

Twin calving in Mongolian Bactrian camels: Incidence and regional patterns

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Abstract

Twin calving in Bactrian camels is considered a rare reproductive event, yet population-level assessments remain limited. This study evaluated the incidence and regional distribution of twin calving in Mongolian Bactrian camels between 2006 and 2025. A total of 42 verified twin calving cases were identified through field documentation and cross-validation procedures. National camel population data were obtained from official livestock statistics, and incidence was standardized per 100,000 camel-years.

Across 7,572,600 camel-years of observation, national incidence was 0.55 per 100,000 camel-years (95% CI: 0.40–0.75). When stratified by region, the Western region demonstrated the highest standardized incidence (0.88), followed by the Eastern (0.82) and Khangai regions (0.65), while the Central region showed the lowest rate (0.33). Overlapping confidence intervals indicate substantial statistical uncertainty.

Twin calving remains an extremely infrequent reproductive outcome in Mongolian Bactrian camels. Apparent temporal increases likely reflect improvements in case detection rather than biological change. These findings provide a population-based baseline for future reproductive and herd demography research in pastoral camel systems. Descriptive analysis of records with available maternal and calf-level information showed a slight male bias among sex-identified calves, but no clear association with dam age or parity. Among cases with known month of occurrence, most twin calvings were recorded in March and April, consistent with the general spring calving season.

Keywords: Bactrian camel; twin calving; reproductive incidence; camel demography; pastoral systems; Mongolia

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Introduction

Twin birth in camelids is uncommon due to anatomical and physiological constraints that strongly favor singleton gestation. In Bactrian camels (*Camelus bactrianus*), prolonged gestation (approximately 13–14 months), functional uterine asymmetry, and placental limitations reduce the likelihood that twin pregnancies are successfully

maintained to term (El-Wishy, 1992; Tibary & Anouassi, 1997). Classical reproductive studies have consistently reported that parturition in camels overwhelmingly results in a single calf, with twin births regarded as rare under natural breeding conditions (Arthur & Al-Rahim, 1982).

In Mongolia, systematic scientific documentation of twin calving in Bactrian

camels remains limited. Nevertheless, national livestock monographs and husbandry studies have repeatedly characterized twin birth as an uncommon reproductive outcome. Earlier research emphasized that camels exhibit slow reproductive turnover, extended lactation, and typically produce one calf at two-year intervals, with twin births occurring only sporadically (Luvsan, 1969; Luvsan, 1975; Tseveenjav, 1990; Mijiddorj & Juramt, 2017). Comprehensive national compilations similarly describe twin calving as highly uncommon within traditional pastoral systems (Erdenebileg & Tsogtuya, 2016). In Mongolia, Bactrian camels are traditionally managed under extensive pastoral conditions and graze on natural rangelands throughout all four seasons of the year.

Although sporadic case reports exist, population-based incidence estimates remain scarce, particularly within traditional pastoral production systems where systematic reproductive monitoring is uncommon. Quantitative assessment of twin calving incidence at the population level is therefore necessary to contextualize anecdotal reports within demographic reality.

The objective of the present study was to quantify the incidence and spatial distribution of twin calving in Mongolian Bactrian camels using standardized population denominators over a 20-year period (2006–2025).

Materials and Methods

A total of 53 twin calving cases were documented in Mongolia between 1961 and 2025. However, incidence analysis was restricted to the most recent 20-year period (2006–2025), during which case verification

and reporting consistency were substantially improved and reliable population denominators were available.

A retrospective population-based study design was employed to evaluate the incidence and spatial distribution of twin calving in Mongolian Bactrian camels (*Camelus bactrianus*) over this defined analytical period.

Twin calving was defined as the confirmed parturition of two live or full-term calves from a single dam during a single birthing event.

Case identification and validation

Data were compiled from multiple complementary sources, including:

- direct field observations and researcher-maintained records;
- structured and semi-structured interviews with local herders and experienced livestock managers;
- verified reports obtained directly from owners of dams that produced twin calves; and
- published materials, including books, booklets, newspapers, magazines, and online media sources.

To enhance data reliability, all reported cases were subjected to cross-verification procedures. Information was validated through source triangulation and, where available, supporting documentation such as photographic evidence. Duplicate reports and unverified cases were excluded from the final dataset.

For each confirmed twin calving event, available information included the year and month of occurrence, geographic location (province/aimag), and, when accessible, the

age of the dam and the sex of the calves. Month of occurrence was summarized descriptively to evaluate the seasonal distribution of verified twin calving cases. Cases with missing month information were excluded from the monthly distribution analysis. Therefore, the seasonal analysis was based only on cases with known month of occurrence. Because dam age, parity and calf sex were not consistently available for all historical and media-reported cases, these variables were summarized descriptively and were not included as covariates in the incidence models. For incidence estimation, only cases occurring between 2006 and 2025 within Mongolia were analyzed (n = 42).

Population data and camel-years calculation

Annual camel population data (2006–2025) were obtained from the official livestock census database maintained by the National Statistical Office of Mongolia (NSO, 2026). Camel-years of observation were calculated as the sum of annual national camel population totals during 2006–2025:

$$T = \sum_{2006}^{2025} N_i$$

Total camel-years for the study period equaled 7,572,600.

Incidence estimation

Incidence was calculated as the number of twin calving cases divided by total camel-years and expressed per 100,000 camel-years:

$$\text{Incidence} = \frac{K}{T} \times 100,000$$

- K represents the number of verified twin calving cases and
- T represents total camel-years.

Incidence was estimated at national level and further stratified into five-year intervals to assess temporal variation.

Regional analysis

Spatial analysis followed the official regional classification of Mongolia (Western, Khangai, Central, and Eastern regions). Each case was assigned to a region according to province of occurrence. Regional camel-years were calculated by summing annual regional camel populations over the study period. Regional incidence rates were calculated using the same standardized approach.

Statistical analysis

Given the rarity of twin calving events, incidence was assumed to follow a Poisson distribution. Exact 95% confidence intervals were calculated using Poisson-based methods appropriate for low-frequency count data. All rate calculations were performed using standard epidemiological methods.

Results

Temporal distribution of twin calving

Between 2006 and 2025, a total of 42 verified twin calving cases were documented in Mongolia. The temporal distribution was not uniform across the study period. When grouped into five-year intervals, the number of recorded cases increased over time:

- 2006–2010: 4 cases
- 2011–2015: 11 cases
- 2016–2020: 10 cases
- 2021–2025: 17 cases

The highest number of cases was observed during 2021–2025, accounting for 40.5% of all cases recorded during the 20-year study window. Although absolute case counts increased in recent years, interpretation of temporal clustering requires consideration of changes in reporting practices and documentation systems.

Seasonal distribution of twin calving

Month of occurrence was available for 38 of the 42 verified twin calving cases. Four cases

with missing month information were excluded from the monthly distribution analysis. Among cases with known month of occurrence, twin calving was strongly concentrated in spring. Twenty-eight cases were recorded in March and nine cases in April, together accounting for 97.4% of month-known cases. Only one case was recorded in July. This seasonal concentration is consistent with the general spring calving season of Bactrian camels under Mongolian pastoral conditions.

Table 1. Monthly distribution of twin calving cases with known month of occurrence

Month	Cases (n)	Percentage of month-known cases
March	28	73.7%
April	9	23.7%
July	1	2.6%
Total	38	100%

Note: Four cases with missing month information were excluded from the monthly distribution analysis. Percentages were calculated only among cases with known month of occurrence.

National incidence of twin calving

Annual national camel population counts between 2006 and 2025 summed to 7,572,600 camel-years of observation. The overall national incidence was 0.55 per 100,000 camel-years (95% CI: 0.40–0.75), confirming that twin calving remains an extremely rare reproductive event in Mongolian Bactrian camels.

When standardized by five-year intervals, incidence rates were the highest incidence was observed during 2021–2025 (0.71), while the lowest occurred during 2006–2010 (0.30) (Table 2). However, given the small number of events, differences between intervals should be interpreted cautiously. Across all intervals, incidence remained below 1 per 100,000 camel-years.

Table 2. Five-year distribution and incidence of twin calving in Mongolian Bactrian camels, 2006–2025

Period	Cases (n)	Incidence (/100,000 camel-years)
2006–2010	4	0.30
2011–2015	11	0.68
2016–2020	10	0.45
2021–2025	17	0.71

Regional incidence

Using the official national regional classification, spatial heterogeneity in twin calving incidence was observed during 2006–2025. The Western region demonstrated the highest incidence (0.88 per 100,000 camel-years), followed by the Eastern region (0.82) and the Khangai region (0.65), while the lowest point estimate was observed in the Central region (0.33).

Although the Western region exhibited the highest standardized rate, confidence

intervals remain wide due to limited case numbers. The apparent spatial variation therefore requires cautious interpretation and cannot be definitively attributed to biological or environmental differences without further evidence. However, confidence intervals overlapped across regions, particularly in the Eastern region where case numbers were limited. Therefore, while spatial heterogeneity was observed, statistical uncertainty limits definitive conclusions regarding stable high-incidence regions.

Table 3. Regional incidence of twin calving in Mongolian Bactrian camels, 2006–2025

Region	Cases (n)	Incidence (/100,000 camel-years)	95% CI
Western	16	0.88	0.50–1.43
Khangai	9	0.65	0.30–1.24
Central	14	0.33	0.18–0.55
Eastern	3	0.82	0.17–2.39
National	42	0.55	0.40–0.75

Sex of twin calves, dam age and parity

Among the documented twin calving cases, information on calf sex, dam age and parity was available only for a subset of records. Therefore, these variables were analysed descriptively rather than as primary predictors of twin calving incidence. Among sex-identified twin calves, males were

slightly more frequent than females. A total of 38 calves had recorded sex information, including 22 males and 16 females. Male calves accounted for 57.9% of sex-identified calves, while female calves accounted for 42.1% (Table 4). However, this difference should be interpreted cautiously because of the small sample size and incomplete sex information.

Table 4. Summary of calf sex and dam age in twin calving records with available information

Variable	Category	Number	Percentage / value
Calf sex	Male calves	22	57.9%
	Female calves	16	42.1%
	Total sex-identified calves	38	100%
Dam age	Mean recorded dam age	—	6.4 years
	Recorded dam age range	—	3–11 years
	Most frequent recorded dam age group	—	6–8 years

Note: Calf sex and dam age were not available for all documented cases. Dam age was therefore summarized only for cases with available information. Calf sex was summarized at the calf level, whereas incidence and parity were summarized at the twin calving case level.

Dam age was available for a limited number of cases. The mean recorded dam age was 6.4 years, and twin calving was observed in dams ranging from 3 to 11 years of age. Most cases with known dam age occurred among dams aged 6–8 years. However, the distribution of calf sex across dam age classes did not indicate a clear age-related pattern.

Parity information was also incomplete. Among records with known parity, twin calving was recorded from the first to the fifth calving (Table 5). The highest number of

recorded cases occurred around the second and third calvings, but this pattern cannot be interpreted as evidence of a biological association because the dataset was based on opportunistically documented rare events rather than systematic reproductive monitoring. Overall, the available data suggest that the sex ratio of twin calves was slightly male-biased, but there was no clear evidence that calf sex was associated with dam age or parity. These findings should be regarded as exploratory.

Table 5. Parity distribution among twin calving records with available information

Parity	Number of twin calving cases
First calving	4
Second calving	4
Third calving	5
Fourth calving	1
Fifth calving	1

Note: Parity information was incomplete and was not used for formal statistical inference.

Relative contribution of regions

The Western and Central regions together accounted for 30 of the 42 cases (71.4%). Despite the Central region contributing a large absolute number of cases ($n = 14$), its standardized incidence remained lower due to substantially larger camel population size.

This indicates that absolute case counts alone do not accurately reflect relative reproductive risk at the population level.

Overall epidemiological characterization

Across 7.57 million camel-years of observation, twin calving remained an exceptionally rare reproductive event. The incidence consistently remained below 1 per 100,000 camel-years across all temporal and spatial strata. The observed increase in recorded cases in recent years did not correspond to a proportional increase in standardized incidence, suggesting that temporal clustering likely reflects improved documentation rather than a biological shift in reproductive patterns.

Discussion

The present study confirms that twin calving in Mongolian Bactrian camels is an exceptionally rare reproductive outcome at the population level, with a standardized incidence of 0.55 per 100,000 camel-years. This finding aligns with the established reproductive physiology of camels, which strongly favors singleton gestation (El-Wishy, 1992; Arthur & Al-Rahim, 1982).

Camel reproduction is characterized by prolonged gestation (approximately 13 months), functional uterine asymmetry, and physiological mechanisms that promote singleton fetal development (El-Wishy, 1992). Classical studies have consistently reported that parturition outcomes in camels overwhelmingly result in single offspring, with twin births regarded as uncommon under natural breeding conditions (Arthur & Al-Rahim, 1982). These biological characteristics are consistent with the extremely low live twin calving incidence observed in the present population-based analysis.

Although twin parturition is rare, ovulatory dynamics in camelids permit multiple follicular development. In dromedaries, multiple ovulation rates may reach up to 45% (Tibary & Anouassi, 1997; Nagy et al., 2013). Ultrasonographic and slaughterhouse-based studies have demonstrated that twin conceptions may initially establish at appreciable frequencies; however, most do not progress to term (Tinson et al., 2001; Nagy et al., 2013). Natural twin reduction frequently occurs between the ninth and thirteenth weeks of gestation, with the majority of pregnancies subsequently continuing as singletons (Tibary & Anouassi, 1997). Complete early pregnancy loss is observed in a smaller proportion of cases, particularly when twin gestation is present (Nagy et al., 2013).

Evidence from South American camelids provides an important comparative context. In alpacas, twin birth is rare despite relatively frequent double ovulation and twin conception. Campbell et al. (2015) reported

that twin pregnancies in double-ovulating alpacas were either reduced to singleton pregnancies or lost completely, with spontaneous reduction occurring before Day 45 in many cases. This pattern supports the interpretation that live twin calving represents only the final and rare outcome of a broader reproductive process in which most twin conceptions are naturally reduced or lost during early gestation. Similar reproductive features in female South American camelids, including induced ovulation and long gestation, further support comparison across camelid species (Vaughan & Tibary, 2006; Sumar, 1999).

This distinction between ovulatory frequency and successful twin birth is biologically significant. While double ovulation may occur relatively frequently, intrauterine maintenance of two viable embryos to parturition is uncommon. Anatomically, pregnancy in camels is predominantly maintained in the left uterine horn, even when ovulation occurs in the right ovary (Tibary & Anouassi, 1997). Such functional asymmetry imposes spatial and vascular limitations on simultaneous embryo development. Competition for uterine space, placental attachment surface, and uterine blood supply likely contributes to selective embryo reduction. These physiological constraints provide a mechanistic explanation for the extremely low live twin calving incidence documented in this study.

The discrepancy between relatively common multiple ovulation and exceedingly rare live twin birth underscores the selective nature of gestational survival in camelids. Population-level incidence reflects the endpoint of a biologically filtered process in which most twin conceptions are reduced or lost before term.

The rarity of twin calving documented here is also consistent with Mongolian livestock scholarship. National monographs and husbandry studies have long described twin birth in Bactrian camels as highly uncommon (Luvsan, 1969; 1975; Tsevvenjav, 1990; Erdenebileg & Tsogttuya, 2016). Such convergence between physiological evidence and national husbandry literature strengthens the interpretation that twin calving is biologically constrained rather than merely underreported.

Beyond biological considerations, the rarity of twin calving has also been reflected in Mongolian pastoral tradition. Ethnographic accounts describe camel twin birth as an extraordinary and auspicious event symbolizing herd prosperity and favorable years. Ceremonial practices, including symbolic adornment of the dam, were reportedly performed to honor such occurrences (Jambaldorj, 1997; 2019). Historical reports from collective farm records in the mid-20th century further document sporadic twin calving cases that were publicly noted due to their exceptional nature. The convergence of physiological constraints and cultural recognition underscores the longstanding perception of twin calving as an unusual event within Mongolian camel husbandry.

The concentration of twin calving records in March and April likely reflects the normal seasonal pattern of Bactrian camel calving in Mongolia rather than a specific seasonal risk factor for twinning. Because cases with missing month information were excluded and because the present study did not include a denominator of all camel calvings by month, the seasonal distribution should be interpreted descriptively. Future reproductive monitoring should compare twin calving

events with the monthly distribution of all camel calvings to determine whether twin calving differs from the general calving season.

The exploratory analysis of calf sex, dam age and parity provides useful descriptive information but does not support a strong explanatory relationship. The slight male bias among sex-identified twin calves may reflect random variation in a small dataset rather than a true biological pattern. Similarly, the occurrence of twin calving among dams of different ages and parities suggests that successful twin parturition is not restricted to a single maternal age group or reproductive stage. Because individual-level nutritional status was not consistently available, this factor could not be evaluated in the present study. Therefore, future studies should record dam age, parity, nutritional condition, season and calf sex systematically in order to evaluate whether maternal characteristics influence the probability of maintaining twin pregnancies to term.

Because the dataset was compiled retrospectively from field records, herder interviews and published or media-reported sources, some twin calving events may have gone unrecorded. Therefore, the incidence estimates should be interpreted as conservative population-based estimates.

Temporal clustering observed during 2021–2025 likely reflects improvements in documentation, communication technologies, and reporting networks rather than a fundamental shift in reproductive biology. Standardized incidence did not increase proportionally with absolute case counts, supporting the interpretation that enhanced detection contributed to apparent temporal variation.

Conclusion

This study presents the first standardized population-based estimate of twin calving incidence in Mongolian Bactrian camels during 2006–2025. Across 7.57 million camel-years of observation, twin calving was confirmed as an exceptionally rare reproductive outcome, with a national incidence of 0.55 per 100,000 camel-years.

Although absolute case numbers increased in recent years, standardized incidence remained consistently below 1 per 100,000 camel-years, suggesting that apparent temporal clustering likely reflects improved reporting rather than biological change. Most twin calving cases with known month of occurrence were recorded in March and April, consistent with the general spring calving season of Mongolian Bactrian camels. Regional variation was observed; however, overlapping confidence intervals and small event numbers limit definitive interpretation. The subset of records containing calf sex, dam age and parity showed a slightly male-biased sex ratio among twin calves, but no clear association with dam age or parity was evident. The findings are consistent with established reproductive physiology favoring singleton gestation and align with long-standing descriptions in Mongolian livestock literature.

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