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Evaluation of biological and socio-economic factors related to persistence of African swine fever in Sardinia

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ABSTRACT

Despite the implementation of several eradication programmes, African swine fever (ASF), a viral disease in pigs caused by a DNA virus (ASFV), has been present in Sardinia (Italy) since 1978. Several studies have been carried out on the epidemiology of ASF in Sardinia, aimed at attaining a better understanding of the role of the risk factors related to ASFV persistence, but those studies did not address the social aspects involved. This work sought to bridge this gap, identifying the main social risk factors associated with ASF persistence. With this aim, this study takes into account not only the known "biological" risk factors identified in previous studies, but also the direct correlation between ASF persistence and well-known socio-economic aspects. The demographic characteristics, the Material Deprivation Index (IDM) and the non-compliance with the rules on ASF controls, including the traditional method of keeping free-range pigs has been evaluated. To assess the weight of each risk factor, data about pig farms, wild boar and social factors in Sardinia, were analysed using the Negative Binomial Regression Model. The main outcome was the number of domestic pig outbreaks occurring in Sardinian during 2011–2016. The effect in terms of the odds ratio (OR) was calculated to each factor included. The biological risk factors identified covered the number of animals (OR = 3.33, $p < .0001$, by 100 animals) and farms (OR = 1.07, $p = .006$, by 10 farms), the animal movements (OR = 1.64, $p = .001$, by 10 movements), the presence of illegal pigs (OR = 6.87, $p < .0001$) and the ASFV prevalence in wild boars (OR = 1.30, $p = .001$). Among the socio-economic factors, the compliance with control measures (OR = 0.90, $p < .0001$), the human population increasing by 1000 people (OR = 0.89, $p < .0001$), the growing age of the farmers (OR = 0.66, $p = .025$, by 5 years) and non-relationships with other farms (OR = 0.85, $p < .001$), decreased the ASF risk. The deprived condition (i.e. cultural and material deprivation, lack of resources and overcrowding index) increases the risk of about four times, as the low educational level (OR = 3.97, $p = .002$). Having highlighted the important role of social conditions, this risk definition allows understanding the Sardinian situation and may be useful to decision-makers to draft specific control strategies against this disease in the island, which should take into account local risk factors.

1. Introduction

African swine fever (ASF) is a complex viral infectious disease in swine species caused by a DNA virus (ASFV) that replicates mainly in the cytoplasm and belongs to the Asfarviridae family, genus Asfivirus (Dixon et al., 2005). ASF has epidemiological characteristics that appear to be different in the various countries where the disease appears. For this reason, it is important to link the disease spread to the characteristics of the territory. In Europe, until 2007 and since the eradication of the disease in the Iberian Peninsula, ASF has been confined to Italy. In April 2007, a potential rapid spread was demonstrated by the appearance of the virus in the Republic of Georgia with subsequent outbreaks in Armenia, Azerbaijan and Southern Russia (Gallardo et al., 2013). The presence of outbreaks in Russia and Eastern European countries has further increased the alert and demonstrated ASF's rapid expansion and spread (Sánchez-Vizcaíno et al., 2012). In

Abbreviations: ASF, African swine fever; ASFV, African swine fever virus; BDN, Italian Veterinarian National Database; DP, domestic pigs; EFSA, European Food Safety Authority; IDM, Material Deprivation Index; ISTAT, Italian Statistician National Institute database; IZS, Istituto Zooprofilattico Sperimentale; hab./km2, inhabitants per square kilometre; NBRM, Negative Binomial Regression Model; OR, odds ratio; PE-ASF15-18, ASF Eradication Plan 2015–18; SIMAN, Italian National Informative System for animal disease notification; SVDP, Sero/virus positive in domestic pig farms; VETINFO, Veterinary Information Systems of the Italian Ministry of Health; WB, wild boar; ZIP, Zero-inflated Poisson; ZNI, zone not infected; ZI, zone infected; Zp, protection zone; Zs, surveillance zone

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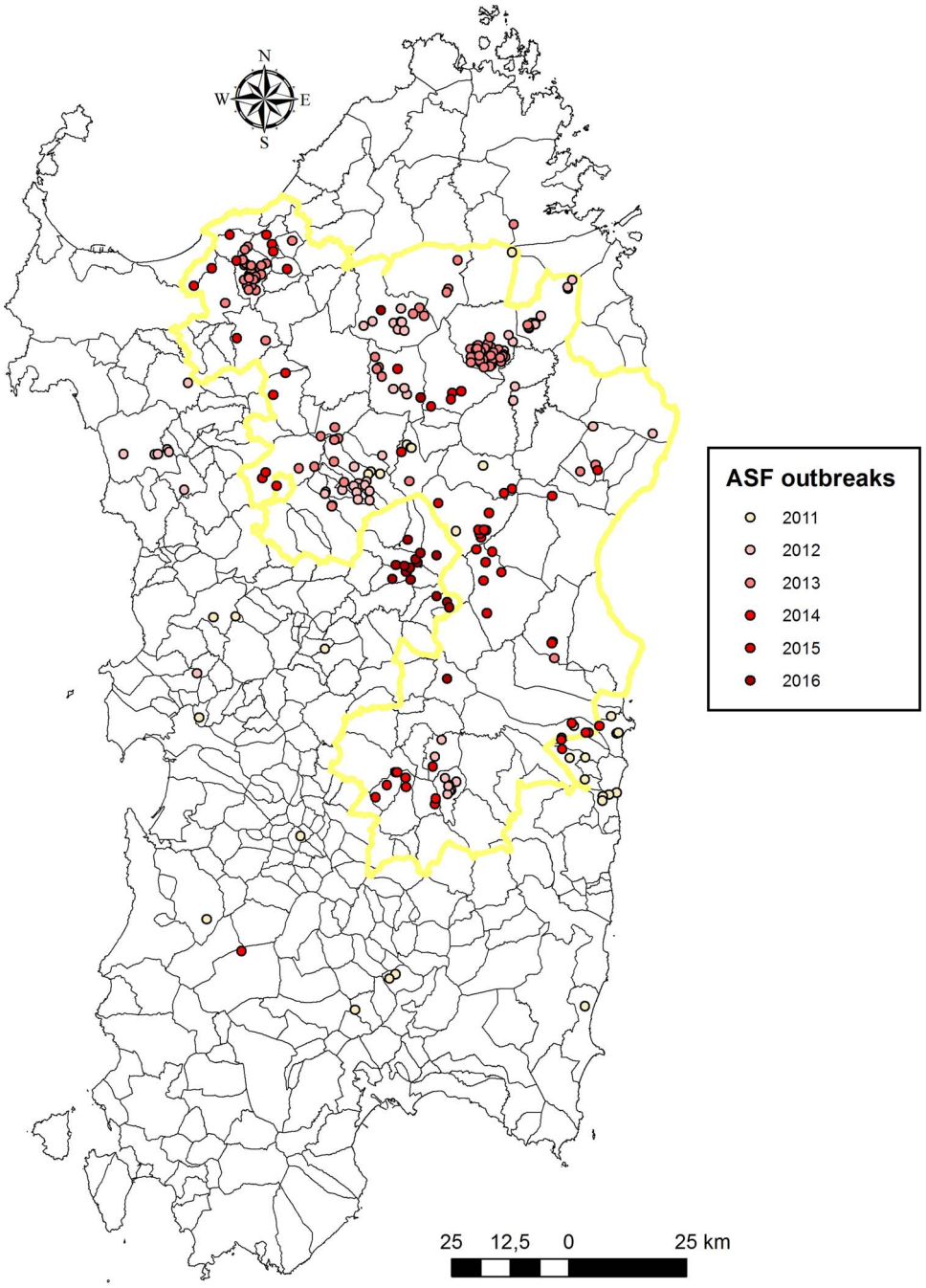

Fig. 1. Number of domestic pig ASF outbreaks from 2011 to 2016 in Sardinia (Italy). The yellow line represents the wild Infected Zone.

Africa, the disease has a "sylvatic cycle" involving wild African Pigs (Phacoerus and Potamochoerus spp.) and soft ticks of the genus *Ornithodoros* (Penrith et al., 2004; Costard et al., 2009). In the current European situation, the risk of ASF spreading to other pig producing countries has increased, and since there is no vaccine, rapid and specific diagnostic procedures is an essential component to control and eradications plans in the affected countries (Raquel et al., 2015; Gallardo et al., 2013; Cappai et al., 2016). ASF was introduced into Sardinia (Italy) 39 years ago. Despite the application of specific eradication plans, the large number of outbreaks in domestic pigs over the years (Fig. 1) are indicative of endemicity (Feliziani et al., 2010). A spatio-temporal analysis conducted by Iglesias et al. (2017) described the monthly dynamics of ASF notifications in Sardinia, revealing a clear peak with different seasons in terms of the maximum values corresponding to domestic pigs and wild boar: the peak in domestic pigs notifications is seen in May and early summer, while the wild boar peak is seen from October to February. Unlike other countries where ASF is endemic, soft ticks are not involved in the ASF cycle in Sardinia, as shown in previous studies (Ruiu et al., 1989; Mur et al., 2016). In February 2014, in accordance with the European Commission, the Sardinian Regional Authority developed a new ASF Eradication Plan 2015–18 (PE-ASF15-18; Regional Decree Number 50/17, 16 December 2014). This extraordinary ASF eradication programme has been in place since 2015 and includes not only better targeted veterinary measures but also measures to eliminate free ranging pigs and incentivization of good practices. Several examples illustrate the devastating economic effects of ASF spilling over from wild boars to domestic pigs (Saatkamp et al., 2000; Komba et al., 2014). The lack of biosecurity, presence of asymptomatic carrier pigs in the wild, illegal pig breeding in free-range grazing, the presence of wild boars, contact