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Modelling African Swine Fever: A Systematic Review of Mechanistic, Statistical and Machine Learning Approaches

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ADMINISTRATIVE INFORMATION

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Review Stage at time of this submission - Data extraction.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 10 October 2025 and was last updated on 10 October 2025.

INTRODUCTION

Review question / Objective How have different mechanistic, statistical, and machine learning modelling techniques been utilized to understand the epidemiology of African Swine Fever and informing its interventions?

Condition being studied African swine fever (ASF) is a highly contagious and often fatal viral disease of domestic and wild pigs. The disease is characterised by high fever, reduced appetite, vomiting, diarrhea, lethargy, and sudden death, with mortality rates reaching up to 100%. It is caused by the African swine fever virus (ASFV), a large double-stranded DNA virus with high genetic variability.

METHODS

Search strategy Electronic databases searched: PubMed, Embase, Web of Science and Scopus

The following search strategy was applied, generated by identifying key terms using the PICO approach:
("African Swine Fever")
AND
(mathematical OR mechanistic OR epidemiolog* OR deterministic OR stochastic OR compartmental OR SEIR OR SIR OR agent-based OR agent OR simulat* OR comput* OR "Monte Carlo" OR sensitivity OR optimi* OR statistic* OR regression* OR linear OR logistic OR baye* OR likelihood OR spatial OR cluster* OR hotspot* OR multivar* OR ARIMA OR autoregressive OR "moving average" OR SARIMA OR mixed OR "random effects" OR

survival OR risk* OR hierarchical OR ANOVA OR Poisson OR correlat* OR associat* OR significan* OR "machine learning" OR "artificial intelligence" OR AI OR supervi$ed OR unsupervi$ed OR "deep learning" OR "neutral network*" OR ANN OR FNN OR "support vector machine*" OR SVM OR forest* OR tree* OR "extreme gradient boost*" OR LSTM OR Transformer* OR ensemble OR encoder* OR decoder* OR autoencoder* OR cross-validation OR "cross validation" OR feature* OR learning OR algorithm* OR classif* OR forecast* OR model*)
NOT
(genom* OR genotyp* OR transcriptom* OR protein* OR proteomic* OR lipid*).

Participant or population Farms affected with African Swine Fever, including simulated settings.

Intervention Mechanistic, statistical, or machine learning approaches applied to model African swine fever, but not research involving vaccine development or study of the disease's biological processes (i.e., genomics, proteomics, transcriptomics, and lipidomics).

Comparator N/A.

Study designs to be included There are no restrictions on the types of study design eligible for inclusion. N/A.

Eligibility criteria Search is restricted to include only peer-reviewed journal articles written in English and published up to 2024. Studies were eligible if they modelled ASF data as the response variable, such as outbreak data or infection status. We excluded studies that modelled biomarker data (e.g. genomics, proteomics, transcriptomics) or non-ASF data (e.g. economic indicators, knowledge–attitude–perception (KAP) responses, farm biosecurity assessments, trade movements). Studies were also excluded if they applied statistical techniques solely for hypothesis testing (e.g. ANOVA/Kruskal–Wallis tests, Pearson/Spearman correlations, Chi-square/Fisher's tests for association, Global Moran's I) or for trend analysis (e.g. ARIMA), as these were considered non-modelling applications.

Information sources Sources include the four electronic databases only: PubMed, Embase, Web of Science and Scopus.

Main outcome(s) To identify, assess, and compare mechanistic, statistical, and machine learning models that have been used to study ASF, providing guidance on model selection and strengthening the evidence base for transmission dynamics and intervention planning.

Additional outcome(s) N/A.

Data management Screening and selection were conducted using Covidence. The list of selected papers will be uploaded in Endnote 21 to manage full articles for extraction, and extracted data will be recorded in a MS Excel spreadsheet.

Quality assessment / Risk of bias analysis Because the included studies were modelling-focused, standard risk of bias tools (e.g., RoB 2, ROBINS-I) were not applicable. We will use the Philips et al. checklist to appraise model quality, focusing on model structure, data inputs, uncertainty analysis, and validation.

Strategy of data synthesis Studies will be categorized by modelling approach, geographic scope, input features, performance metrics, and policy translation, organized to draw comparisons and insights on identifying best practices and knowledge gaps for future research.
Hierarchical clustering on principal components (HCPC), using factor analysis of mixed data (FAMD) to accommodate mixed variable types, will be conducted to identify method-objective-geography-year clusters across studies.

Subgroup analysis Strategy for data synthesis will be applied; no specific unique strategies for subgroups.

Sensitivity analysis Not applicable.

Language restriction Yes, only papers written in English will be included.

Country(ies) involved Australia.

Keywords African swine fever, modelling, mechanistic, statistical, machine learning.

Contributions of each author
Author 1 - Kim Dianne Ligue - Author 1 conceptualized the design, led the development of the research protocol, conducted the systematic search and screened papers for inclusion, and will perform extraction, analysis, generate insights, and draft the manuscript.
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Author 2 - Kien Quoc Do - Author 2 acted as the 2nd independent reviewer during conduct of the search and paper screening for inclusion, and will review extracted data, assist in generating insights, and writing the manuscript.

Author 3 - Yoni Nzarathy - Author 3 contributed to the development of the research protocol, refined the elegibility criteria, analysis of results, generating insights for discussion, and writing the manuscript.
Author 4 - Benn Sartorius - Author 4 served as the third independent reviewer during the selection process, and contributed to the development of the research protocol, including the elegibility criteria, analysis of results, generating insights for discussion, and writing the manuscript.
Author 5 - Luis Furuya-Kanamori - Author 5 contributed to the development of design of the research protocol, informing choices in adherence to the review and reporting guidelines, generating insights for discussion, and writing the manuscript.
Author 6 - Yusuf Sucol - Author 6 contributed to the development of the research protocol, analysing results, particularly those requirng veterinary expertise, generating insights for discussion, and writing the manuscript.
Author 7 - Colleen Lau - Author 7 contributed to conceptualization of the study, development of the research protocol, in particular the research questions, generating insights for discussion, and writing of the manuscript.