

1 **Review Article**

2 **Retrospective Analysis of Officially Confirmed Animal Infectious Disease**
3 **Outbreaks and Pasteurellosis Vaccination Records in East Kazakhstan and**
4 **Abai Regions, Kazakhstan**

5 Running title: Animal disease outbreaks in eastern Kazakhstan

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19 Display items: 3 tables and 2 figures. All figures are original and were generated by the authors from the
20 study data.

21 **Abstract**

22 Official veterinary surveillance records help identify recurrent disease priorities, allocate
23 response resources and document control activities. This retrospective review and synthesis
24 characterized temporal, territorial, etiological, animal-category, seasonal and operational
25 patterns of officially confirmed animal infectious disease outbreaks in East Kazakhstan and
26 Abai regions, Kazakhstan, and summarized available pasteurellosis vaccination records. A
27 cleaned official administrative dataset of 131 unique outbreak records from 2019–2024 was
28 analyzed descriptively and using exploratory Pearson chi-square tests with 10,000 Monte
29 Carlo permutations, Holm correction for four association tests and Cramer's V effect sizes.
30 Administrative concentration was summarized using the Herfindahl-Hirschman index and
31 Gini coefficient. Rabies accounted for 72 records (55.0%), blackleg for 35 (26.7%) and
32 pasteurellosis for 13 (9.9%); together, they represented 91.6% of all records. Annual counts
33 were highest in 2020 (38) and lowest in 2021 (6). After Holm correction, disease profiles
34 differed by animal category (adjusted $p=0.016$; $V=0.31$), administrative group (adjusted
35 $p=0.016$; $V=0.30$) and season (adjusted $p=0.046$; $V=0.27$), but not by reporting year (adjusted
36 $p=0.101$; $V=0.23$). Six administrative units accounted for 76.3% of records ($Gini=0.526$).
37 Response records documented 818,600 m² of disinfection and quarantine periods of 15–60
38 days. The available pasteurellosis archive documented 2.378 million animal-head
39 vaccinations, but it was discontinuous and overlapped the outbreak series only in 2019–2020;
40 therefore, vaccine effectiveness could not be assessed. Rabies, blackleg and pasteurellosis
41 were the dominant recorded priorities. The findings support targeted regional surveillance and
42 coordinated response planning, while the borderline seasonal association, incomplete
43 diagnostic metadata and missing population denominators require cautious interpretation.

44 **Keywords:** Animal Diseases; Disease Outbreaks; Rabies; Pasteurella Infections; Vaccination;
45 Population Surveillance; Kazakhstan

46 1. Context

47 Animal infectious diseases remain a central concern for veterinary services because they
48 affect livestock productivity, food security, animal welfare, trade and, for zoonotic infections,
49 public health. Surveillance is not only a reporting function; it is the structured collection,
50 collation, analysis, interpretation and dissemination of animal-health information for decision-
51 making. International guidance emphasizes that surveillance records should support early
52 detection, risk analysis, emergency preparedness, resource allocation and evaluation of
53 control programs, while laboratory and vaccine standards strengthen comparability of disease-
54 control systems [1-4].

55 These principles are particularly relevant for eastern Kazakhstan. East Kazakhstan and Abai
56 regions include extensive grazing systems, rural settlements, urban and peri-urban interfaces,
57 mountain and steppe landscapes and mixed animal populations. In such settings, livestock
58 diseases, companion-animal infections and wildlife-associated zoonoses may be recorded in
59 the same administrative system. Regional veterinary services therefore need integrated
60 summaries that identify which diseases dominate, where records concentrate, which animal
61 categories are repeatedly involved and what operational response burden accompanies official
62 outbreak registration.

63 Regional literature provides relevant points of comparison. Ishchanova et al. analyzed
64 registered infectious diseases in West Kazakhstan during 2009–2025 and described annual,
65 seasonal and district-level variation [5]. In Abai Region, Bilyalov et al. examined brucellosis
66 surveillance in cattle, small ruminants and carnivores, distinguishing routine screening from
67 risk-enriched diagnostic streams [6]. These studies support comparison of surveillance
68 patterns, but their populations, case definitions and units of observation differ from the
69 outbreak records analyzed here. Their purpose is to contextualize the findings rather than pool
70 outcomes across diseases, regions or surveillance systems.

71 Rabies is a priority example because it is vaccine-preventable but almost invariably fatal after
72 clinical disease appears and requires coordination across veterinary, wildlife and public-health
73 sectors [7,8]. Earlier publications from East Kazakhstan specifically addressed population
74 indicators of rabies and the spread of rabies among animals in relation to human health [9,10].
75 More recent Kazakhstan-wide studies show that rabies has spatial and temporal heterogeneity,
76 involves multiple host categories and remains relevant for cross-border animal-health
77 surveillance [11-13]. Blackleg represents a different cattle-health problem: it is associated
78 with sudden mortality, environmental persistence of *Clostridium chauvoei* and prevention

79 through targeted vaccination and carcass-management practices [14,15]. Pasteurellosis is also
80 important in cattle production because *Pasteurella multocida* and related bacterial respiratory
81 pathogens are influenced by host susceptibility, management stressors and herd-level
82 prevention measures [16,17].

83 Despite disease-specific studies, a practical gap remains at the regional administrative level.
84 Most published analyses do not combine multi-disease outbreak records, district-level burden,
85 response measures and available vaccination archives in the same descriptive framework. At
86 the same time, broad claims about vaccination programs are inappropriate unless disease-
87 specific vaccination records are available. For this reason, the present study separates the
88 2019-2024 outbreak dataset from the available pasteurellosis vaccination archive and avoids
89 causal vaccine-effectiveness interpretation.

90 The objective of this retrospective synthesis was to characterize officially confirmed animal
91 infectious disease outbreaks in East Kazakhstan and Abai regions by year, disease group,
92 administrative unit, animal category, season and recorded response measures; to summarize
93 the available official pasteurellosis vaccination records; and to use exploratory categorical
94 statistics to assess whether the observed distributions differed across animal categories,
95 administrative groups, seasons and reporting years.

96 **2. Data Acquisition**

97 **2.1. Review scope, setting and administrative data sources**

98 This article presents a retrospective review and synthesis of administrative veterinary records,
99 interpreted alongside selected published literature. Its quantitative component is the
100 retrospective observational analysis described below; it is not a systematic literature review or
101 meta-analysis. The cited studies provide contextual comparisons and do not contribute
102 additional outbreak observations to the 131-record dataset.

103 This retrospective observational study used official veterinary surveillance and vaccination
104 records from East Kazakhstan and Abai regions, Kazakhstan. The outbreak dataset covered
105 the 2019-2024 reporting period. The analytical unit was an officially registered disease focus
106 at a specified settlement or location and administrative unit. Source fields included reporting
107 year, administrative unit, location, disease name, affected animal category, decision date or
108 decision number, disinfection area, animals destroyed or compensated, animals vaccinated or
109 sampled during response, vaccine doses, staff involvement and quarantine duration when
110 available.

111 According to the official recording practice applied to these datasets, suspected but
112 unconfirmed events are not entered as outbreaks in final administrative forms. Therefore, the
113 analyzed outbreak records were treated as officially confirmed records. Nevertheless, the
114 study did not have laboratory protocol numbers, test methods or primary laboratory
115 worksheets for every row. Confirmation was therefore interpreted at the level of the official
116 register, not at the level of individual diagnostic protocols.

117 The vaccination archive consisted of available official pasteurellosis vaccination records. In
118 these administrative forms, the number of animals planned for vaccination corresponded to
119 the number vaccinated; planned values were therefore analyzed as implemented official
120 vaccination volumes. The archive contained entries for selected years and did not constitute a
121 continuous annual series. The outbreak and vaccination datasets overlapped only in 2019 and
122 2020. For years without an archived pasteurellosis vaccination entry, absence was treated as
123 missing program information, not as zero vaccination. Depending on the administrative
124 context, a missing entry may indicate that no campaign was scheduled, no outbreak- or risk-
125 based indication was recorded, dedicated funding was not allocated, or the relevant record
126 was not retained; the available files did not permit these explanations to be distinguished.
127 Consequently, no statistical association between vaccination volume and outbreak occurrence
128 was estimated. No corresponding vaccination archives were available in this dataset for
129 rabies, anthrax, blackleg, IBR/BVD or other recorded infections; therefore, vaccination-
130 related interpretation was restricted to pasteurellosis records.

131 **2.2. Data cleaning and variable standardization**

132 Source Excel workbooks were copied before cleaning to preserve the originals. Broken
133 reference cells and formula errors were removed from analytical copies. Duplicate detection
134 was performed at the consolidated-record level using reporting year, disease, administrative
135 unit, location and animal category; one duplicate record was removed. Disease names were
136 standardized into rabies, blackleg, pasteurellosis, IBR/BVD complex and other recorded
137 infections. The last category retained rare or unclear administrative categories as recorded in
138 the official files, including kul and malignant-edema-like disease, because the available tables
139 did not provide sufficient diagnostic detail for further reclassification.

140 Administrative units were standardized by harmonizing spelling, transliteration, typographic
141 variants and district/city variants. Animal categories were standardized across Kazakh and
142 Russian abbreviations. A mixed cattle-horse outbreak was counted once in the total number of

143 outbreaks and retained as a mixed category for animal interpretation; it was also described as
144 cattle-involved because cattle were one of the affected species. This approach avoided double
145 counting while preserving biological meaning.

146 **2.3. Statistical analysis and visualization**

147 Reporting of the observational component was guided by the STROBE recommendations for
148 observational studies [18]. Descriptive statistics were used because the dataset consisted of
149 final administrative records and the primary purpose was to characterize surveillance patterns
150 and response measures rather than test causal hypotheses. Categorical variables were
151 summarized as counts and percentages. Annual dynamics were summarized by disease group.
152 Administrative distribution was visualized as a district/city bar chart because exact outbreak
153 coordinates were unavailable for geospatial mapping. Disinfection was summarized as treated
154 area in square metres. Disinfectant amounts were not summed as a single indicator because
155 source records contained mixed product-specific mass and volume units.

156 To strengthen interpretation, exploratory contingency analyses were performed. A chi-square
157 goodness-of-fit test was used to compare annual totals with an equal-count distribution.
158 Pearson chi-square tests were applied to collapsed contingency tables for disease group by
159 animal category, administrative group, season and reporting year. Because several expected
160 cell counts were below five, p-values for the four association tests were estimated by 10,000
161 Monte Carlo label permutations while preserving marginal totals. The four Monte Carlo p-
162 values were adjusted using Holm's step-down procedure to control the family-wise error rate;
163 both unadjusted and adjusted values are reported. Cramer's V was used as the effect-size
164 measure for categorical association [19,20]. Administrative concentration was summarized
165 using the Herfindahl-Hirschman index and Gini coefficient calculated from standardized
166 district/city counts. Analyses were conducted in Python 3.13.5 using pandas 2.2.3, NumPy
167 2.3.5, SciPy 1.17.0 and reproducible custom permutation code. All inferential analyses were
168 considered exploratory and were not interpreted as evidence of causality.

169 No incidence rates per livestock population were calculated because complete district- and
170 species-specific susceptible-population denominators by year and disease were unavailable.
171 The 2021 annual count was interpreted cautiously because it coincided with the COVID-19
172 pandemic period, during which veterinary-service delivery, animal-disease reporting and field
173 surveillance were disrupted in many settings [21]. Therefore, annual values were treated as
174 descriptive counts from available official records.

3. Result

3.1. Disease composition and annual dynamics

After cleaning, the outbreak database contained 131 unique officially confirmed records for 2019–2024. The annual number of records was 27 in 2019, 38 in 2020, 6 in 2021, 24 in 2022, 13 in 2023 and 23 in 2024. Annual totals varied more than expected under an equal-count assumption (chi-square=28.53, df=5, $p<0.001$), mainly because of the low 2021 value.

However, relative disease composition by reporting year was not distinct in the exploratory contingency table (chi-square=28.52, df=20; Monte Carlo $p=0.101$; Holm-adjusted $p=0.101$; Cramer's $V=0.23$). The 2021 value was therefore interpreted cautiously as a possible surveillance or reporting anomaly as well as a possible epidemiological change.

The disease profile was concentrated in three groups (Table 1; Figure 1). Rabies accounted for 72 records (55.0%), blackleg for 35 records (26.7%) and pasteurellosis for 13 records (9.9%). Together, these three infections represented 120 of 131 records (91.6%). Other recorded infections comprised IBR/BVD complex, kul, malignant-edema-like disease, listeriosis and anthrax.

Table 1. Annual distribution of officially confirmed animal infectious disease outbreaks by disease group, 2019–2024.

Disease group	2019	2020	2021	2022	2023	2024	Total	%
Rabies	10	22	4	11	9	16	72	55.0
Blackleg	12	12	2	5	1	3	35	26.7
Pasteurellosis	4	4	0	3	1	1	13	9.9
IBR/BVD complex	0	0	0	3	0	2	5	3.8
Other recorded infections*	1	0	0	2	2	1	6	4.6
Total	27	38	6	24	13	23	131	100.0

*Other recorded infections include kul, malignant-edema-like disease, listeriosis and anthrax as recorded in official source files. Kul and malignant-edema-like disease were not reclassified beyond the available administrative terminology. IBR, infectious bovine rhinotracheitis; BVD, bovine viral diarrhea.

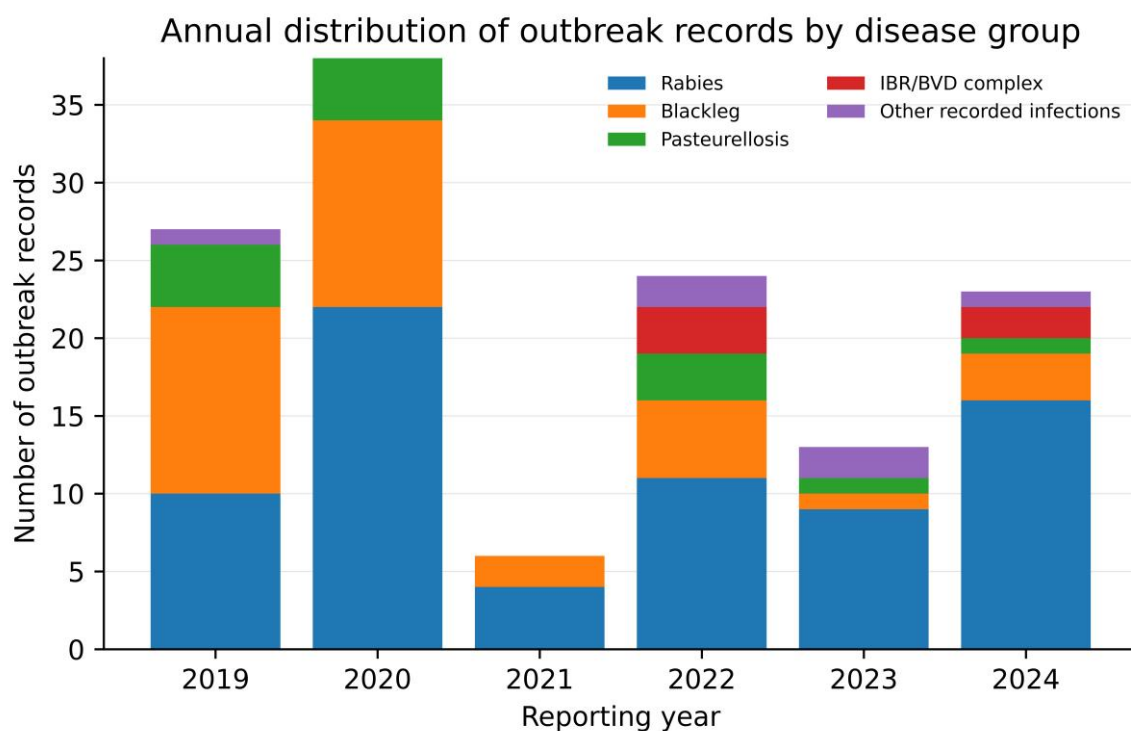


Figure 1. Annual distribution of officially confirmed animal infectious disease outbreak records by major disease group, 2019-2024.

3.2. Administrative and animal-category distribution

After standardization of spelling variants, 17 administrative units were represented. The distribution was concentrated: Semey city accounted for 38 records (29.0%), followed by Ayagoz district/city (15; 11.5%), Tarbagatay district (14; 10.7%), Urzhar district (14; 10.7%), Kokpekty district (11; 8.4%) and Altai district (8; 6.1%). These six units accounted for 100 of 131 records (76.3%). Administrative concentration was moderate to high for an administrative surveillance dataset (Herfindahl-Hirschman index=0.137; normalized HHI=0.083; Gini coefficient=0.526). The disease-by-administrative-group distribution differed in exploratory analysis (chi-square=46.61, df=24; Monte Carlo p=0.005; Holm-adjusted p=0.016; Cramer's V=0.30). District/city counts are shown in Figure 2. A geographic map was not constructed because precise coordinates of individual outbreak foci were unavailable.

Cattle predominated among animal categories. Cattle-only records accounted for 103 outbreaks, and one additional mixed cattle-horse record involved cattle; therefore, cattle were involved in 104 records (79.4%). Carnivore and wild-carnivore records were concentrated in rabies, while blackleg and IBR/BVD complex were recorded only in cattle-involved categories in the cleaned dataset. The disease-by-animal-category table showed an exploratory association (chi-square=25.25, df=8; Monte Carlo p=0.004; Holm-adjusted p=0.016; Cramer's

V=0.31), indicating that host-category profiles differed among disease groups. The mixed cattle-horse record was counted once in the overall total and was not double-counted.

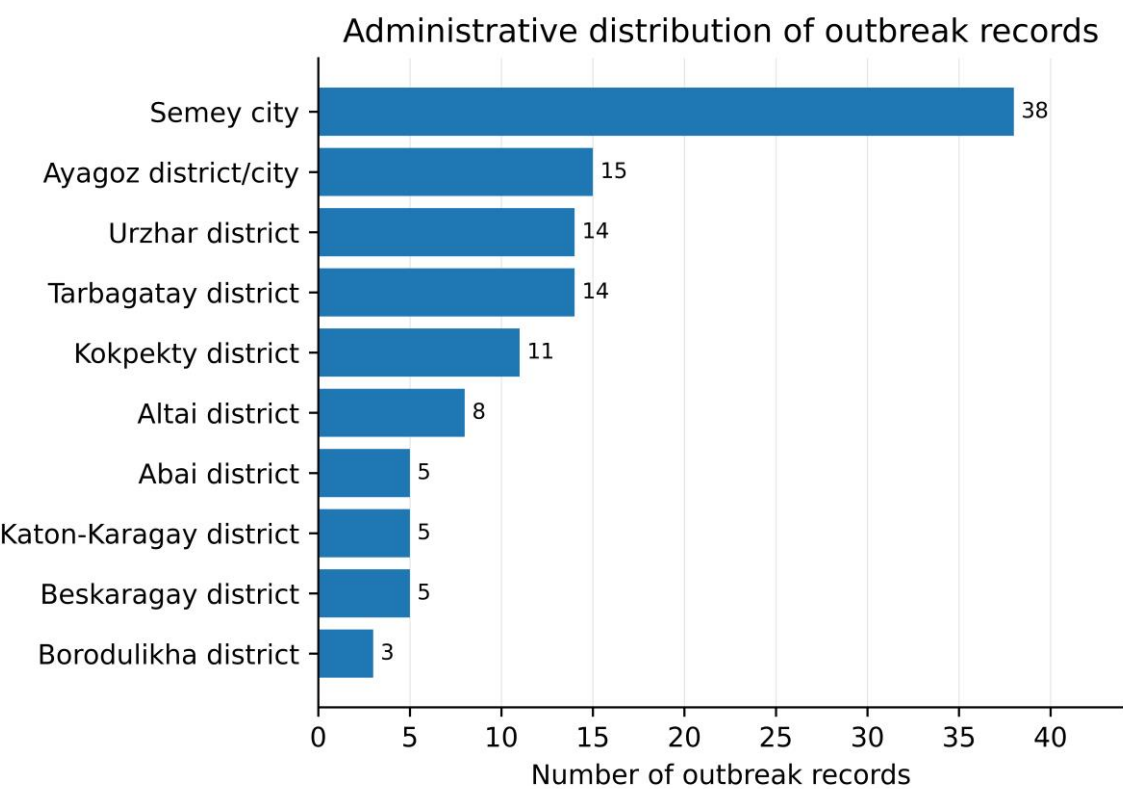


Figure 2. Administrative distribution of officially confirmed animal infectious disease outbreak records after spelling and district/city standardization. The figure shows the 10 highest-count administrative units.

3.3. Seasonality and response measures

Decision dates could be parsed from 104 records. In this subset, rabies records occurred across all seasons, whereas blackleg and pasteurellosis had relatively higher proportions in warm and transitional seasons. The disease-by-season table showed a moderate exploratory association (chi-square=23.10, df=12; Monte Carlo p=0.023; Holm-adjusted p=0.046; Cramer's V=0.27). Because the adjusted value was close to 0.05, some dates were unavailable and administrative decision dates may lag disease onset, this was interpreted as a borderline descriptive signal rather than proof of season-specific incidence.

Response-measure fields were available with variable completeness across disease groups (Table 2). Overall, official response records documented 89 destroyed or culled animals, 81,202 animals vaccinated or sampled during response activities, 82,860 doses, 818,600 m² of disinfection and recorded quarantine durations of 15-60 days. Rabies accounted for 240,021 m² of recorded disinfection, blackleg for 175,193 m², pasteurellosis for 87,736 m² and

233 IBR/BVD complex for 250,250 m². Disinfectant products were not summed as a single total
 234 because source records used mixed mass and volume units.

235 Table 2. Recorded control measures by disease group in official outbreak records.

Disease group	n	%	Destroyed/c ulled animals	Vaccinated or sampled animals	Doses	Disinfection, m ²	Recorded quarantine duration, days
Rabies	72	55.0	62	39,114	39,118	240,021	60
Blackleg	35	26.7	22	5,747	5,747	175,193	15
Pasteurellosis	13	9.9	3	15,843	17,157	87,736	15
IBR/BVD complex	5	3.8	0	10,672	11,012	250,250	30
Other recorded infections*	6	4.6	2	9,826	9,826	65,400	20-30
Total	131	100.0	89	81,202	82,860	818,600	15-60

236 *Other recorded infections include kul, malignant-edema-like disease, listeriosis and anthrax. Disinfectant quantities
 237 were recorded product-wise in mixed mass and volume units and were therefore not aggregated as a single total. n,
 238 number of outbreak records; IBR, infectious bovine rhinotracheitis; BVD, bovine viral diarrhea. Vaccinated or
 239 sampled animals is a combined administrative field, not a vaccination-only count.

240 3.4. Official pasteurellosis vaccination records

241 The available pasteurellosis vaccination archive documented 2,377.8 thousand implemented
 242 animal-head vaccinations (Table 3). Cattle accounted for 1,319.8 thousand animal-head
 243 vaccinations, small ruminants for 720.0 thousand, horses for 136.0 thousand, pigs for 166.0
 244 thousand and marals for 36.0 thousand. Annual totals in the represented records ranged from
 245 108.1 thousand to 707.0 thousand animal-head vaccinations. Only 2019 and 2020 overlapped
 246 the outbreak observation period. The archive was therefore summarized descriptively and was
 247 not used to estimate vaccination effectiveness or a temporal association with outbreak counts.

248 Table 3. Available official pasteurellosis vaccination records by animal category, thousand animal-head
 249 vaccinations.

Year	Cattle	Small ruminants	Horses	Pigs	Marals	Total
2015	255.0	360.0	31.0	56.0	5.0	707.0
2016	255.0	360.0	31.0	56.0	5.0	707.0
2017	0.0	0.0	48.0	54.0	6.1	108.1
2019	309.8	0.0	0.0	0.0	12.7	322.5
2020	500.0	0.0	26.0	0.0	7.2	533.2
Total	1,319.8	720.0	136.0	166.0	36.0	2,377.8

250 Values are thousand animal-head vaccinations. Source planned values were treated as implemented volumes. Only
 251 archived years are shown; years without records represent missing information, not zero vaccination. The outbreak and
 252 vaccination series overlap only in 2019–2020.

3.5. Interpretation of the surveillance dataset

This retrospective synthesis provides a cleaned and statistically strengthened retrospective summary of officially confirmed animal infectious disease outbreak records in East Kazakhstan and Abai regions. The regional archive was dominated by rabies, blackleg and pasteurellosis. This concentration is operationally important because veterinary resources, laboratory readiness and field-response planning can be directed toward a limited number of recurring disease problems while maintaining capacity for rarer infections. After Holm correction, disease distributions remained associated with animal category and administrative group, both with moderate effect sizes. The seasonal association was weaker and close to the adjusted significance threshold, whereas disease composition by reporting year was not distinct. These findings should be regarded as exploratory surveillance patterns rather than causal or population-risk estimates.

The results should be understood as surveillance-record patterns, not population incidence. Without complete susceptible-population denominators, a higher count in one district cannot be interpreted as a higher true risk per animal. It may reflect larger animal populations, stronger detection, more intensive reporting or genuine disease concentration. Nevertheless, from an operational perspective, recorded outbreaks still represent real workload for veterinary services. This is why integrating response variables, such as disinfection area, quarantine duration, vaccination or sampling, culling and compensation, improves the usefulness of the analysis for planning.

3.6. Rabies as the dominant One Health priority

Rabies was the dominant disease group, accounting for more than half of all records. This finding aligns with the One Health importance of rabies in Kazakhstan and with previous studies demonstrating spatial heterogeneity, multi-host involvement and wildlife-domestic animal interfaces in the national rabies situation [7-13]. The presence of cattle, dogs, cats and wild carnivores among rabies-related records is epidemiologically important because it suggests that the regional surveillance system captures events across both livestock and carnivore interfaces.

The high proportion of rabies records does not necessarily mean that rabies incidence is higher than other diseases at population level, because detection probability and reporting requirements differ among diseases. However, it does indicate that rabies generates frequent administrative response events. For veterinary planning, this supports continued coordination

285 between vaccination activities in domestic carnivores, livestock-owner awareness,
286 investigation of wildlife-linked events and rapid post-detection response. District-level
287 concentration further suggests that local animal-density, waste-management, free-roaming
288 dog and wildlife-contact factors should be evaluated in future studies.

289 **3.7. Blackleg and pasteurellosis as cattle-health priorities**

290 Blackleg was the second most frequent disease group and was recorded almost entirely as a
291 cattle-involved problem. This is biologically plausible because blackleg is a highly fatal
292 clostridial disease of cattle associated with environmental persistence of *C. chauvoei* spores,
293 sudden death and prevention through vaccination and carcass-management measures [14,15].
294 The present regional findings are also consistent with recent national evidence that blackleg
295 remains relevant in Kazakhstan and has regional and seasonal heterogeneity [15].

296 Pasteurellosis represented a smaller proportion of outbreak records but accounted for
297 substantial implemented vaccination volumes in the available archive. Previous Kazakhstan
298 research identified East Kazakhstan among territories with notable pasteurellosis spread and
299 emphasized epizootic zoning and veterinary-sanitary measures [16]. Broader literature on
300 *Pasteurella multocida* and bovine respiratory disease shows that pasteurellosis-related
301 problems are shaped by pathogen biology, host immunity and management stressors [17]. The
302 present study places pasteurellosis within a wider multi-disease administrative archive while
303 explicitly separating pasteurellosis vaccination records from vaccination data for other
304 diseases. Because the vaccination series was discontinuous and overlapped the outbreak series
305 only in 2019–2020, the observed vaccination volumes cannot be interpreted as explaining
306 annual outbreak counts or as evidence of vaccine effectiveness.

307 Farm-level reports add clinical and laboratory context without establishing regional incidence.
308 Mukataev et al. described clinical and pathological manifestations of bovine pasteurellosis in
309 the Beskaragai district [22]. A subsequent report from a cattle farm in Abai Region described
310 recovery of *Pasteurella multocida* and associated bacterial microflora from affected animals
311 [23]. These observations complement the administrative archive, but cannot establish the
312 effectiveness of its recorded vaccination activities or be counted as additional outbreak
313 records.

314 **3.8. Administrative concentration, seasonality and the 2021 anomaly**

315 The administrative concentration indices quantify a pattern that was also visually apparent.
316 Six administrative units accounted for more than three quarters of all records, and the Gini

coefficient indicated uneven territorial distribution. The disease-by-administrative-group association remained statistically detectable after Holm correction, suggesting that disease profiles were not simply proportional across the collapsed administrative groups. However, because exact coordinates and population denominators were unavailable, these findings should guide targeted review and resource planning rather than be interpreted as formal spatial risk clusters.

Earlier work by Toleuova and Bilyalov, using veterinary statistics for 2016–2018, also described differences in bovine brucellosis findings between rural districts within Urzhar [24]. This is a disease-specific historical comparison rather than evidence that the present territorial distribution has the same causes. In particular, brucellosis serological findings and officially registered multi-disease outbreak foci are different surveillance outcomes.

Seasonal analysis added useful but less robust information. The disease-by-season association remained just below the 0.05 threshold after Holm correction (adjusted $p=0.046$) and had a moderate effect size. This signal is sensitive to incomplete dates, the use of administrative decision dates rather than onset dates and the four-test multiplicity framework. It may help frame hypotheses about field preparedness and vaccination timing, but it requires confirmation in a dataset with complete onset dates, denominators and prospectively defined seasonal comparisons.

The sharp decrease in 2021 requires caution. It may reflect a true reduction in recorded outbreaks, but it may also partly reflect pandemic-period disruption of surveillance and reporting. International assessments during COVID-19 documented negative impacts on veterinary-service delivery, field surveillance and animal-disease reporting [21]. Therefore, the 2021 count should not be used alone to infer sustained epidemiological improvement. This point is important because the surrounding years showed substantially higher counts.

3.9. Strengths, limitations and recommendations

The strengths of this study include use of official records, multi-year coverage, multi-disease scope, district-level standardization, explicit separation of outbreak data from disease-specific vaccination archives and addition of exploratory categorical statistics with effect sizes. The study also retained operational response variables that are often omitted from descriptive outbreak summaries but are important for service planning.

Several limitations should be considered. First, the study used final official administrative records rather than primary laboratory worksheets. Records were treated as officially

349 confirmed because unconfirmed events are not registered as outbreaks in final forms;
350 however, individual laboratory protocol numbers and diagnostic methods were unavailable for
351 every analytical row. Second, the low 2021 count may have been influenced by pandemic-
352 period disruption of veterinary services, field visits and reporting. Third, the pasteurellosis
353 vaccination archive was discontinuous and temporally mismatched with the outbreak series:
354 only 2019 and 2020 overlapped. An unrepresented year could indicate that no campaign was
355 scheduled, no outbreak- or risk-based indication was recorded, dedicated funds were not
356 allocated, or the record was not retained; these alternatives could not be distinguished.
357 Missing entries were therefore not treated as zero, and no vaccination-effectiveness or
358 outbreak-association analysis was undertaken. Fourth, vaccination findings cannot be
359 generalized to rabies, blackleg, anthrax or other diseases. Fifth, complete denominators by
360 animal species, year and district were unavailable, preventing incidence-rate estimation.
361 Sixth, exact geographic coordinates were absent, so the administrative bar chart is not a
362 spatial cluster analysis. Finally, the contingency tests used collapsed categories and were
363 exploratory. Holm correction controlled family-wise multiplicity across four association tests,
364 but the seasonal result remained close to the significance threshold and should be interpreted
365 as the least robust of the adjusted findings.

366 Diagnostic-method documentation is also relevant to interpretation. Bulashev et al. evaluated
367 combined recombinant periplasmic proteins BP26 and superoxide dismutase for
368 supplementary serological diagnosis of bovine brucellosis [25]. This provides a specific
369 example of diagnostic evaluation in Kazakhstan, not validation of the outbreak diagnoses in
370 the present archive. The sensitivity or specificity reported for that assay cannot be transferred
371 to these administrative records.

372 Although anthrax was infrequent in the present archive, earlier regional work described the
373 epizootiological situation of anthrax in East Kazakhstan and Pavlodar regions [26]. This
374 historical regional evidence supports retaining low-frequency but high-consequence infections
375 within surveillance and preparedness frameworks; it does not imply that anthrax burden in the
376 present 2019–2024 dataset was high.

377 The most valuable next step would be a unified digital surveillance dataset linking each
378 confirmed outbreak to laboratory protocol metadata, disease-specific test method, animal
379 population denominator, geographic coordinates, vaccination history, date of suspicion, date
380 of confirmation and date of quarantine release. Such a dataset would allow incidence
381 estimation, spatial cluster detection, time-to-response analysis and formal evaluation of

382 vaccination programs. Until then, the present cleaned archive provides a practical baseline for
383 regional veterinary prioritization.

384 **4. Conclusion**

385 Official veterinary records supported a retrospective observational analysis of 131 officially
386 confirmed animal infectious disease outbreaks in East Kazakhstan and Abai regions during
387 2019–2024. Rabies, blackleg and pasteurellosis dominated the recorded profile. After Holm
388 correction, disease distribution remained associated with animal category and administrative
389 group; the seasonal association was borderline, and disease composition did not differ
390 significantly by reporting year. Six administrative units accounted for most records, and cattle
391 were the principal animal category involved. The available pasteurellosis archive documented
392 approximately 2.38 million implemented animal-head vaccinations, but it represented selected
393 years and overlapped the outbreak series only in 2019–2020. It should therefore be interpreted
394 as a descriptive record of pasteurellosis prevention activity, not as evidence of vaccine
395 effectiveness. The findings support continued rabies surveillance at wildlife-domestic animal-
396 settlement interfaces, district-prioritized blackleg prevention in cattle, targeted pasteurellosis
397 planning and improved integration of laboratory metadata, vaccination records, animal-
398 population denominators and geographic coordinates in regional veterinary information
399 systems.

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402 involved in maintaining official outbreak and vaccination records in East Kazakhstan and
403 Abai regions.

404 **Authors' Contributions**

405 A.M. contributed to the study concept and design, veterinary and epizootiological
406 interpretation, validation of disease-control terminology, and critical revision of the
407 manuscript. E.B. contributed to data acquisition and curation, interpretation of official
408 veterinary records, manuscript preparation, and correspondence with the journal. D.M.
409 contributed to methodological verification, statistical interpretation, drafting of the
410 manuscript, and critical revision. A.K. contributed to data cleaning, tabulation, data
411 visualization, and verification of numerical consistency. Y.S. contributed to the literature
412 review, reference verification, and manuscript editing. All authors read and approved the final
413 version of the manuscript.

414 **Ethics Approval**

415 Not applicable. This study used retrospective official administrative veterinary records and
416 did not involve experimental animal procedures, owner-level personal data or direct animal
417 handling by the authors.

418 **Conflict of Interest**

419 The authors declare no conflict of interest.

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422 not-for-profit sectors.

423 **Data Availability**

424 Aggregated data supporting the findings are included in the manuscript tables and figures.
425 The cleaned analytical dataset may be made available by the corresponding author upon
426 reasonable request, subject to permission from the relevant veterinary authority and
427 institutional data-sharing rules.

428 **AI-Assisted Drafting Declaration**

429 The authors declare that no Gen AI/DeepSeek was used in the writing/creation of this
430 manuscript. The authors reviewed, edited and verified the content and remain fully responsible
431 for all data, analyses, interpretations, references and declarations in the final submitted
432 manuscript.

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