Integrating digital and field surveillance as complementary efforts to manage epidemic diseases of livestock: African swine fever as a case study

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Abstract

The COVID-19 pandemic has highlighted the importance of a top-down approach to managing infectious diseases, complemented by a bottom-up response. The study investigates a novel approach to surveillance for transboundary animal diseases, using African Swine Fever (ASF) as a case study. Data on information-seeking behavior were collected at both population and local level, using digital data and targeted surveys. The study found that attention during an epidemic can be identified through novel data streams from digital platforms such as Wikipedia, and that field surveys aimed at local workers and veterinary authorities remain a crucial tool to assess preparedness and awareness among front-line actors. In conclusion, the combination of these two tools can help to maximize the outcome of surveillance and prevention activities for selected transboundary animal diseases such as ASF.

Keywords: public attention, digital surveillance, epidemiology, Wikipedia pageviews, digital epidemiology

Introduction

African Swine Fever (ASF) is a transboundary animal disease that affects wild and domestic pigs, with a high case fatality rate. Despite decades of international control efforts, the disease is still spreading in various regions of the world with different epidemiological dynamics. Human behavior plays a key role in the transmission and geographic spread of the ASF virus through infringement or low compliance with biosecurity and preventive measures, movement of contaminated fomites, and/or products, and underreporting of ASF suspected cases. Estonia has been active in field and research programs on ASF prevention and control and has invested efforts in raising awareness of ASF among the general population and animal-related target groups. This work combines survey data and digital trade data to monitor public awareness and preparedness of the veterinary health authorities and field workers based on a combination of non-traditional data sources and survey-based methodologies.

Methods

The study adopts a two-fold approach to assess the level of preparedness towards African Swine Fever (ASF) among the general public and stakeholders. The first approach involves monitoring digital sources such as news and Wikipedia pageviews, while the second approach involves field surveys of veterinary authorities and farmers in Estonia. The digital data collection focused on ASF-affected countries in Europe and Asia between January 2015 and May 2020. The study used two regression models to analyze the correlation between ASF media coverage and online users' collective response.

$$modelIy_t = \alpha_1 news_t + u_t \quad (1)$$

$$modelIIy_t = \alpha_1 news_t + \alpha_1 newsMEM_t + u_t \quad (2)$$

where y_t is the number of country-specific Wikipedia pageviews and u_t is the error term, and the independent variables are either the news volume or the news volume plus a memory term. The first model is a simple linear regression, while the second one includes a memory kernel to account for "memory effects". In the latter, we weighted the cumulative news articles volume time series with an exponential decaying term(Tizzoni et al., 2020; Gozzi et al., 2020). The study also performed a topic modeling analysis on the news content to qualitatively assess the information exposure of both the general population and stakeholders. The survey data were analyzed descriptively. The study found that the level of preparedness toward ASF varied among the general public and stakeholders, and there was a need for improved communication strategies to increase awareness and preparedness.

Results

Figure 1 shows the normalized volume of digital signals, i.e. news and Wikipedia pageviews, and African swine fever (ASF) outbreaks in various countries. The temporal profile of the two digital signals is very similar, showing synchronization of the time-series for most of the countries. The information-seeking behavior decreased after reaching the highest peak, even if the exposure to the news remained high. Latvia, Lithuania, and Poland have similar temporal profiles, presenting multiple peaks in both

Wikipedia pageviews and the volume of news during the reporting time of ASF outbreaks. In Italy, Wikipedia searches only started after the first peak of news volume, suggesting that the disease might be already known in the country. These trends suggest a necessary threshold of information exposure to trigger the information-seeking behaviors which is not necessarily dependent on the surveillance reports of the outbreaks. The two models (1) were compared using the adjusted coefficient of determination (R2). Memory effects improve the model performance. Comparing the two models using the F-test for nested models, led to $p < 0.001$ in most of the cases except for Poland, Belgium, and China, for which $p < 0.02$. Hence, strong statistical evidence suggested that adding the memory term improves performance. To compare the analysis of digital data and on-field surveys the study focused only on Estonia (where the survey was collected). The digital news analyses led to twenty-five topics which were grouped into 5 main broad topics. The most relevant one/ones refer to control measures, intended to prevent both the spreading of ASF and the presence of infected products on the market. This result confirms the most prevalent topics exposure for Estonia to be about control measures during the entire period of the study. The exposure to control measures information is confirmed by the analysis of the survey to the veterinary authorities.

Discussion/Conclusions

The article discusses the importance of managing public health emergencies at both the general population and local levels, with a focus on the African Swine Fever (ASF) outbreak. The study combines non-traditional data sources, such as digital traces generated by user activity on digital platforms, with traditional data collection approaches to assess awareness and preparedness for ASF at different scales. The study found that public interest in ASF peaks rapidly during an initial attention window after exposure to news coverage of a specific outbreak, but declines as media outlets drop the topic. The study also found that engagement of the general public is essential to mitigate the risk of infection and that preventative behavior, such as prohibiting swill feeding and pork product release into the environment, can be essential when the disease is actively circulating. The study suggests that if governmental and health authorities' outreach strategies become dynamic and customized to the evolving epidemiological situation, a bottom-up response coming from the general public could become a tool to support control and mitigation efforts. The study also highlights the potential strength of combined conventional and digital multi-stakeholder engagement efforts to contribute to reducing the spread and impact of potentially devastating epidemics of transboundary animal diseases such as ASF. The study faced limitations due to the SARS-CoV-2 pandemic, such as a small sample size of farmers and veterinary authorities, disruption of the data collection process, and anchoring bias. Digital surveys for both sectorial workers and the general population could help extend the reachable countries and provide guidelines for optimal country-specific strategies.

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