UNIVERSITI PUTRA MALAYSIA

# A DESCRIPTIVE STUDY ON THE OUTBREAKS AND DISSEMINATION OF AFRICAN SWINE FEVER IN MALAYSIA

MUHAMMAD TAUFIK IBRAHIM

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FACULTY OF VETERINARY MEDICINE

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# A DESCRIPTIVE STUDY ON THE OUTBREAKS AND DISSEMINATION OF AFRICAN SWINE FEVER IN MALAYSIA

**MUHAMMAD TAUFIK IBRAHIM**

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**CERTIFICATIONS**

It is hereby certified that I have read this project paper entitled "A Descriptive Study on the Outbreaks and Dissemination of African Swine Fever in Malaysia" by Muhammad Taufik Ibrahim and in my opinion, it is satisfactory in terms of scope, quality, and presentation as partial fulfilment of the requirement for the course VPD 4999 – Project.

________________________________________

**PROFESSOR DR. LATIFFAH HASSAN**
**DVM (UPM), PhD (CORNELL)**
Professor in Veterinary Public Health and Epidemiology
Faculty of Veterinary Medicine
Universiti Putra Malaysia
(Supervisor)

## DEDICATIONS

For the health of everyone and everything.

**ACKNOWLEDGEMENTS**

I am grateful to all who have assisted me, not only in the completion of this project but also throughout my five years of veterinary school.

I extend my deepest gratitude to the following individuals who have been a constant source of motivation for the completion of this project: my supervisor, Professor Dr. Latiffah Hassan, for her unwavering support, invaluable guidance, and mentorship throughout the study; my Final Year Project peer, Nicole, for her awesome collaboration and shared enthusiasm; my parents and siblings for their continuous support, understanding, and encouragement; and my friends, Faiz, Iskandar, and DVM 2024, whose friendships have provided me with a vital source of happiness and motivation during challenging times.

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Their unwavering belief in my abilities has been a driving force throughout this academic endeavour. Their support has been invaluable and defies description.

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## ABBREVIATIONS

| | |
|---|---|
| ASF | African Swine Fever |
| WOAH | World Organisation for Animal Health |
| WAHIS | World Animal Health Information System |
| ASFV | African Swine Fever Virus |
| MyBIS | Malaysia Biodiversity Information System |
| WHO | World Health Organisation |

## ABSTRAK


Abstrak daripada kertas projek yang dikemukakan kepada Fakulti Perubatan Veterinar untuk memenuhi sebahagian daripada keperluan kursus VPD 4999 – Projek Ilmiah Tahun Akhir

**KAJIAN DESKRIPTIF PENYEBARAN WABAK DEMAM BABI AFRIKA DI MALAYSIA**

Oleh

**Muhammad Taufik Ibrahim**

**2023**

**Penyelia: Professor Dr. Latiffah Hassan**

Demam Babi Afrika (ASF) ialah penyakit babi berjangkit yang merentas sempadan dan merupakan penyakit wajib lapor dengan pengedaran global dan ancaman sosio-ekonomi yang luas kepada komuniti ternakan. Kes pertama ASF di Malaysia dilaporkan pada Februari 2021. Tujuan kajian ini adalah untuk menerangkan taburan wabak ASF di Malaysia antara Februari 2021 dan April 2023 melalui pendekatan epidemiologi deskriptif. Data awam mengenai wabak ASF telah diambil daripada *World Organisation for Animal Health* (WOAH) *World Animal Health Information System* (WAHIS) dan dianalisis selanjutnya melalui statistik deskriptif, lengkung wabak, peta penyakit dan penyiasatan kelompok. Sejumlah 176 wabak dilaporkan di Malaysia sepanjang tempoh kajian yang terdiri

daripada 111 wabak babi domestik dan 65 wabak babi liar. Di antara wabak babi domestik, 7524 kes dilaporkan dalam kalangan 74333 babi yang terdedah (min morbiditi: 43.94%); daripada babi yang dijangkiti, 6186 kematian berlaku (min kes-kematian: 73.62%) dan 62937 babi telah dimusnahkan (min dimusnahkan: 57.37%). Sabah mempunyai kadar morbiditi (93.90%) dan kadar kematian (89.00%) tertinggi antara negeri-negeri lain. Kadar kematian kes yang tinggi (69.78% - 100%) direkodkan di beberapa negeri, khususnya Melaka, Sarawak, Sabah dan Pahang. Lengkung wabak dengan kes puncak dicatatkan di Sabah. Lima kluster direkodkan sepanjang tempoh wabak, khususnya di negeri Sabah, Johor, Melaka, Perak dan Pulau Pinang. Wabak ASF telah bermula di Beluran, Sabah sebelum dilaporkan di Batang Padang, Perak di Semenanjung Malaysia. Kes awal ASF dilaporkan dalam babi hutan untuk kedua-dua zon sebelum wabak berlaku pada babi domestik; oleh itu, populasi liar berpotensi berfungsi sebagai sumber atau takungan penyakit. Sumber lain yang berkemungkinan termasuk produk daging babi yang dijangkiti, kewaspadaan sempadan yang longgar dan '*swill feeding*', dan ia terus disebarkan melalui biosekuriti ladang yang lemah serta perkongsian kenderaan di kalangan ladang lain. Negara-negara lain di rantau ini turut mencadangkan laluan penyebab wabak yang sama. ASF di Malaysia menjejaskan populasi babi liar dan domestik dengan kadar kematian kes yang membimbangkan. Penemuan ini berfungsi sebagai usaha awal untuk memahami dengan lebih lanjut faktor risiko yang berkaitan dan memulakan pelan kawalan yang berkesan untuk penyakit ini demi menjamin kestabilan ekonomi, keselamatan makanan dan konservasi hidupan liar.

**Kata kunci**: Demam Babi Afrika; epidemiologi deskriptif; Malaysia; WAHIS

## ABSTRACT

An abstract of the project paper presented to the Faculty of Veterinary Medicine inpartial fulfilment of the course VPD 4999- Final Year Project.

**A DESCRIPTIVE STUDY ON THE OUTBREAKS AND DISSEMINATION OF AFRICAN SWINE FEVER IN MALAYSIA**

By

**Muhammad Taufik Ibrahim**

**2023**

**Supervisor: Professor Dr. Latiffah Hassan**

African Swine Fever (ASF) is an infectious, transboundary and notifiable disease of pigs with global distribution and a vast socio-economic threat to the livestock communities. The first-ever case of ASF in Malaysia was reported in February 2021. The purpose of the study was to describe the distribution of ASF outbreaks in Malaysia between February 2021 and April 2023 through a descriptive epidemiological approach. Public data on ASF outbreaks were retrieved from the World Organisation for Animal Health (WOAH) World Animal Health Information System (WAHIS) interface and further analysed through descriptive statistics, epidemic curves, disease maps and clusters investigation. A total number of 176 outbreaks were reported in Malaysia throughout the study period which comprises 111 domestic pig outbreaks and 65 wild pig outbreaks. Among the domestic pig outbreaks, 7524 cases were reported among 74333 susceptible pigs (mean morbidity: 43.94%); from those infected, 6186 deaths occurred (mean case-fatality: 73.62%) and 62937 pigs were culled (mean culled rate: 57.37%). Sabah has the highest morbidity (93.90%) and mortality rates (89.00%) among the other states. A high case-fatality rate (69.78% - 100%) was recorded in several states, specifically Melaka, Sarawak, Sabah and Pahang. Propagated epidemic curves were observed with peak cases recorded in Sabah. Five outbreak clusters were recorded throughout the epidemic period, particularly in the states of Sabah, Johor, Melaka, Perak and Pulau Pinang. ASF outbreaks appear to have started in Beluran, Sabah before being reported in Batang Padang, Perak in Peninsular Malaysia. Initial cases of ASF were reported in wild boar for both zones before outbreaks occurred in domestic pigs; thus, the wild population may have served as a potential source of the outbreak or the disease reservoir. Other probable sources of the outbreak include infected pork products, loose border vigilance and swill feeding, and AFS was further spread through poor farm biosecurity and vehicle sharing among other farms. Other countries in the region suggested the same path of outbreak causation. Therefore, ASF in Malaysia affected the wild and domestic pig population with a high case-fatality rate. These findings serve as a preliminary effort to further understand the associated risk factors and initiate effective control plans for the disease to secure economic stability, food security and wildlife conservation.

**Keywords**: African Swine Fever; descriptive epidemiology; Malaysia; WAHIS

## 1.0 INTRODUCTION

African Swine Fever (ASF) is an infectious transboundary disease of pigs, distributed globally and listed as a notifiable disease by the World Organization for Animal Health (WOAH). The ASF virus is the only member of the *Asfaviridae* family under the genus *Asfivirus*. The virus possesses a large double-stranded DNA with a complex icosahedral appearance that replicates in the cell cytoplasm (Morilla et al., 2008; Dixon et al., 2019). ASF virus infects wild and domestic pigs in which soft ticks may partake as reservoirs in the cycle (Dixon et al., 2019).

ASF holds a vast socio-economic threat to the livestock communities. The earliest report by Montgomery (1921) described the ASF outbreaks as an acute haemorrhagic fever of domestic pigs in Kenya between 1909 and 1915 of which 98.9% of the infected pigs died due to the disease. The first occurrence of ASF in Asia was reported to the WOAH in August 2018 and has spread continuously in the region ever since (Dixon et al., 2019). Malaysia reported ASF in Sabah in February 2021. A further characterization of the ASF virus confirmed that the genotype of the agent is identical to those in Europe and Asia-Pacific which indicates the necessity for a holistic international intervention to curb the spread (Khoo et al., 2021).

World Animal Health Information System (WAHIS) serves as a notification platform to disseminate information on the current occurrences of the disease to WOAH Member countries (Jebara, 2007). This study aims to describe the distribution of ASF outbreaks in Malaysia based on data extracted from the WAHIS website database through a descriptive epidemiological approach.

# 2.0 LITERITURE REVIEW

## 2.1 AFRICAN SWINE FEVER VIRUS

African Swine Fever Virus (ASFV) is a large double-stranded DNA virus from the *Asfavirus* genus and the only member of the *Asfaviridae* family (Dixon et al., 2019). The same authors stated that the primary cells targeted for replication by ASFV are macrophages and the virus plays a crucial role in altering the function of macrophages, influencing both pathogenicity and immune evasion mechanisms.

ASFV infects both domestic and wild suids, such as warthogs and bushpigs in Africa, as well as wild boars in Eurasia (Dixon et al., 2019). The same article stated that soft ticks of the *Ornithodoros* species can carry the virus for extended periods and serve as reservoirs. Nonetheless, Heath et al. (2020) underscore the ongoing spread of ASF in Europe and Asia seems to continue affecting both wild and domestic pig populations without the involvement of soft tick vectors, marking soft ticks currently to have no role in the European and Asian epidemic.

Another transmission mode of ASFV could be through direct contact, fomites and infected pig products (Guinat et al., 2016). In acute and peracute forms, the incubation period may range from three to seven days with high fever, inappetence, incoordination, prostration and even fatal (Oura, 2022). Wild suids infected with ASF in Africa typically do not exhibit apparent clinical signs, except for young animals that may experience temporary viremia (Jori et al., 2013).

## 2.2 SOCIO-ECONOMIC IMPACTS OF AFRICAN SWINE FEVER

Since Montgomery's (1921) initial case report of an acute haemorrhagic fever outbreak with a 98.9% case fatality rate, ASF has subsequently disseminated worldwide. According to WOAH (2023), this transboundary disease made its first appearance in the European Union in 2014 and Asia, specifically the People's Republic of China, in 2018. Malaysia and Thailand only recorded an index case of ASF in 2021 after the Philippines and Indonesia in 2019.

The wide dispersion of the disease only creates devastating socio-economic repercussions. The economic impact of the 2001 epidemic in Nigeria, with reported mortality rate of 91% across 306 farms, amounted to US$ 9,41,492 loss (Babalobi et al., 2007). In Asia, ASF caused devastating effects on swine production of China which resulted in the tripled price of live finishers (Huang et al., 2021). Within the Southeast Asian regions, particularly in Vietnam, 20% of the pig population either died or was culled in the initial five months following the onset of the epidemic which led to a notable economic impact, amounting to losses up to US$ 880 million in 2019 alone (Nguyen-Thi et al., 2021). Analysis by Weaver and Habib (2010) showed that burden is disproportionately affecting small-scale farmers, posing the risks of elevated vulnerability, poverty and food insecurity.

Since January 2021, ASF has been reported as present in five different world regions in 50 countries, affecting more than 953,000 pigs and more than 28,600 wild boars, with more than 1,508,000 animal losses (WOAH, 2023). As of February 2023, the continued detection of ASF across Asia underscores the potential of further transmission in this region (Bacigalupo et al., 2023).

## 2.3 WILDLIFE RESERVOIR OF AFRICAN SWINE FEVER

Wild animals, such as wild boars, may serve as reservoir for ASF virus (Jori & Bastos, 2009). The reservoir's potential exposure to naive domestic pigs poses a significant risk, leading to extensive disease spread, increased mortality, and substantial economic losses for the swine industry (Gavier-Widén et al., 2015). Dixon et al. (2019) suggested that the movement of wild boars through wildlife corridors and across borders plays a crucial mechanism for the virus's spread. The authors added that areas with high wild boar density will more likely increase the chance of contact with domestic pigs, particularly with those establishments having poor biosecurity implementation. Eliminating and managing disease in wild pig populations pose unique challenges that demand innovative surveillance methods, extending beyond traditional approaches. (Stallknecht, 2007). These challenges encompass issues such as the difficulties in identifying dead and sick animals in such a vastly remote area, disguised clinical signs of sick animals and rapid removal of carcasses by other scavengers (Sleeman et al., 2012).

According to the data presented by the Malaysia Biodiversity Information System (MyBIS), two species of wild boar are native to Malaysia: *Sus scrofa* and *Sus barbatus*. However, the bearded pigs, or *Sus barbatus*, are also native to the archipelago of Southeast Asia since they inhabit tropical rainforests, mangrove thickets, secondary forests, and areas affected by disturbances or logging (Meijaard & Sheil, 2008). As of 2017, the bearded pigs are listed under Vulnerable (VU) of the IUCN Red List of Threatened Species. A study by Luskins et al (2023) conducted on wild boar of Peninsular Malaysia since the outbreaks of ASF, confirmed via camera trapping that 87% declined has occurred in wild boar activity and carcass recovery has increased up to 100 folds compared to previous years. This highlights the conservation and welfare impact of ASF on the wild species.

# 3.0 MATERIALS AND METHODS

## 3.1 DATA COLLECTION

The public data on reported ASF outbreaks were retrieved from the WAHIS database (https://wahis.woah.org/#/event-management). Data were selected based on occurrence across of ASF Malaysia between the first ever case reported in the region, February 2021, until April 2023. Information derived from each report were as follows: outbreak reference ID, report date, report administrative division, epidemiological unit, location, latitude, longitude, animal species, number of susceptible, cases, death and culled. According to the website, each positive case report was reported and diagnosed by local authorities through real-time polymerase chain reaction and necropsy (for wild carcasses). All data were transferred to Microsoft Excel (Version 2308 Build 16.1) and grouped into smaller datasets. Quality control measures were implemented during the error-checking process, including the examination of logical values for each data entry. Additionally, a manual verification was conducted by cross-referencing the data with the original reports from the WAHIS database.

## 3.2 EPIDEMIC CURVES

Day 1 of the epidemic was assigned to the first case reported in Malaysia and continuously applied to the next reports based on the corresponding dates. Epidemic curves were derived from number of cases and outbreak reports on each day and depicted to a graph according to its state of origin. Microsoft Excel (Version 2308 Build 16.1) was utilised to construct the epidemic curves.

### 3.3 DISEASE MAPPING

Each location was then mapped with Geographical Information System (ArcGIS version 10.8) according to its longitude and latitude. A colour ramp was also utilised to provide better visualisation of the spatial distribution based on the number of epidemic days (green to red [day 1-801]) and number of reported cases (green to red [0-1063 cases]) across Malaysia.

### 3.4 DESCRIPTIVE STATISTICS

Descriptive analysis was conducted using Microsoft Excel (Version 2308 Build 16.1). A total of 111 domestic pig outbreaks were considered in this analysis. Morbidity (number of domestic pig cases ÷ susceptible domestic pigs), mortality (number of domestic pig deaths ÷ susceptible domestic pigs), case fatality (number of domestic pig deaths ÷ number of domestic pig cases) and the culled rate (number of domestic pigs culled ÷ susceptible domestic pigs) were calculated. The number of outbreaks, susceptible pigs, cases, deaths, culled, mean, median and interquartile range (IQR) were included as further analysis for each state in Malaysia

### 3.5 CLUSTRER ANALYSIS

Retrospective space-time analysis was employed with SatScan version 10.12 to identify any statistically significant clusters among the domestic pig outbreaks. The analysis employed a discrete Poisson model based on the population at risk, assuming a Poisson distribution for the reported cases at each location. These data were scrutinized for clusters exhibiting high attack rates. The maximum spatial cluster size was arbitrarily set at 20% of the population at risk, and the maximum temporal cluster size was set at 50% of the study period to identify significant clusters. Identified clusters were interpreted using the ratio of expected to observed cases, and their statistical significance was assessed through log-likelihood ratios via Monte Carlo simulation with 999 iterations. The statistically significant clusters were then mapped using Geographical Information System (ArcGIS version 10.8) based on the longitude and latitude of the cluster centre.

**4.0 RESULTS**

A total number of 176 ASF outbreaks were reported in Malaysia from February 2021 and April 2023 which comprises 111 domestic pig outbreaks and 65 wild boar reports. Among the domestic pig outbreaks, a cumulative of 74333 susceptible pigs, 7524 cases, 6186 deaths and 62937 pigs culled were recorded (Table 1 and Table 2). Sixty-five reports of ASF among wild boar in Malaysia were retrieved which comprises 151 cases and 151 deaths in total (Table 3). All wild boar ASF cases were from animals found dead. The first report of ASF in Malaysia recorded was in Beluran Sabah (East Malaysia) on 8th February 2021 and the first report in Peninsular Malaysia was in Batang Padang, Perak on 28th October 2021 (Figure 3). Both first occurrence in East and Peninsular Malaysia was from wild boar populations. The final outbreak was recorded in Johor on 19th April 2023.

The epidemic curve depicted a propagated epidemic pattern, indicative of animal-to-animal transmission, with one major peak case number in Sabah on Day 303 (Figure 1 and Figure 4). ASF outbreaks in Malaysia were more concentrated in Sabah during earlier days (Day 1-605). Most the domestic pig outbreak reports ($n$ = 4135), cases ($n$ = 3978) and deaths ($n$ = 3570) were reported from Sabah (Table 1 and Table 2). The highest number of susceptible pigs was recorded in Melaka ($n$ = 26712) and the highest number of culled were recorded in Pulau Pinang ($n$ = 21790). Secondary to Sabah, Pulau Pinang recorded with subsequent highest case number ($n$ = 1209) and followed by Johor ($n$ = 820). In wild boar populations, Sabah recorded the highest number of reports ($n$ = 27), cases ($n$ = 72) and deaths ($n$ = 72) (Table 3).

Pahang was recorded with the second-highest number of ASF reports of wild boar (*n* = 11), cases (*n* = 26) and death (*n* = 26).

Five statistically significant clusters were observed through retrospective space-time analysis. A primary cluster was identified to occurr in Sabah from January 2021 to December 2021 (Figure 6). Within the radius of 257.4km, the statistically significant ratio of observed-to-expected cases was 14.98 ($P < 0.001$). Within the same time frame, four other secondary clusters of ASF cases were observed in Johor, Perak, Penang and Melaka with statistically significant observed-to-expected cases ratio of 27.85, 51.08, 5.60 and 3.00 respectively ($P < 0.001$).

As a whole, ASF of domestic pigs in Malaysia was recorded with 43.9% morbidity rate, 39.9% mortality rate, 73.6% case fatality rate and 57% culled rate (Table 1). The highest morbidity rate was in Sabah (93.9%), followed by Sarawak (34.17%) and Johor (19.17%). Mortality rate was highest in Sabah (89%), Sarawak (32.5%) and Johor (16.67%). Pahang was recorded with the highest number of case fatality rate (100%), subsequently Sabah (94.95%), Sarawak (80%) and Melaka (69.78%). The highest culled rate was observed in Pulau Pinang, Negeri Sembilan and Sarawak at 100%.

**Table 1: Summary Statistics of African Swine Fever (ASF) Among Domestic Pigs in Malaysia from February 2021 to April 2023**

| Parameters | Sabah | Sarawak | Perak | Pahang | Melaka | Johor | Negeri Sembilan | Pulau Pinang | Average | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of outbreaks | 46 | 2 | 14 | 1 | 30 | 3 | 1 | 14 | 13.88 | 111 |
| Number of susceptible pigs | 4135 | 210 | 21651 | 1040 | 26712 | 2257 | 275 | 22398 | 9834.75 | 74333 |
| Number of cases | 3978 | 95 | 913 | 10 | 489 | 820 | 10 | 1209 | 940.5 | 7524 |
| Number of deaths | 3570 | 93 | 842 | 10 | 263 | 800 | 0 | 608 | 773.25 | 6186 |
| Number culled | 563 | 117 | 19025 | 1030 | 19360 | 1457 | 275 | 21790 | 7952.13 | 62937 |
| Mean morbidity (%) | 93.90 | 34.17 | 8.95 | 0.96 | 2.81 | 19.17 | 3.64 | 15.51 | 43.94 | —— |
| Mean mortality (%) | 89.00 | 32.50 | 8.23 | 0.96 | 1.32 | 16.67 | 0.00 | 3.89 | 39.81 | —— |
| Mean case fatality (%) | 94.95 | 80.00 | 47.50 | 100.00 | 69.78 | 33.33 | 0.0 | 48.96 | 73.62 | —— |
| Mean Culled (%) | 19.57 | 100.00 | 47.50 | 99.04 | 67.68 | 33.33 | 100.00 | 100.00 | 57.37 | —— |

**Table 2: Summary Statistics of African Swine Fever (ASF) Cases Among Domestic Pigs in Malaysia from February 2021 to April 2023**

| Parameters | Sabah | Sarawak | Perak | Pahang | Melaka | Johor | Negeri Sembilan | Pulau Pinang | Average |
|---|---|---|---|---|---|---|---|---|---|
| Number of susceptible pigs | 4135 | 210 | 21651 | 1040 | 26712 | 2257 | 275 | 22398 | 9834.75 |
| Number of cases | 3978 | 95 | 913 | 10 | 489 | 820 | 10 | 1209 | 940.50 |
| Minimum cases in single report | 2 | 0 | 2 | 5 | 0 | 10 | 1 | 1 | 4.10 |
| 1$^{st}$ quartile | 12.00 | 3.00 | 12.25 | 26.25 | 10.00 | 10.00 | 1.00 | 7.00 | 10.15 |
| Mean | 84.85 | 54.78 | 86.48 | 47.50 | 65.21 | 10.00 | 16.30 | 86.36 | 73.48 |
| Median | 22.00 | 12.00 | 22.00 | 47.50 | 14.50 | 10.00 | 7.50 | 20.00 | 17.55 |
| 3$^{rd}$ quartile | 42.75 | 30.00 | 40.75 | 68.75 | 29.25 | 10.00 | 27.50 | 35.00 | 69.90 |
| Maximum cases in single report | 1063.00 | 800.00 | 1063.00 | 90.00 | 467.00 | 10.00 | 53.00 | 600.00 | 495.60 |
| IQR | 30.75 | 27.00 | 28.50 | 42.50 | 19.25 | 0.00 | 26.50 | 28.00 | 59.75 |

**Table 3: Summary Statistics of African Swine Fever (ASF) Cases Among Wild Boars in Malaysia from February 2021 to April 2023**

| Parameters | Sabah | Sarawak | Perak | Pahang | Melaka | Johor | Negeri Sembilan | Pulau Pinang | Kelantan | Terengganu | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of reports | 27 | 0 | 6 | 11 | 2 | 4 | 4 | 2 | 1 | 8 | 65 |
| Number of cases | 72 | 0 | 6 | 26 | 7 | 4 | 20 | 2 | 1 | 13 | 151 |
| Number of deaths | 72 | 0 | 6 | 26 | 7 | 4 | 20 | 2 | 1 | 13 | 151 |
| Number culled | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Figure 1: Number of African Swine Fever (ASF) Cases Among Domestic Pigs in Malaysia from February 2021 to April 2023**

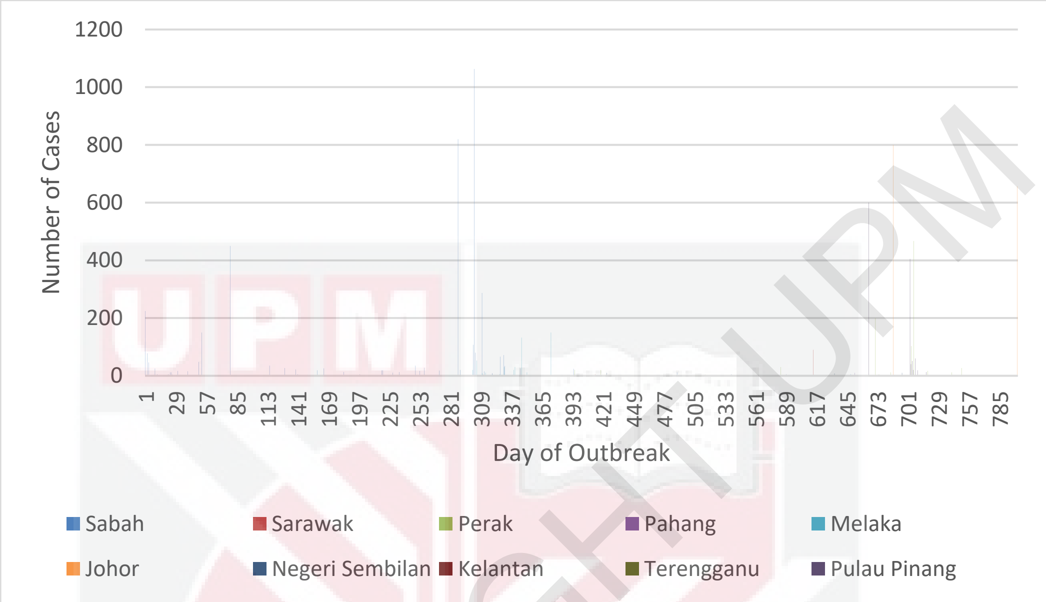



**Figure 2: Number of African Swine Fever (ASF) Outbreaks Among Domestic Pigs in Malaysia from February 2021 to April 2023**

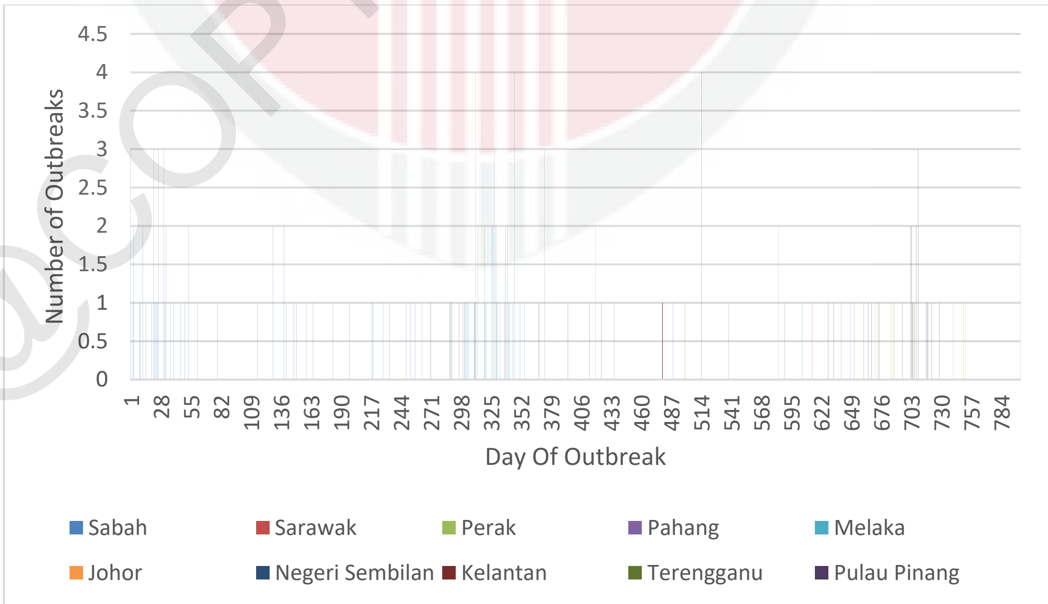


**Figure 3: Spatial Distribution of African Swine Fever (ASF) Among Domestic Pigs in Malaysia According to Epidemic Day**

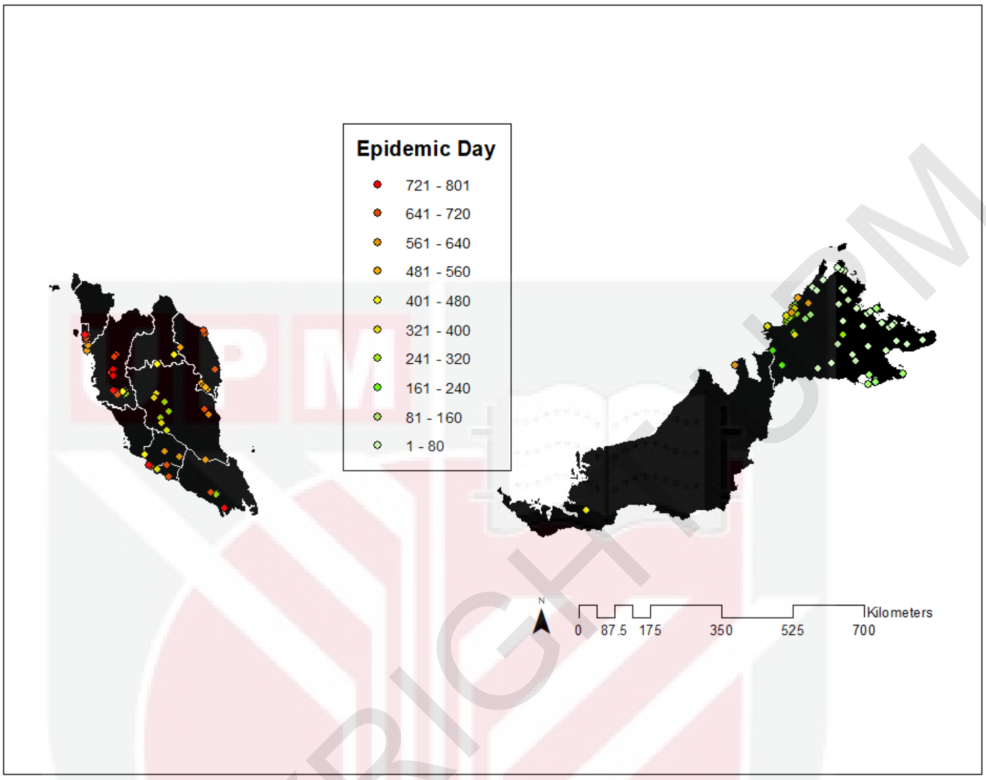



**Figure 4: Spatial Distribution of African Swine Fever (ASF) Among Domestic Pigs in Malaysia According to Number of Cases**

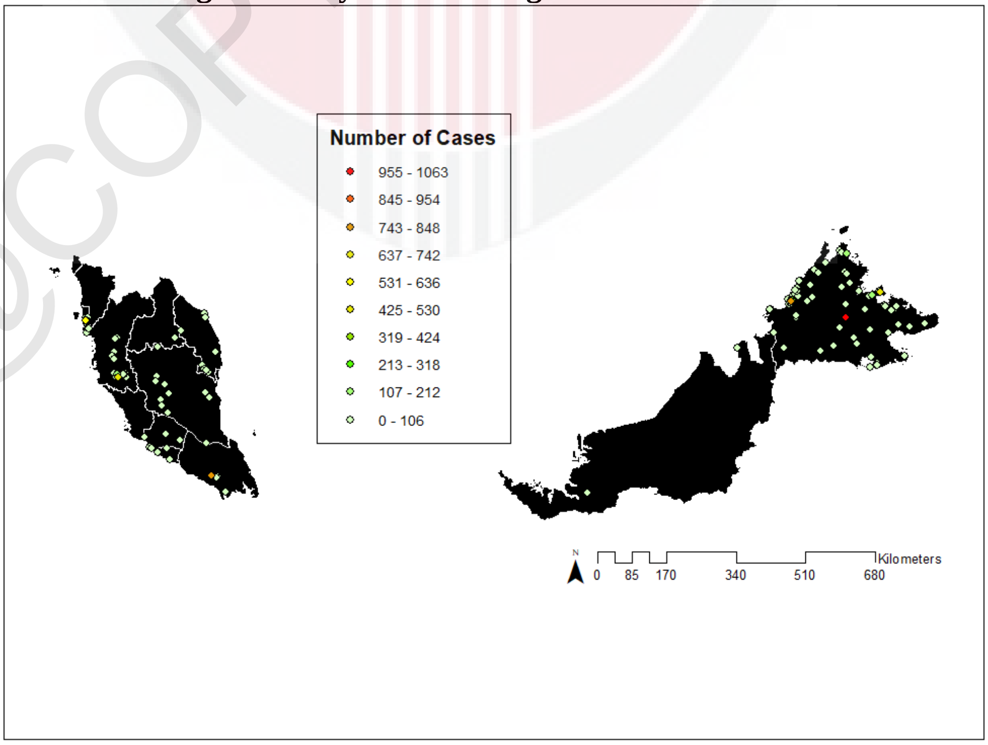


**Figure 5: Spatial Distribution of African Swine Fever (ASF) in Malaysia According to Domestic Pigs and Wild Boar Reports**

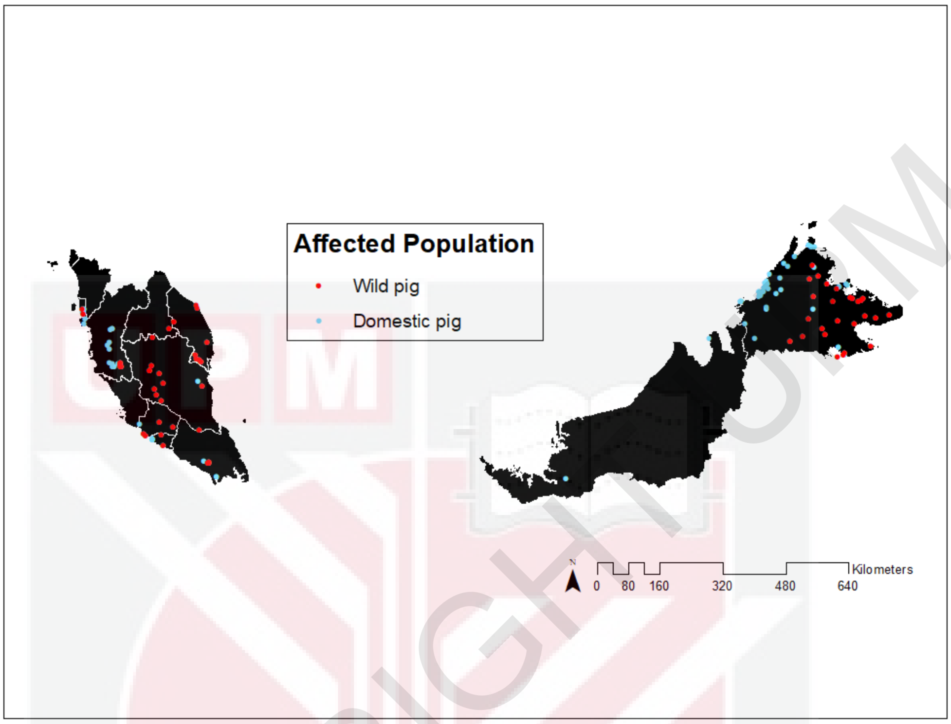
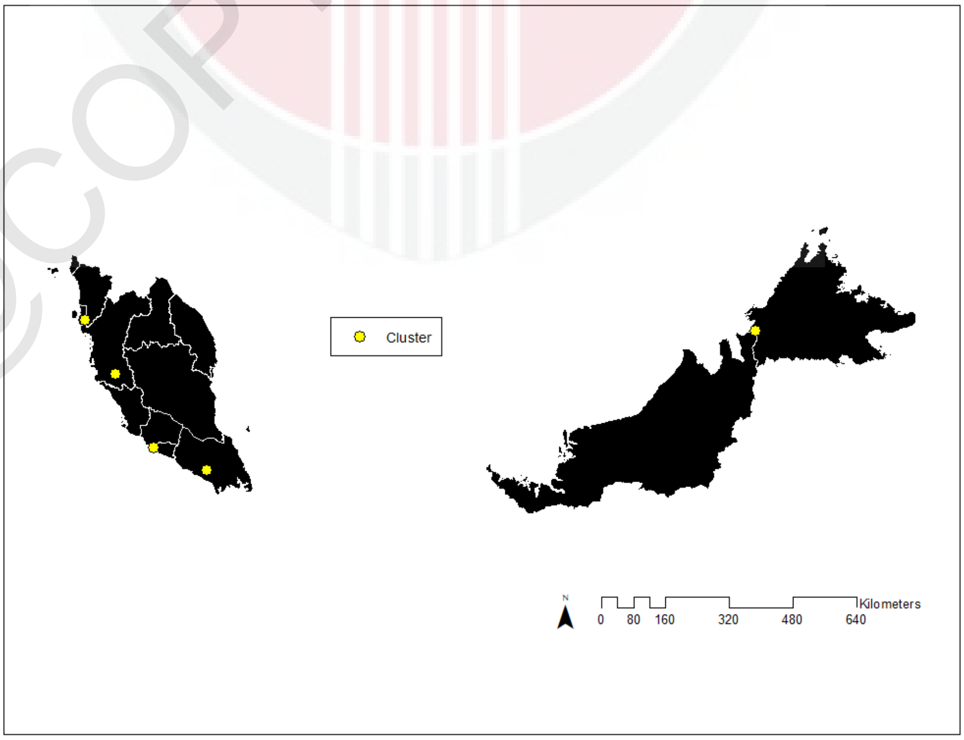



**Figure 6: Spatial Distribution of African Swine Fever (ASF) Clusters Among Domestic Pig in Malaysia**



## 5.0 DISCUSSION

This study presents the summary of ASF dissemination across Malaysia from the initial outbreak of the disease in February 2021 to April 2023 through a descriptive epidemiological approach. The analysis highlighted in this study includes descriptive statistics, epidemic curves, disease mapping, and cluster analysis to provide a detailed overview of the disease's distribution in the region during the specified timeframe.

The analysis conducted in this investigation is confined to data accessible and reported by local authorities to the WOAH WAHIS database, presenting a notable limitation to the study. This research heavily relies on self-reported information regarding ASF outbreaks, thereby introducing the potential for reporting bias, and varied data quality and consistency. Additionally, the WAHIS database may not be able to comprehensively encompass all ASF aspects in Malaysia, particularly concerning elements such as the wild population status. This recognition is essential to acknowledge the limitations that may arise in the effort to fully understand the disease dynamics in the country. Nevertheless, the reported data on the domestic pig and wild boar populations are adequate to create a foundational understanding of the baseline prevalence and dynamics of ASF within the context of Malaysia.

The high ASF case fatality rate of 73.6% among domestic pigs in Malaysia, is in agreement with several other literatures elsewhere around the globe. A high case fatality rate was also recorded in other regions such as in China (Liu et al., 2019). Multiple studies also suggested high case fatality rates up to 90% or more in domestic pig worldwide (EFSA, 2014; Rock, 2017). This phenomenon could be explained by the novelty of the virus in this part of the world, where pools of susceptible and immunologically naïve animals are large and a low preparedness for the disease. Furthermore, in the absence of a viable vaccine for the disease, the success of controlling the disease spread depends on biosecurity which may be challenging to implement given farm infrastructures (Prodanov-Radulović et al., 2023). Fortunately, it has been shown that in regions where ASF become established and endemic mortality rates reduce over time (Gollardo et al., 2015), however subacute and subclinical infections may occur leading to difficulty in gaining freedom from ASF.

Sabah reported a morbidity rate of 93.9% for ASF among their domestic pig cases. Data reveals that a considerable percentage of reported outbreaks in Sabah originated from small-scale farmers, which are often associated with limited resources and low biosecurity. This observation is consistent with the findings from Schembri's (2014) that reported a significant positive correlation between herd size and the adoption of on-farm biosecurity measures.

To date, the precise route of ASF introduction into Malaysia has remained uncertain. Conan et al. (2021) have proposed the existence of two risk pathways for ASF introduction into Malaysia: the trade of domestic pig products and the cross-border movement of wild boars. This could be further supported by the involvement of wild boars as index cases observed in both Sabah and Peninsular Malaysia. In addition, other probable sources of the outbreak may include infected pork products, loose border vigilance and swill feeding, and potential further transmission through poor farm biosecurity and shared vehicles among other farms (Dixon et al., 2020; Khoo, 2021). Furthermore, it is possible that the cases in Peninsular and East Malaysia are not directly linked. The loose border controls to neighbouring countries where ASF outbreaks were reported prior to ASF outbreaks in Malaysia serve multiple opportunities for disease entry through infected animals or products.

According to Dixon et al. (2020), preventing and curbing the ASF disease must include these steps: 1. Border control and point of entry surveillance 2. Control of pig related products from ASF infected countries, this includes importations of pork products via trade or products brought in by travellers 3. Increasing biosecurity at pig farms 4. Monitoring and surveillance of wild boar populations 5. Rapid disease control response to outbreaks 6. Implementing policy instruments customized to local socioeconomic and cultural factors. The most challenging aspect for ASF is controlling or eradicating the disease within the wildlife reservoir. Many European countries, such as the Czech Republic and Belgium, have implemented zoning, fencing and hunting bans accompanied with intensive wild boar carcass surveillance as one of the strategies to control ASF outbreaks (Dixon et al., 2020). However, the measures are costly and highly resource-intensive but will need to be implemented until vaccine is ready and available.

## 6.0 CONCLUSION AND RECOMMENDATION

This study has described the ASF outbreaks and dissemination across Malaysia. ASF is devastating and has resulted in very high morbidity and death amongst pigs in Malaysia. The total death of domestic pigs was 73.62% of the total positive cases between February 2021 and April 2023. The source of the outbreak in Sabah and the peninsula is most likely wild boar. Malaysia was free from ASF and at the time this thesis is written, has not regain its disease freedom due to multiple challenges. We recommend that future study to obtain data through collaboration with local authorities, veterinary services and other relevant stakeholders to enhance the comprehensiveness of information on ASF in Malaysia.

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