence (%) was defined as the proportion of herds reporting at least one abortion case during the reproduction period, calculated by dividing the number of affected herds by the total number of herds surveyed and expressed as a percentage. Associations between herd-level abortion occurrence and potential risk factors were first assessed using Chi-square test or Fisher's exact test, as appropriate. In addition, univariable logistic regression analysis was performed to estimate odds ratios (OR) and 95% confidence intervals (CI) for each explanatory variable. A 95% confidence level was considered, and statistical significance was set at $P < 0.05$.

Results

Herd Characteristics and Reproductive Outcomes

The descriptive analysis included 75 camel breeders from 13 municipalities, representing a total population of 5870 dromedary camels, of which 4460 were females.

Herd size was distributed into six categories: [1–50], [50–100], [100–200], [200–300], [300–400], and [400–500], accounting for 44.0%, 33.3%, 16.0%, 1.3%, 4.0%, and 1.3%, respectively. Three husbandry systems were reported, namely extensive (62.7%), semi-intensive (28.0%), and intensive (9.3%). Herd replacement strategies were mainly self-replacement (58.7%), followed by mixed systems (29.3%) and purchase-based replacement (12.0%).

Among the surveyed breeders, 60 (80%) reported a history of abortion in their herds (Fig. 2). Among these affected herds, abortion frequency was classified as rare in 51.7% (31/60), frequent in 40.0% (24/60), and high in 8.3% (5/60).

Multiparous females showed higher abortion rates during the period 2022–2024, whereas primiparous females recorded a slightly higher rate in 2025.

Overall, abortion rates increased progressively throughout the study period, reaching their highest values in 2025 (Fig. 3).

At the individual female level, 502 abortions were recorded among 5886 pregnant females, corresponding to an overall abortion rate of 8.52% during the study period. The abortion rates according to year and parity group were as follows:

- 2022: primiparous (7.8%), multiparous (8.53%);
- 2023: primiparous (6.95%), multiparous (8.15%);
- 2024: primiparous (7.71%), multiparous (8.73%);
- 2025: primiparous (10%), multiparous (9.36%).

The spatial distribution of abortion cases across municipalities in El Oued Province is presented in Fig. 4.

Monthly abortion occurrence showed a progressive increase from July (16.7%) and August (25%), reaching a peak in September (53.3%), followed by

October (48.3%) and November (28.3%), before declining in December (8.3%), with lower values recorded earlier in the year. Regarding gestational stage, abortions were mainly observed in the third trimester (65%), followed by the fourth trimester (25%), while lower proportions were recorded in the second (6.7%) and first trimesters (3.3%). Placental expulsion was complete in 90% of cases. The placenta and aborted fetuses were mainly buried (88.3%), while 10% were discarded in open desert areas and 1.7% were incinerated. Following abortion events, 75% of breeders reported no intervention, whereas 25% sought veterinary consultation.

Clinical signs reported in aborted females included lethargy (15%), fever (11.7%), anorexia (10%), weight loss (6.7%), stress (5%), neurological signs (3.3%), agitation (3.3%), pulmonary inflammation (1.7%), and weakness (3.3%). However, 43.3% of breeders

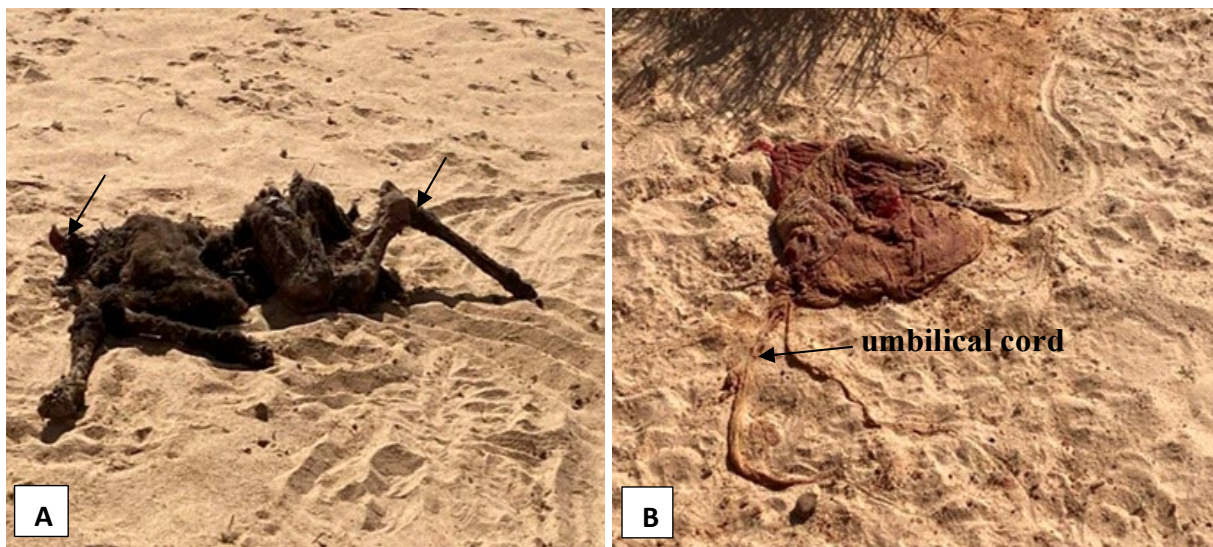


Fig. 2. A case of late-term abortion (11 months) observed during our survey in the Saharan region of El Oued province. A – Aborted fetus in an advanced state of desiccation with absence of the head and exposed bones of the hind limbs (arrows), suggesting scavenging by wild animals. B – Placenta from the she-camel that aborted.

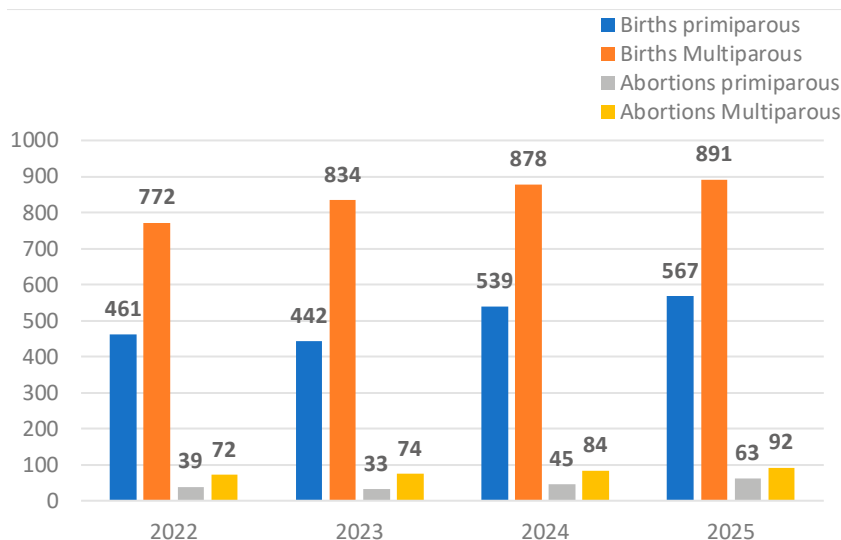


Fig. 3. Evolution of births and abortions among female dromedary camels in El Oued

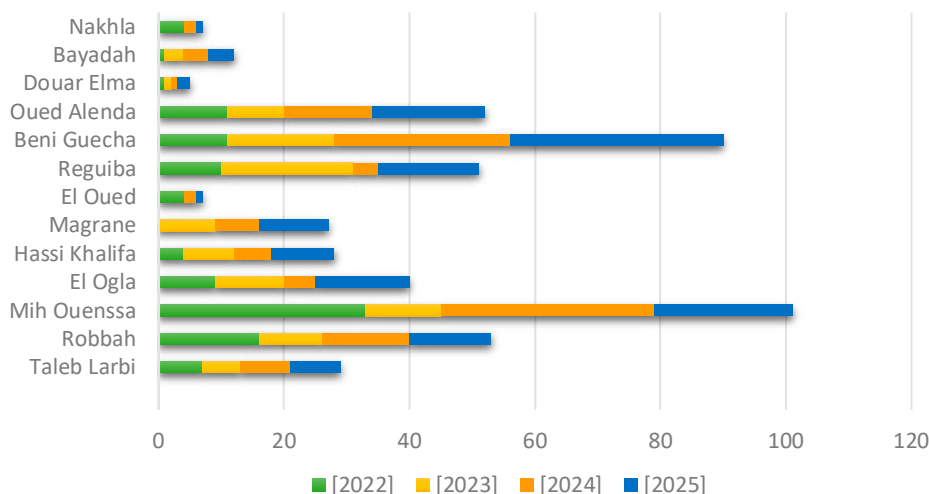


Fig. 4. Incidence of abortions in female dromedary camels by municipality in El Oued

reported no observable clinical signs. Breeders reported multiple perceived causes of abortion, including drought (55%), insect infestation (28.3%), consumption of contaminated water (23.3%), various diseases (23.3%), malnutrition (16.7%), excessive heat (13.3%), fever (6.7%), poor management practices (3.3%), anorexia (1.7%), and plant toxicity (1.7%).

Among the 60 abortion-affected herds, the presence of other animal species was reported, including cattle (5%), sheep (58.3%), goats (60%), dogs (71.6%), and cats (80%). In addition, 13 breeders reported possible contact with stray dogs and cats. Among the 60 breeders reporting abortion cases, 36 (60%) also reported stillbirths during the 2022–2025 period, while 3 (5%) observed neonatal mortality within 2–6 days after birth, and 21 (35%) reported no such events. In cases of stillbirth, reported observations included fetal swelling (6%), fever (6%), stress in the last three days before parturition (3%), and anemia/cachexia (3%). However, 81.8% of breeders reported no associated clinical signs.

Association Analysis of Risk Factors

Most of the investigated factors showed no statistically significant association with abortion in camel herds ($P > 0.05$), including geographic zone, variables such as the presence of cattle, sheep, and goats, as well as management-related factors including husbandry system and herd replacement strategy. These results indicate weak statistical evidence supporting an association between abortion occurrence and the majority of structural or management characteristics assessed.

In contrast, A strong and statistically significant association was observed between the presence of cats and herd-level abortion occurrence (OR = 11, 95% CI: 2.98–40.67; $p < 0.001$), indicating that herds with cats had approximately 11-fold higher odds of abortion occurrence compared with herds without cats. Similarly, the presence of dogs was significantly associated with abortion occurrence (OR = 3.79, 95%

CI: 1.17–12.30; $p = 0.033$), with herds where dogs were present showing approximately 3.8-fold higher odds of abortion compared with herds without dogs (Table 1, Fig. 5).

Discussion

General and Reproductive Characteristics of the Herds

The camel herds investigated in this study were mainly small-sized herds, with a predominance of breeding females. This structure reflects the typical management strategy of camel production systems, in which maintaining a high proportion of females is essential to ensure reproduction and herd sustainability. Similar patterns have been reported by Megersa et al. (2008) and Al-Dahash and Sassi (2009). The predominance of extensive management and reliance on self-replacement indicate a low-input production system mainly based on natural herd renewal, which may contribute to maintaining herd stability. However, these systems may also limit reproductive monitoring and health control measures, potentially affecting reproductive performance, particularly abortion occurrence, as reported in previous studies (Adamou, 2008; Mayouf et al., 2014).

Data on abortions in dromedaries in North Africa remain limited. To the best of our knowledge, this study represents one of the first epidemiological surveys conducted in Algeria in this field, providing baseline data that may serve as a reference for future research in this context.

A high proportion of breeders reported abortion cases in their herds, while the use of veterinary services remained limited. This finding, also reported by Khalafalla et al. (2017), suggests that reproductive losses may be insufficiently diagnosed and managed in camel herds. In dromedaries, where reproductive performance is naturally limited by delayed sexual maturity, seasonal breeding activity, and prolonged gestation, abortions may have a significant impact on herd productivity by extending the calving interval.

Table 1. Analysis of potential risk factors associated with abortion in female dromedaries

Variables	Categories	Total Herds	No of Unaffected Herds	No of Affected Herds	OR (95% CI)	P value
Geographic zone	North	34	5	29	1 (ref)	0.56
	South	41	10	31	0.53 (0.16–1.75)	
The presence of cattle	No	68	11	57	1 (ref)	0.13
	Yes	7	3	4	0.26 (0.05–1.31)	
The presence of sheep	No	35	10	25	1 (ref)	0.093
	Yes	40	5	35	2.80 (0.85–9.20)	
The presence of goats	No	31	7	24	1 (ref)	0.771
	Yes	44	8	36	1.31 (0.42–4.10)	
The presence of dogs	No	26	9	17	1 (ref)	0.033*
	Yes	49	6	43	3.79 (1.17–12.30)	
The presence of cats	No	23	11	12	1 (ref)	< 0.001*
	Yes	52	4	48	11 (2.98–40.67)	
Husbandry system	Extensive	45	10	35	1 (ref)	0.075
	Intensive	7	4	3	0.21 (0.04–1.12)	
	Semi-intensive	23	1	22	6.29 (0.75–52.56)	
Herd replacement strategy	Purchase	9	3	6	1 (ref)	0.37
	Self-replacement	44	8	36	2.25 (0.46–10.96)	
	Mixed	22	4	18	2.25 (0.39–13.07)	

No, number; OR, odds ratio; CI, confidence interval; *, significant,

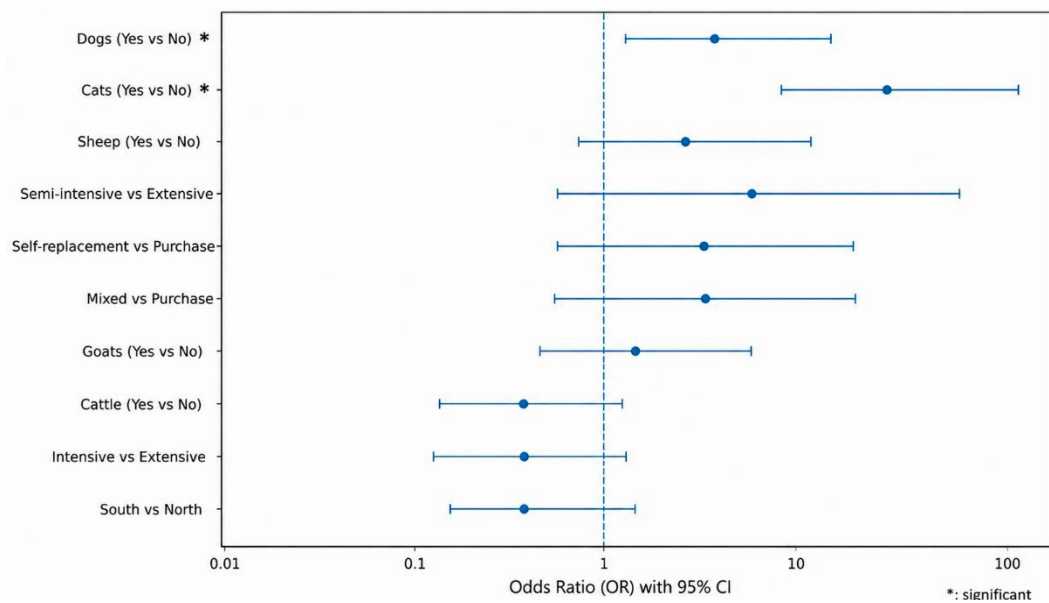


Fig. 5 .A forest plot of risk factors associated with herd-level abortion

These findings highlight the importance of improving reproductive monitoring and strengthening access to veterinary services in camel production systems (Monaco et al., 2015; Faye et al., 2022).

The limited use of veterinary services in cases of abortion likely reflects gaps in animal health awareness, insufficient veterinary outreach, and limited integration of camel production systems into

formal veterinary surveillance programs. In addition, assessment of carcass and tissue disposal practices showed that only a small proportion of breeders failed to properly dispose of aborted materials, suggesting a relatively moderate level of awareness regarding potential health risks.

Multiparous females recorded higher numbers of both births and abortions compared with primiparous

females, which is expected given their reproductive history. However, the persistently higher abortion frequency in multiparous females may also reflect cumulative exposure to infectious agents or age-related physiological changes. A gradual increase in abortion cases was observed in 2025, particularly among primiparous females, which may indicate increased susceptibility potentially associated with environmental stressors or underlying reproductive disorders.

During the study period, the overall abortion rate observed was higher than those reported in previous studies by Al-Dahash and Sassi (2009) and Nagy et al. (2023) but remained lower than the levels described in Niger by Gilles et al. (2006) and in Chad by Touka et al. (2025). These discrepancies between studies may be attributed to several factors, including differences in sampling strategies, herd management systems, production conditions, climatic parameters, as well as variations in the prevalence of infectious and non-infectious reproductive disorders.

Overall, most farms showed relatively low abortion frequencies, suggesting that abortion is not uniformly distributed across herds but rather concentrated in specific vulnerable populations. However, early embryonic losses are likely underreported due to difficulties in detection, which may lead to the underestimation of true reproductive losses. Previous studies have reported that early pregnancy losses may be substantial in camels (Toolan, 2003; Henker et al., 2022). Tibary et al. (2006) further reported a wide variability in reproductive performance, with pregnancy or calving rates ranging from 12% to 85% and abortion rates reaching up to 40%.

Abortion occurrence showed a seasonal distribution, with a noticeable increase during September and October. This variation may be associated with the combined influence of several factors, including climatic conditions, feed availability, nutritional status of females, herd management practices, and seasonal dynamics of infectious agents. Similar trends were reported by Nagy et al. (2023), whereas other studies described peaks occurring at different periods, including June or early spring (Gilles et al., 2006). These differences suggest that the seasonality of abortion in dromedaries depends on geographical context, production systems, and local epidemiological conditions, confirming the multifactorial nature of this phenomenon.

Incomplete expulsion was observed in a small proportion of cases, in agreement with the findings reported by Al-Dahash and Sassi (2009). Although uncommon, this complication may contribute to postpartum disorders and highlights the importance of appropriate reproductive management following abortion events.

Most abortions occurred during the advanced stages of gestation, suggesting a greater involvement of factors affecting the maintenance of late pregnancy.

Similar observations were reported by Nagy et al. (2023). This pattern may be associated with several factors, including infections, nutritional conditions, maternal stress, or placental disorders, whose impact may vary according to herd management practices and the local epidemiological context.

Finally, more than half of the breeders reporting abortion also reported stillbirths within their herds. This concurrent occurrence may reflect shared underlying risk factors affecting gestation and perinatal survival, potentially involving infectious, environmental, or management-related determinants.

Risk Factors Associated with Abortion in Camel Herds

The absence of significant associations between abortion occurrence and most of the investigated variables, including geographic zone, herd composition, husbandry system, and herd replacement strategy, indicates that these factors were not statistically related to abortion under the conditions of the present study. In contrast, the presence of dogs and cats showed significant associations at the herd level. However, given the questionnaire-based nature of the study and the absence of clinical, pathological, and laboratory investigations, these findings should be considered as potential epidemiological indicators. Overall, the results suggest that additional factors not assessed in the present study, including environmental, infectious, or herd health management-related factors, may also contribute to the observed variability in abortion occurrence.

Potential Causes of Abortion in Dromedary Camels

The diversity of observations reported by breeders indicates that abortions in dromedaries may occur under various conditions. Clinical manifestations such as fever, weight loss, and other non-specific signs were reported in some cases, whereas a substantial proportion of breeders reported no apparent signs associated with abortion events. These observations may reflect the heterogeneous nature of abortion occurrence in camel herds; however, the absence of clinical examinations and diagnostic confirmation does not allow the underlying causes to be determined.

Several factors potentially responsible for abortions were reported in this survey, including drought, the presence of insects, diseases, wastewater contamination, and feed shortages. The relative importance of these factors varied considerably across municipalities, highlighting the key role of environmental conditions and local management practices in abortion risk. Indeed, the prolonged drought observed in the study area has led to significant food shortages, notably a marked decline in forage vegetation. This situation has harmful effects on the animals, resulting in weight loss and weakened immunity (Adamou, 2008), which

may compromise the reproductive performance of she-camels and lead to abortions and stillbirths. Other non-infectious factors were also reported by Nagy et al. (2023), including fetal and placental abnormalities (such as twinning, umbilical cord torsion, placental insufficiency and genetic defects), endocrine disorders, and various environmental factors, such as nutritional deficiencies, toxicosis, trauma and maternal diseases.

Infectious agents play a major role in the occurrence of abortions, with incidence rates showing significant regional disparities, ranging from 10% to over 70% depending on the geographic area. According to Tibary et al. (2006), brucellosis and trypanosomiasis (mainly transmitted through insect bites) are the main causes of infectious abortion in camels, particularly in the Middle East and Africa. In contrast, in llamas and alpacas, abortions are mainly attributed to leptospirosis, toxoplasmosis and chlamydiosis. The distribution of both infectious and non-infectious causes of abortion varies across countries and breeding seasons. Nevertheless, a considerable proportion of cases (8% to 35%) remain of unknown etiology (Nagy et al., 2021). Overall, the reviewed studies consistently show that reproductive losses in dromedaries are associated with a wide range of infectious agents, with marked geographical variability in their relative importance. In Algeria, serological data have highlighted exposure to several abortive pathogens, including *Brucella* spp., *Trypanosoma evansi*, *Chlamydia abortus* and BoHV-1 (Benaissa, 2015). Similarly, in Egypt and Saudi Arabia, multiple bacterial, viral and protozoan agents have been identified as causes of abortion, stillbirth and neonatal mortality, including *Toxoplasma gondii*, *Theileria* spp., *Anaplasma* spp., *Chlamydia psittaci*, *Coxiella burnetii*, *Campylobacter* spp., *Salmonella* spp., as well as bovine viral diarrhea virus (Osman et al., 2016; Khalafalla et al., 2017; Khalifa et al., 2018). In addition, studies from Iran confirm that the main causes of fetal losses include brucellosis, trypanosomiasis, leptospirosis,

salmonellosis, BVD, IBR and aspergillosis (Hassani, 2021). Furthermore, protozoal infections such as toxoplasmosis, neosporosis, sarcocystosis and trypanosomiasis are also recognized as important zoonotic causes of abortion in camels (Shaapan, 2016). Taken together, these findings highlight that abortions in camels are of multifactorial origin, involving a complex interaction between bacterial, viral, protozoal and possibly environmental factors, which makes their diagnosis and control particularly challenging.

This study presents several limitations that should be considered when interpreting the findings. Its cross-sectional questionnaire-based design does not allow causal inference and limits the interpretation of the results to statistical associations. In addition, data based on breeders' reports may be subject to recall bias and potential misclassification of reproductive events and exposure variables. Furthermore, the absence of clinical, pathological, and laboratory investigations did not allow confirmation of the etiological causes of abortion. Consequently, the present findings should be interpreted strictly at an epidemiological level, and further studies integrating epidemiological, clinical, pathological, and laboratory approaches are required to better characterize the factors involved in abortion in dromedaries.

Conclusion

This study highlights a high frequency of abortions in dromedary camel herds, accompanied by a notable proportion of stillbirths. Most factors related to herd characteristics and management practices showed no significant association with abortion occurrence within the framework of this survey. These findings should be interpreted with caution due to the observational and declarative nature of the data. In this context, further investigations integrating epidemiological, clinical, pathological, and laboratory diagnostic approaches are required to better understand the underlying mechanisms of abortion in dromedaries and to guide appropriate preventive strategies.

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