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Research Article

African Horse Sickness Distribution and Vaccination Coverage in North Shewa Zone, Ethiopia: A 5-Year Retrospective Study (2019–2025)

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Abstract

African horse sickness (AHS) is a severe, vector-borne viral disease of equids associated with high mortality and substantial socioeconomic losses. However, regional epidemiological evidence from Ethiopia remains limited. This study aimed to describe the temporal, seasonal, and spatial distribution of reported AHS outbreaks and assess vaccination coverage in North Shewa Zone, Ethiopia. A retrospective descriptive study was conducted using Disease Outbreak and Vaccination Activity Report (DOVAR) records from 23 districts for the period 2019–2025. Outbreak occurrence, morbidity, mortality, case fatality rate (CFR), temporal and seasonal patterns, spatial distribution, and vaccination coverage were summarized using descriptive statistics. A total of 29 outbreaks were reported in 15 of the 23 districts, involving 21,461 equids at risk. Overall, 302 cases and 217 deaths were recorded, corresponding to a morbidity rate of 1.41%, mortality rate of 1.01%, and CFR of 71.85%. Outbreak occurrence varied considerably over time, with 21 outbreaks (72.4%) reported in 2024. All reported cases occurred during the post-rainy season, with September and October accounting for 97.4% of cases and 98.6% of deaths. Siyader Wayu District recorded the highest numbers of outbreaks, cases, and deaths. Outbreak-response vaccination coverage reached 97.6%, while routine prophylactic vaccination coverage increased from 35.2% in 2019 to 78.7% in 2025. In conclusion, reported AHS occurrence showed substantial temporal and spatial variation, with a high CFR among affected equids and a marked concentration of cases during September and October. Strengthening pre-emptive vaccination before the high-risk season, seasonal surveillance, and laboratory confirmation is recommended to improve early detection and disease control.

Keywords

African Horse Sickness, Case Fatality Rate, North Shewa Zone, Retrospective Surveillance, Vaccination Coverage

1. Introduction

African horse sickness (AHS) is a highly infectious, non-contagious, arthropod-borne viral disease of equids caused by African horse sickness virus (AHSV), a member of the genus *Orbivirus* within the family *Sedoreoviridae*. The disease affects all equid species, although horses are particularly susceptible to severe clinical disease, whereas donkeys and zebras generally experience milder or subclinical infections[1, 2] Clinical manifestations include fever, respiratory distress, pulmonary edema, hemorrhage, and circulatory disturbances,

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with disease severity influenced by viral serotype, host species, and immune status. In susceptible horses, pulmonary and mixed forms can result in very high case-fatality rates, making AHS an important transboundary animal disease [2].

AHSV is transmitted primarily by infected *Culicoides* biting midges, particularly *Culicoidesimicola* and other competent vector species. Consequently, the occurrence of AHS is strongly influenced by environmental and climatic conditions that affect vector abundance, distribution, and transmission dynamics [3]. The epidemiology of AHS is characterized by pronounced temporal, seasonal, and spatial variation, reflecting interactions between environmental conditions and the ecology of its *Culicoides* vectors. Climatic factors, including rainfall, temperature, humidity, and vegetation, influence the abundance, distribution, and seasonal activity of *Culicoides* and may consequently affect the timing and geographic occurrence of AHS [4, 5] In Ethiopia, the distribution and habitat suitability of *Culicoidesimicola*, an important AHS vector, have been associated with agro-ecological conditions, particularly temperature, rainfall, and livestock-related environmental characteristics [6]. In Northwest Ethiopia, *Culicoides* abundance also varies significantly across seasons and geographic locations, with higher abundance during the wet season [7] These ecological patterns may contribute to heterogeneity in AHS occurrence and transmission risk across time and space. Therefore, characterizing temporal, seasonal, and spatial patterns is essential for identifying high-risk periods and areas and for strengthening surveillance, early-warning systems, and risk-based preventive measures, including appropriately timed vaccination [4, 7]

AHS has substantial socioeconomic importance in Ethiopia, where equids are essential for transportation, agricultural activities, and rural livelihoods. Equid-based transport and draft services contribute an estimated US$1.2 billion annually to the national economy [8] AHS outbreaks can therefore cause significant economic losses through animal mortality, reduced working capacity, disease-control costs, and movement or trade restrictions. Investment in effective vaccination has been shown to reduce these losses and provide important economic benefits, particularly for communities dependent on working equids [9] Strengthening surveillance, timely vaccination, and preventive control measures is consequently essential to minimize the socioeconomic impact of AHS.

Ethiopia has a large equine population, with horses, donkeys, and mules playing important roles in transportation, agricultural production, rural mobility, and household livelihoods [10] The country's diverse agro-ecological conditions, together with the distribution and seasonal activity of *Culicoides* vectors, may contribute to spatial and temporal variation in the occurrence of African horse sickness (AHS) [7]. Recent evidence from Central Gondar further demonstrates substantial exposure to AHS virus among equids, highlighting the continuing importance of the disease in Ethiopia [11] Vaccination therefore remains a key preventive measure, and effective disease control requires adequate vaccination coverage and appropriate timing to protect equid populations before periods of increased transmission risk.

North Shewa Zone of the Amhara Region encompasses diverse agro-ecological settings and supports a substantial population of horses, donkeys, and mules that are important for transportation, agricultural activities, and rural livelihoods. Recent studies in Ethiopia continue to demonstrate substantial exposure to AHS virus among equids and emphasize the importance of strengthened surveillance and vaccination, while also indicating that epidemiological information remains limited in several areas [11, 12]. Despite the importance of equids in North Shewa and the potential impact of AHS, systematic information on the temporal trends, seasonal occurrence, spatial distribution, and vaccination coverage of reported AHS in the zone remains limited.

Routine animal disease surveillance records provide an important source of epidemiological information for monitoring disease occurrence and evaluating control measures. Retrospective analysis of these records can characterize temporal and seasonal patterns, identify affected geographic areas, and assess vaccination coverage. Such analyses can help identify high-risk periods and locations, strengthen surveillance and early-warning systems, improve vaccination planning, and support evidence-based allocation of limited disease-control resources [13].

Despite the importance of equids to rural communities in North Shewa Zone, the epidemiology of reported African horse sickness during 2019–2025 has not been adequately characterized. In particular, the temporal, seasonal, and spatial patterns of reported disease and the extent of vaccination coverage have not been systematically consolidated and evaluated. Addressing this information gap is important for understanding the reported disease burden and distribution and for identifying areas and periods requiring strengthened surveillance, preventive vaccination, and preparedness [12, 13].

Therefore, this study aimed to characterize the epidemiology of reported African horse sickness in North Shewa Zone, Ethiopia, during 2019–2025, with particular emphasis on temporal, seasonal, and spatial patterns and vaccination coverage. The findings are expected to provide epidemiological evidence to support risk-based surveillance, timely vaccination, preparedness, and improved prevention and control of AHS in the zone.

1.1. Problem Statement

African horse sickness (AHS) is a severe, vector-borne viral disease of equids that can cause substantial morbidity and mortality, with important socioeconomic consequences for communities that depend on horses, donkeys, and mules for transportation and livelihoods. Its occurrence is influenced by vector activity, climatic conditions, seasonality, and ecological factors, resulting in considerable temporal and spatial variation in disease risk.

In North Shewa Zone, equids play an important role in rural

livelihoods and transportation. However, epidemiological information on the magnitude, temporal and seasonal patterns, and spatial distribution of reported AHS remains limited. Although routine surveillance records provide an important source of historical disease information, these data have not been systematically analyzed to characterize the epidemiological patterns of AHS in the zone.

This information gap may constrain the identification of high-risk periods and locations and limit evidence-based prioritization of surveillance, vaccination, preparedness, and control interventions. Therefore, a retrospective analysis of available surveillance records is needed to characterize the temporal, seasonal, and spatial epidemiology of reported AHS in North Shewa Zone and provide evidence to strengthen risk-based surveillance, prevention, and control strategies.

1.2. Rationale of the Study

African horse sickness (AHS) is a severe, vector-borne viral disease of equids, particularly horses, and can cause high morbidity and mortality. In Ethiopia, AHS has been reported across different regions, with marked temporal and geographic variation. Retrospective surveillance data have demonstrated substantial annual variation in outbreaks, with disease occurrence particularly concentrated during September–December. Multiple AHSV serotypes, including AHSV-2, AHSV-4, AHSV-6, AHSV-8, and AHSV-9, have also been identified in Ethiopia [14, 15]

Serological evidence further indicates widespread exposure to AHSV among equids in Ethiopia. In West Amhara, an AHSV seroprevalence of 57.4% was reported among mules and donkeys [16]while a recent study in Central Gondar reported an 80.7% seroprevalence among equids [11].

1.3. General Objective

To assess the epidemiological characteristics and distribution of reported African horse sickness (AHS) in North Shewa Zone, Amhara Region, Ethiopia, using retrospective animal disease surveillance data.

1.4. Specific Objectives

To determine the temporal and seasonal distribution of reported African horse sickness cases in North Shewa Zone during the study period (2019–2025).

To assess the spatial distribution of reported African horse sickness cases among districts of North Shewa Zone during the study period.

To assess African horse sickness vaccination coverage and describe its relationship with the occurrence of reported cases.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in North Shewa Zone, Amhara Region, central Ethiopia, approximately 130 km northeast of Addis Ababa. The zone covers an area of approximately 16,172.52 km² and encompasses diverse agro-ecological conditions, ranging from lowland to highland areas at elevations of approximately 1,290–3,000 m above sea level. The predominant production system is mixed crop livestock farming. These diverse environmental and production conditions support a substantial equine population and may influence the occurrence and spatial distribution of African horse sickness (AHS).

North Shewa has an established animal health service network comprising 23 district veterinary clinics and 343 veterinary posts, providing broad coverage for animal disease surveillance, outbreak investigation, vaccination, disease reporting, and control activities. The zone has an estimated 455,469 equids, in addition to approximately 2,403,688 cattle, 1,297,577 sheep, 1,061,654 goats, and 21,756 camels. The relatively large equine population and established veterinary service infrastructure make North Shewa an important setting for assessing the temporal, seasonal, and spatial patterns of reported AHS and vaccination coverage.

2.2. Study Design

A retrospective descriptive surveillance study was conducted using secondary data on African horse sickness (AHS) reported in North Shewa Zone, Ethiopia, from 2019 to 2025. Data were extracted from the Disease Outbreak and Vaccination Activity Report (DOVAR) database maintained by the Livestock and Fishery Resource Department of North Shewa Zone. The study characterized the temporal, seasonal, and spatial distribution of reported AHS outbreaks and affected equid populations and assessed AHS vaccination activities and coverage among equids during the study period.

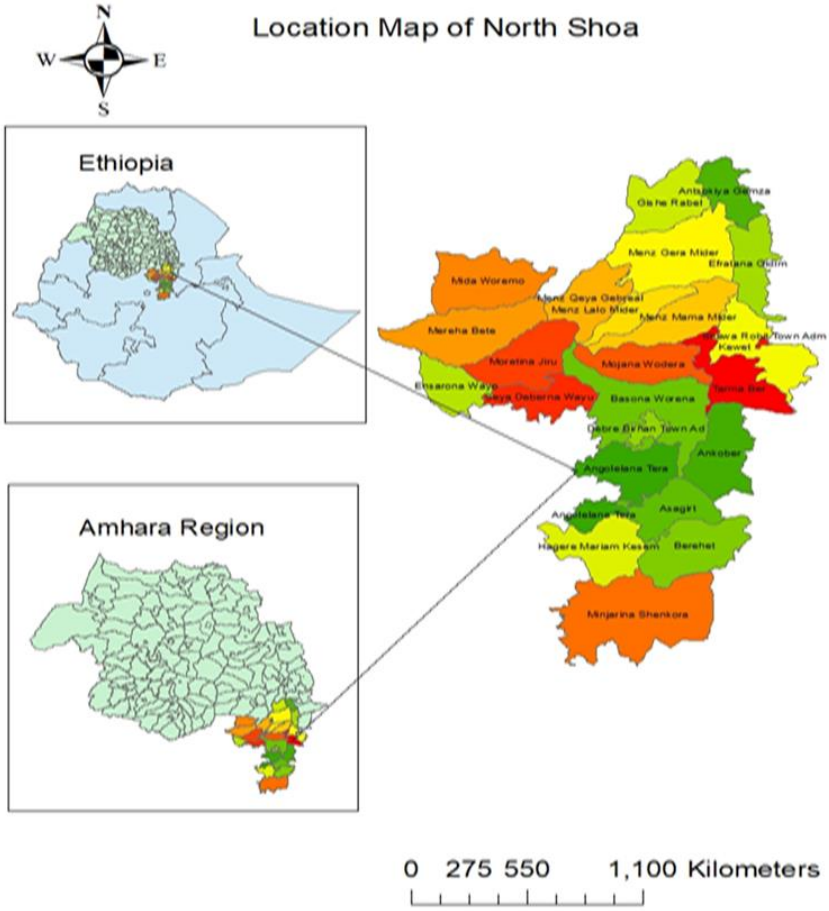

Figure 1. *Map of the study area showing districts of North Shewa Zone, Amhara Region, Ethiopia.*

2.3. Source and Study Population

The source population comprised domestic equids, primarily horses, donkeys, and mules, reared in the 23 districts of North Shewa Zone, Amhara Region, Ethiopia, during 2019–2025. The study population comprised all AHS outbreak records reported through the DOVAR system during the study period. Records containing relevant epidemiological information, including district, outbreak date, affected equid species, number of cases, deaths, and animals at risk, were eligible for analysis. Duplicate, incomplete, or unverifiable recordswere excluded from the analysis.

2.4. Data Collection and Analysis

AHS outbreak and vaccination data were extracted from the DOVAR database using a standardized data extraction format. The variables extracted included district, outbreak date, affected equid species, number of outbreaks, cases, deaths, animals at risk, and number of vaccinated animals. Annual equid population estimates were obtained from the Livestock and Fishery Resource Department of North Shewa Zone and were used to calculate relevant epidemiological indicators and vaccination coverage.

The data were entered, cleaned, coded, and checked for completeness and consistency using Microsoft Excel. Descriptive analyses included frequencies, proportions, morbidity, mortality, case fatality rate (CFR), outbreak occurrence, and vaccination coverage. Morbidity, mortality, and CFR were calculated using the number of cases, deaths, and animals at risk, as appropriate. Vaccination coverage was calculated based on the number of animals vaccinated relative to the estimated target equid population. Temporal, seasonal, and spatial patterns of reported AHS outbreaks, cases, deaths, and vaccination activities were summarized using tables, graphs, and maps.

3. Result

3.1. Temporal Distribution

Across the 23 districts and 374 peasant associations (PAs) included in the study area, a total of 29 African horse sickness (AHS) outbreaks were reported during the seven-year study period (2019–2025), corresponding to an overall outbreak occurrence of 7.75%**.** The annual distribution of outbreaks varied considerably across the study period. The highest number of outbreaks was recorded in 2024**,** with 21 outbreaks (72.4%)

and an outbreak occurrence of 5.61%, followed by 2025, with four outbreaks (13.8%) and an occurrence of 1.07%. In contrast, 2021 recorded the lowest number of outbreaks among the years in which outbreaks were reported, with one outbreak (3.5%) and an occurrence of 0.27%. No AHS outbreaks were reported in 2019, 2020, or 2023. Overall, the temporal distribution showed an irregular pattern, with a marked increase in the number and occurrence of outbreaks in 2024 compared with the preceding years (Table 1).

Table 1. Annual distribution of African Horse Sickness outbreaks (2019–2025).

Year	Number of Outbreaks	Outbreaks occurrence (%)	Proportion of total Outbreaks (%)
2019	0	0	0
2020	0	0	0
2021	1	0.27	3.5
2022	3	0.80	10.3
2023	0	0	0
2024	21	5.61	72.4
2025	4	1.07	13.8
Total	29	7.75	100

3.2. Epidemiological Measures AHS Morbidity, Mortality, and Fatality Rate Across Years

Across the seven-year study period (2019–2025), 302 cases and 217 deaths were reported among21,461 animals at risk, corresponding to an overall morbidity rate of 1.41%, mortality rate of 1.01%, and case fatality rate (CFR) of 71.9%. No cases were reported in 2019, 2020, or 2023. Cases were first reported in 2021 and increased substantially thereafter, with the highest numbers of cases (253) and deaths (187) recorded in 2024.

In contrast, 2025 recorded the highest morbidity (2.56%) and mortality (1.73%) rates, despite a smaller population at risk. The CFR remained high in all years with reported cases, ranging from 46.7% to 73.91%, indicating severe outcomes among reported cases. Overall, the findings demonstrate substantial temporal variation in disease occurrence, with a marked increase in disease burden during 2024–2025. The absence of reported cases in some years should be interpreted cautiously, as it may reflect variations in surveillance and reporting in addition to true differences in disease occurrence (Table 2).

Table 2. AHS morbidity, mortality, and fatality rate across years in the North Shewa zone, Ethiopia, from 2019 to 2025.

Year	Population at risk	Number of case	Number of Death	Morbidity rate (%)	Mortality rate (%)	Case Fatality rate (%)
2019	0	0	0	0	0	0
2020	0	0	0	0	0	0
2021	390	3	2	0.77	0.51	66.67
2022	2550	15	7	0.59	0.27	46.7
2023	0	0	0	0.0	0.0	0.0
2024	17308	253	187	1.46	1.08	73.91
2025	1213	31	21	2.56	1.73	67.7
Total	21,461	302	217	1.41	1.01	71.9

3.3. Monthly and Seasonal Distribution of AHS

A total of 302 cases and 217 deaths were reported during the study period. Disease occurrence was confined to the early dry/cold season (September–November), with no cases or deaths recorded during the long rainy, short rainy, or dry/hot seasons, or from January to August and in December. September and October accounted for 294 cases (97.4%) and 214 deaths (98.6%), respectively, while November recorded only 8 cases and 3 deaths. The highest case fatality rate (CFR) was observed in October (84.7%), followed by September (61.3%) and November (37.5%). Overall, the early dry/cold season accounted for all reported cases and deaths, with an overall CFR of 71.9% (217/302), and October showing the greatest disease burden and fatality. (Table 3 and Table 4)

Table 3. AHS Case, Death and CFR by Month.

Monthly distribution	No. of Case	No. of Death	CFR %
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0	0
May	0	0	0
June	0	0	0
July	0	0	0
August	0	0	0
September	150	92	61.3
October	144	122	84.7
November	8	3	37.5
December	0	0	0
TOTAL	302	217	71.9

Table 4. Seasonal Distribution of AHS Cases, Deaths, and Case Fatality Rate (CFR) in North Shewa Zone (2019–2025).

Season	Total Number of Cases	Total Number of death	CFR %
Long rainy (June-August)	0	0	0
short rainy(march-May)	0	0	0
Post-rainy (September -November)	302	217	71.5
Dry/hot (December-February)	0	0	0
Total	302	217	71.9

3.4. Spatial Distribution of AHS Outbreaks, Cases, and Deaths

A total of 29 AHS outbreaks were reported in 15 of the 23 districts of North Shewa Zone during the study period, while the remaining eight districts had no reported AHS outbreaks. Considerable spatial variation in disease occurrence and mortality was observed across districts. Overall, 29 outbreaks, 302 cases, and 217 deaths were reported, corresponding to an overall case fatality rate (CFR) of 71.9%.

SiyaderWayu recorded the highest number of outbreaks, with seven outbreaks, and accounted for the largest proportion of cases (91; 30.1%) and deaths (78; 35.9%), with a CFR of

85.7%. Gishi recorded four outbreaks involving 27 cases (8.9%) and 25 deaths (11.5%), with a CFR of 92.6%, whereas BassonaWorena recorded three outbreaks, 26 cases (8.6%), and 21 deaths (9.7%), with a CFR of 80.8%.

Other districts also demonstrated notable differences in disease burden and fatality. Menz Lalo recorded three outbreaks and the second-highest number of cases after SiyaderWayu, with 28 cases (9.3%) and 18 deaths (8.3%), resulting in a CFR of 64.3%. Anegollela reported two outbreaks involving 25 cases (8.3%) and 23 deaths (10.6%), with a CFR of 92.0%. Hagermariam recorded one outbreak involving 22 cases (7.3%) and 18 deaths (8.3%), resulting in a CFR of 81.8%. In contrast, Minjar reported 39 cases (12.9%) from a single outbreak but only 10 deaths (4.6%), yielding a comparatively low CFR of 25.6%. Similarly, Menz Gera recorded three outbreaks, involving 17 cases (5.6%) and five deaths (2.3%), with a CFR of 29.4%, the lowest among districts reporting multiple outbreaks.

The highest CFRs were observed in Kewot (100%), Gishi (92.6%), Anegollela (92.0%), and Asagirt (91.7%). However, the CFR estimate for Kewot was based on only two cases and should therefore be interpreted cautiously. Moretena Jeru recorded four cases with no reported deaths, corresponding to a CFR of 0%.

Overall, the findings demonstrate a markedly heterogeneous spatial epidemiological pattern, characterized by a concentration of outbreaks and cases in a subset of districts and substantial inter-district variation in fatality. These differences may reflect variation in disease exposure, equid populations, outbreak detection and reporting, access to veterinary services, timeliness of intervention, and case management. However, these potential determinants could not be established from the available retrospective surveillance data and require further epidemiological investigation (Table 5 and Figure 2).

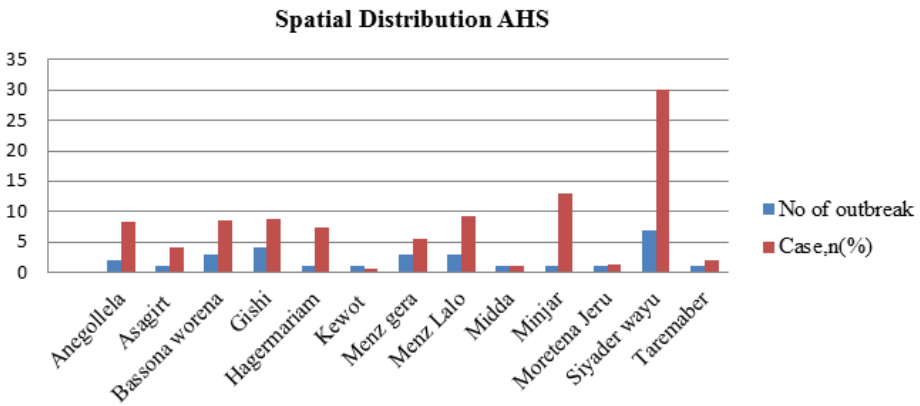

Figure 2. Spatial distribution AHS in North Shewa Zone.

Table 5. Spatial Distribution of Reported AHS Outbreaks.

District	No. of outbreaks	Cases, n (%)	Deaths, n (%)	CFR (%)
Anegollela	2	25(8.3)	23(10.6)	92
Asagirt	1	12(4.0)	11(5.1)	91.7
Bassonaworena	3	26(8.6)	21(9.7)	80.8
Gishi	4	27(8.9)	25(11.5)	92.6
Hagermariam	1	22(7.3)	18(8.3)	81.8
Kewot	1	2(0.7)	2(0.9)	100
Menzgera	3	17(5.6)	5(2.3)	29.4
Menz Lalo	3	28(9.3)	18(8.3)	64.3
Midda	1	3(1.0)	2(0.9)	66.7
Minjar	1	39(12.9)	10(4.6)	25.6
Moretena Jeru	1	4(1.3)	0(0)	0
Siyaderwayu	7	91(30.1)	78(35.9)	85.7

District	No. of outbreaks	Cases, n (%)	Deaths, n (%)	CFR (%)
Taremaber	1	6(2.0)	4(1.8)	66.7
Total	29	302 (100.0)	217 (100.0)	71.9

3.5. Annual AHS Outbreaks, Outbreak Response, and Prophylactic Vaccination Coverage

During 2019–2025, a total of 29 AHS outbreaks were reported in 15 districts, affecting 21,461 animals at risk. Outbreak occurrence showed marked temporal and spatial variation, with no outbreaks reported in 2019, 2020, or 2023. The highest disease occurrence was observed in 2024, when 21 outbreaks (72.4%) were reported across 11 districts, involving 17,308 animals at risk. This was followed by a substantial decline in 2025, when four outbreaks were reported in two districts, involving 1,213 animals at risk.

Outbreak-response vaccination coverage was high, reaching 97.6% overall and 98.8% in 2024. Concurrently, routine control and prophylactic vaccination coverage increased from 35.2% in 2019 to 78.7% in 2025. The marked reduction in reported outbreaks following the 2024 epidemic coincided with intensified vaccination activities and may indicate a potential contribution of increased population immunity to disease control. However, this temporal association does not establish a causal effect of vaccination. The occurrence of outbreaks despite high reactive vaccination coverage highlights the importance of sustained preventive vaccination, risk-based targeting of high-risk areas, timely surveillance, and pre-emptive vaccination to reduce the risk of future outbreaks (Table 6 and Figure 3).

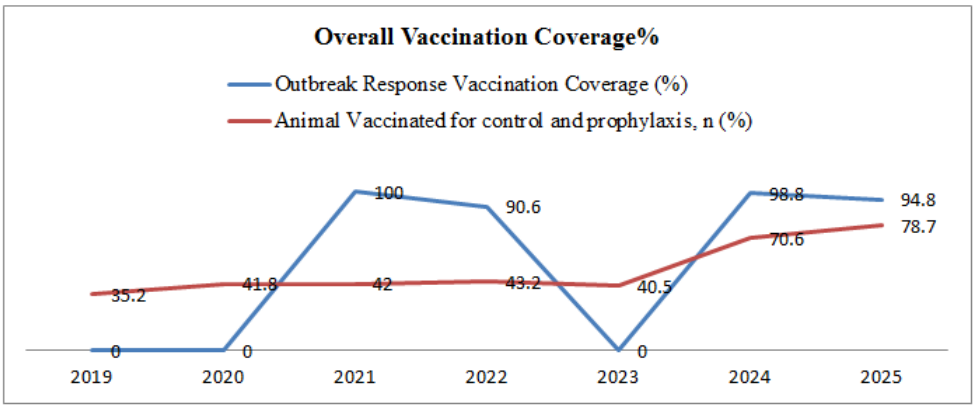

Figure 3. *AHS outbreaks response and prophylactic vaccination coverage in Equids, North Shewa Zone, Ethiopia, 2019–2025.*

Table 6. *Annual distribution of AHS outbreaks and vaccination activities in North Shewa Zone, Amhara Region, Ethiopia, 2019–2025.*

Year	No. of Outbreaks	Affected Districts, n	Animal at risk, n	Animals Vaccinated During Outbreak Response (n)	Outbreak Response Vaccination Coverage (%)	Animal Vaccinated for control and prophylaxis, n (%)
2019	0	0	0	0	0	160,252 (35.2%)
2020	0	0	0	0	0	190,168 (41.8%)
2021	1	1	390	390	100	191,403 (42.0%)
2022	3	1	2,550	2,310	90.6	196,905 (43.2%)
2023	0	0	0	0	0	184,352(40.5%)
2024	21	11	17,308	17,100	98.8	321,543(70.6%)
2025	4	2	1,213	1,150	94.8	358,551(78.7%)

Year	No. of Outbreaks	Affected Districts, n	Animal at risk, n	Animals Vaccinated During Outbreak Response (n)	Outbreak Response Vaccination Coverage (%)	Animal Vaccinated for control and prophylaxis, n (%)
Total	29	15	21,461	20,950	97.6	1,603,174

Abbreviations: n, number of animals. Outbreak response vaccination coverage was calculated as the number of animals vaccinated during outbreak response divided by the livestock population at risk × 100. Percentages in the routine prophylaxis vaccination column represent the proportion of the cumulative target livestock population (455,469 Equines) vaccinated during each year and across the study period.

4. Discussion

The present study demonstrated marked temporal heterogeneity in the occurrence of reported African horse sickness (AHS) in North Shewa Zone during 2019–2025. Of the 29 reported outbreaks, 21 (72.4%) occurred in 2024, followed by four (13.8%) in 2025, while no outbreaks were reported in 2019, 2020, or 2023. This pronounced fluctuation is consistent with the episodic nature of AHS transmission in Ethiopia. [14] Based on 737 reported outbreaks, documented substantial temporal and geographic variation in AHS occurrence across the country. Similarly, [15] reported that AHS outbreaks were particularly frequent during and after the main rainy season, suggesting an important influence of environmental conditions and vector activity on transmission.

The sharp increase in reported outbreaks in 2024 may have resulted from a combination of favorable environmental conditions, increased vector abundance, the presence of susceptible equid populations, and variations in vaccination and surveillance intensity. Conversely, the decline in reported outbreaks in 2025 may reflect reduced transmission following the previous outbreak peak and subsequent control interventions, although this cannot be confirmed using routine surveillance data alone. Importantly, the absence of reported outbreaks in some years should not be interpreted as evidence of complete absence of AHSV circulation. Recent evidence from Central Gondar reported an AHSV seroprevalence of 80.7% among equids, demonstrating widespread exposure despite differences in the occurrence of clinically reported outbreaks [11].

The overall outbreak occurrence of 7.75% should therefore be interpreted as the proportion of reporting units with reported AHS outbreaks within the surveillance system, rather than as the true incidence of AHSV infection. Passive surveillance may underestimate the actual occurrence of AHS because outbreaks can remain undetected or unreported, particularly in areas with limited diagnostic capacity, veterinary services, or disease-reporting infrastructure. Consequently, the observed temporal pattern likely reflects a combination of actual variation in disease occurrence and variation in surveillance and reporting intensity. Strengthening active surveillance and laboratory confirmation would improve the detection and characterization of AHS and provide more reliable estimates of its temporal distribution in North Shewa Zone.

4.1. Epidemiological Measures of AHS: Morbidity, Mortality, and Case Fatality Rate

The present study demonstrated marked temporal variation in the occurrence and severity of reported African horse sickness (AHS) in North Shewa Zone during 2019–2025. Overall, 302 cases and 217 deaths were recorded among 21,461 equids at risk, corresponding to morbidity, mortality, and case fatality rates (CFRs) of 1.41%, 1.01%, and 71.85%, respectively. Although the greatest numbers of cases and deaths were recorded in 2024, 2025 had the highest morbidity (2.56%) and mortality (1.73%) relative to the population at risk. This interannual variation is consistent with the heterogeneous epidemiology of AHS, which may vary according to host susceptibility, geographic location, season, environmental conditions, surveillance intensity, and diagnostic approaches [14, 17]

The high overall CFR observed in the present study is consistent with the severe clinical manifestations of AHS in susceptible equids and with previous Ethiopian studies reporting substantial mortality associated with AHS outbreaks [14, 15] Nevertheless, CFR estimates may vary between studies because of differences in circulating virus types, host susceptibility, vaccination status, case definitions, clinical management, and surveillance systems. The dependence of AHS transmission on *Culicoides* vectors and environmental conditions may also contribute to temporal variation in disease occurrence and severity [1] However, because vector abundance and environmental variables were not directly assessed in the present study, their contribution to the observed temporal pattern cannot be established.

The relatively low overall morbidity observed in this study should not necessarily be interpreted as evidence of limited AHSV exposure or circulation. Recent evidence from Central Gondar reported an AHSV seroprevalence of 80.7% among equids, indicating widespread prior exposure despite differences in clinically reported disease [11]. This apparent difference is epidemiologically plausible because serological surveys detect evidence of previous exposure, including infections that may have been subclinical or not captured by routine surveillance. Similarly, a recent systematic review reported

substantial heterogeneity in AHS prevalence according to geographic location, host species, season, diagnostic approach, and study period, highlighting the limitations of directly comparing surveillance-based morbidity estimates with serological prevalence estimates [17].

The absence of reported cases in 2019, 2020, and 2023 should therefore be interpreted cautiously. It may reflect genuine temporal variation in disease occurrence, but could also be influenced by differences in surveillance sensitivity, reporting completeness, vaccination coverage, and environmental conditions. Because the present study relied on routinely reported surveillance data, the observed morbidity and mortality estimates represent reported disease burden rather than the total burden of AHS in the equid population. Overall, the combination of relatively low population-level morbidity and high CFR indicates that, although reported clinical disease affected a relatively small proportion of the equid population, AHS outbreaks can result in substantial mortality when clinical disease occurs. Strengthening seasonal surveillance, laboratory confirmation, risk-based and pre-emptive vaccination, and the integration of clinical, serological, and molecular surveillance would improve detection and characterization of AHSV infection and provide a more comprehensive understanding of AHS epidemiology in North Shewa Zone.

4.2. Monthly and Seasonal Distribution of AHS

The present study demonstrated a marked seasonal concentration of AHS, with all 302 cases and 217 deaths occurring during September–November and the greatest disease burden recorded during September–October. October had the highest case fatality rate (CFR) of 84.7%, indicating substantial clinical severity during the peak transmission period. This pattern is consistent with previous Ethiopian evidence showing that AHS outbreaks occur predominantly from September to December, with October representing the peak outbreak month [15].

The observed seasonality may be associated with vector and environmental dynamics. Recent research in Northwest Ethiopia demonstrated significant seasonal variation in *Culicoides* abundance, with higher abundance during the wet season, supporting the potential role of vector ecology in AHS transmission [7]. However, because the present study did not include entomological or meteorological data, this relationship should be interpreted as plausible rather than causal. The concentration of 98.6% of deaths during September–October and the overall CFR of 71.9% further emphasize the severe impact of AHS during the peak period. Recent evidence of 80.7% AHSV seroprevalence among equines in Central Gondar also indicates substantial exposure to AHSV in Ethiopia [11]

These findings support seasonally targeted vaccination, intensified surveillance, and early outbreak preparedness before the September–November high-risk period. Future studies integrating *Culicoides* abundance, climatic variables, vaccination status, and laboratory-confirmed infection are warranted to clarify the determinants of AHS seasonality in North Shewa.

4.3. Spatial Distribution of Reported AHS Outbreaks

The present study demonstrated marked spatial heterogeneity in reported AHS occurrence across North Shewa, with outbreaks reported in 15 of 23 districts and disease burden concentrated in a limited number of districts. SiyaderWayu recorded the highest numbers of outbreaks, cases, and deaths, whereas Gishi and Anegollela showed particularly high CFRs. In contrast, Minjar and Menz Gera had comparatively lower CFRs. This geographic variation is consistent with previous Ethiopian studies reporting differences in AHS occurrence across locations and agroecological settings [14, 15, 17].

Spatial differences in AHS occurrence may be influenced by variation in equine density and movement, ecological conditions, vector distribution, vaccination coverage, and surveillance capacity. Ethiopian studies have demonstrated substantial geographic and environmental variation in *Culicoides* distribution, suggesting that local ecological conditions may influence the spatial risk of vector-borne diseases[6, 7]. However, these potential determinants were not directly assessed in the present study; therefore, the observed geographic patterns should be interpreted as descriptive rather than causal. The high CFRs observed in several districts also emphasize the potential severity of AHS, although estimates based on small numbers of cases should be interpreted cautiously.

These findings support risk-based surveillance, targeted vaccination, and strengthened preparedness in high-burden districts. Future studies integrating equine population density, animal movement, vaccination status, vector ecology, climatic variables, and laboratory confirmation could provide a better understanding of the spatial determinants of AHS risk in North Shewa.

4.4. Annual AHS Outbreaks, Outbreak Response, and Prophylactic Vaccination Coverage

The study demonstrated marked temporal variation in AHS occurrence, with 21 of the 29 outbreaks (72.4%) reported in 2024, followed by a decline to four outbreaks in 2025. Similar temporal and geographic variability has been reported in Ethiopia and elsewhere, reflecting differences in seasonality, agroecology, host populations, vector dynamics, and other epidemiological factors [14, 15, 17]. The decline in reported outbreaks in 2025 coincided with increased routine vaccination coverage; however, this temporal association does not establish vaccine effectiveness, as vector activity, climatic conditions, animal movement, surveillance intensity, and circulating virus strains may also influence outbreak occurrence [1, 3]. Recent detection of AHSV-9 in Ethiopia further supports ongoing viral circulation and highlights the need for continued molecular surveillance [12].

Overall outbreak-response vaccination coverage was high (97.6%), indicating strong reactive control capacity. Nevertheless, the occurrence of outbreaks despite high reactive vaccination coverage highlights the limitations of vaccination initiated after disease emergence. Evidence indicates that vaccination conducted before exposure and during periods of low transmission provides more effective protection than vaccination initiated after virus circulation has already been established. Therefore, vaccination should be strategically timed, achieve adequate coverage against relevant serotypes, and be integrated with effective surveillance and vector-control measures.[1, 3]

Routine prophylactic vaccination coverage increased from 35.2% in 2019 to 78.7% in 2025, indicating a shift toward preventive and potentially risk-based disease control. The high AHSV seroprevalence reported among equines in Central Gondar (80.7%) further indicates substantial exposure to AHSV in Ethiopia [11]. Accordingly, pre-emptive vaccination before the high-risk season, prioritization of high-risk districts, strengthened seasonal surveillance, and rapid outbreak response are recommended to reduce the risk and impact of future AHS outbreaks in North Shewa.

5. Conclusion

African horse sickness (AHS) remains an important equine health concern in North Shewa Zone, characterized by marked temporal, seasonal, and spatial heterogeneity and high fatality among reported cases. During 2019–2025, 29 outbreaks involving 302 cases and 217 deaths were reported, with the greatest disease burden occurring in 2024 and all reported cases concentrated during September–November. Disease occurrence and severity varied substantially among districts, with a particularly high burden reported in Siyader-Wayu, Gishi, and other affected districts. The overall case fatality rate (CFR) of 71.85% further demonstrates the severe consequences of clinically apparent AHS in affected equines.

Routine prophylactic vaccination coverage increased from 35.2% in 2019 to 78.7% in 2025, while outbreak-response vaccination coverage reached 97.6%, indicating strengthened vaccination and outbreak-control activities. However, the occurrence of outbreaks despite high reactive vaccination coverage highlights the limitations of relying primarily on post-outbreak vaccination and supports the importance of preventive vaccination before the high-risk season.

Overall, these findings highlight the need to transition from predominantly reactive control toward proactive, risk-based AHS prevention. This approach should integrate timely vaccination with intensified seasonal surveillance, early detection, laboratory confirmation, and targeted outbreak preparedness. Because this study relied on routine surveillance data, the reported occurrence likely represents only the documented burden and may underestimate the true level of AHSV circulation in the zone.

Based on the findings of this study, key recommendations include implementing pre-emptive vaccination ahead of the September–November high-risk period and prioritizing high-burden districts such as Siyader Wayu, Gishi, Basona Worena, Menz Lalo, and Anegollela. Additionally, the study emphasizes strengthening seasonal surveillance, improving laboratory confirmation and integrated surveillance, and enhancing outbreak preparedness with adequate supplies, trained personnel, and rapid response teams.

Abbreviations

AHS	African Horse Sickness
AHSV	African Horse Sickness Virus
CFR	Case Fatality Rate
DOVAR	Disease Outbreak and Vaccination Report
PAR	Population at Risk
PA	Peasant Association
WOAH	for the World Organization for Animal Health

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Author Contributions

Kurabachew Gebrehiwot: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Super vision, Validation, Visualization, Writing -original draft, Writing- review & editing

Data Availability Statement

The data used in this article can be found upon request to the corresponding author on reasonable request.

Conflicts of Interest

The author declares no conflicts of interest.

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Biography

Kurabachew Gebrehiwot was born on 10 December 1977 in Menz Keya district of North Shoa, Amhara Region. He completed his elementary and junior education at Zemero Elementary and Junior School, and his secondary studies at Mehal-Meda Senior Comprehensive Secondary School. In 2002 he joined Alage ATVET College and graduated in 2005 with a diploma in Animal Health. Soon after, he began his professional career with the Amhara Region Bureau of Agriculture, serving from 2005 to 2009 as a field veterinarian in Asagirt District, North Shoa Administrative Zone. Committed to advancing his expertise; he enrolled at Wollo University in 2010 and earned a Bachelor of Veterinary Science (BVSc) degree in 2012. Since then, he has worked with the North Shoa Zone Agricultural Office and later the North Shoa Zone Livestock Office, taking on expert and supervisory roles and providing technical support across all districts of the zone. He enrolled at Debre Berhan University, College of Graduate Studies to pursue specialization in veterinary public health.