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Risk Factor Analysis for the Transmission of Classical Swine Fever in West Timor, Indonesia

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INTRODUCTION

Classical Swine Fever (CSF) is a serious and highly infectious viral disease of domestic pigs and wild boar (Paton and Greiser-Wilke 2003). The causative agent, Classical Swine Fever Virus (CSFV) is a small (40±60 nm) enveloped ribonucleic acid (RNA) virus with a single stranded genome with positive polarity (Horzinek *et al*. 1971; Moennig and Greiser-Wilke 2008). The virus is one of three pestiviruses that forms a group of economically important pathogens (Moennig *et al.* 1990) belonging to the Flaviviridae family. It has a close antigenic relationship with the other pestiviruses - bovine viral diarrhoea virus (BVDV) and border disease virus (BDV), as demonstrated by immunodiffusion and immunofluorescence tests, and their similar morphology and nucleic acid homology (Wengler 1991; Wengler *et al.* 1995). Indonesia was free from CSF until 1993. Between 1994 and 1996 thousands of pigs were reported to have died from the disease in the Indonesian regions of North Sumatera, Jakarta, Bali, Central Java, and North Sulawesi (Satya and Santhia 2000). An outbreak of CSF was reported in Dili, East Timor in August 1997 and the disease then spread to the Kupang district of West Timor in March 1998 (Satya and Santhia 2009) and subsequently to all districts of Timor (Santhia *et al.* 1997; Santhia *et al.* 1998).

The existence of CSF in an area and the potential for introducing the disease into a new area can be associated with the presence of certain risk factors. Identification of these risk factors is important in understanding the transmission of disease and for developing effective prevention, control and eradication programs. Farmers are a valuable source of information about potential risk factors and associated management and husbandry practices linked with disease as they often have many years of experience in raising or trading livestock. This knowledge can be used to identify risk factors for disease.

The objective of the study was to identify potential risk factors associated with CSF infection in West Timor. In particular factors involved in the management and husbandry of pigs were investigated.

MATERIALS AND METHODS

A cross-sectional serological study was undertaken in 2 districts of West Timor in April and May 2010. A multi-staged sampling approach was used to select the districts, sub-districts, villages, pig owners and pigs sampled in this study. Two districts were selected in West Timor. The selection of districts was purposive given a prior history of clinical cases of CSF and importance in terms of pig production and trading. Sub-districts were selected using simple random sampling after exclusion of sub-districts that were remote or considered to be unsafe or not co-operative. Random selection with replacement was used to determine which pig owners would be invited to participate in the survey on the day of visit. Farmers were eligible for selection if they were: present on day of visit; gave consent to participate; and currently owned more than one pig over the age of 3 months.

Face to face interviews were conducted with farmers in order to identify possible risk factors associated with CSF infection. The questionnaire was conducted to study and identify whether these factors were associated with the presence of CSFV infection in West Timor. Prior to conducting an interview the purpose of the survey was explained to the owner. The questionnaire, approved by the Murdoch University Human Ethics Committee, was administered to 30 farmers from each of the 8 villages. The questionnaire included closed, open and ranking questions.

Data were entered into a Microsoft ACCESS 2007 database and exported into a

statistical package (SPSS Statistics version 17.0) for analysis. For univariable analyses, potential risk factors were compared with positivity on the ELISA test to CSF (seropositive versus seronegative) using the Pearson's chi-square test for independence or the Fisher's exact test. For continuous variables the mean value for seropositive pigs was compared with that of seronegative pigs with an ANOVA, after testing for normality of data and homogeneity of variance. Odds ratios (OR) and their 95% confidence intervals (95% CI) were also calculated to measure the degree of association between putative risk factors and the presence of CSF (Kahn and Sempos 1989).

Factors with a significance level of $P < 0.25$ on the univariable analyses and which were considered to be biologically important were offered to the multivariable binary logistic regression model. This model was built using a manual backwards elimination process as described by Dohoo *et al.* (2003) with a significance level of $P > 0.05$ as the criterion for removal of a variable from the model. If two variables had a high level of collinearity ($r > 0.8$) than one was removed from the logistic regression analysis. The analysis commenced with a saturated model and variables were eliminated from the model in an iterative process. The level of significance for a factor to remain in the final model was set at 0.05. Because of the likely presence of additional variation due to the clustering of herds in villages, village was incorporated as a random effect in the model. Two-way interaction terms among the explanatory variables were examined after identification of the reduced set main effects. Each interaction was added to the model and the significance assessed in the same way as for the explanatory variables. The suitability of the final model was assessed based on the Hosmer and Lemeshow and Nagelkerke R Square values (Hosmer and Lemeshow 2003).

RESULT AND DISCUSSION

Putative risk factors that were potentially involved in CSF infection in West Timor were investigated. In the univariable analyses, seven categories of potential risk factors for the spread of CSFV (pig household characteristics, farm structure and herd information, husbandry, reproductive management, pig movement, health status of pigs, knowledge of pig owners on CSFV and vaccination, and body condition of pigs) were investigated.

The final model generated through backward conditional binary logistic regression is displayed in Table 1. Three factors were retained in the final model. The most strongly associated factor with CSF was introducing pigs in the preceding 12-month period (P =0.01; OR=4.7; 95% CI 1.5, 15.7). Farmers who kept goats were more likely (P=0.022; OR 3.4; 95% CI 1.2, 9.8) to have infected pigs than owners who did not keep these species. Farmers who had vaccinated pigs against CSF were also more likely to have seropositive animals (P=0.035; OR = 2.3; 95% CI 1.1, 5.1). The final model had a reasonable fit with a chi square value for the Hosmer and Lemeshow Test of 3.48 (P = 0.63). The Nagelkerke R square value was 0.344 suggesting that 34.4% of the variability could be explained by the final set of variables. No significant interaction was detected among the final reduced set variables of the model.

Table 1. Multivariable analysis of potential risk factors for CSF in West Timor

Variable name	ß	P	OR	95% CI for OR	
				Lower	Upper
Constant	-3.19	0.000			
Own one or more goats	1.23	0.022	3.42	1.20	9.81
Introduced pigs in the last 12 months	1.57	0.010	4.78	1.46	15.71
Vaccinated pigs against CSF	0.85	0.035	2.33	1.10	5.12

Classical swine fever is a major disease of pigs (ref) and identifying risk factors for infection and understanding factors influencing the transmission and dissemination of this disease is essential when developing control programs.

The presence of cattle and small ruminants in the neighbourhood of pigs has previously been linked to seropositivity of pigs to CSF (Crauwels *et al.* 2003; Liess 1990; Loeffen *et al.* 2009). In the multivariable analysis of this study, farmers who kept goats were 3.42 times more likely to have seropositive pigs than were those who did not keep goats. In West Timor, goats are commonly raised together with pigs or are kept in the same locality. Goats are known to be a host for border disease (BD), which is closely related to CSFV and BVDV (Nettleton *et al.* 1998). It has been suggested that the presence of antibodies to BVDV or BDV in pigs may provide some protection against the transmission of CSFV in and between infected herds (Wieringa-Jelsma 2006). Although no published reports of the presence of BD have been made in Indonesia, this could be due to a lack of testing rather than actual freedom from the disease.

The movement of pigs, in particular that associated with the trading of pigs, has both positive and negative impacts on a population. There are benefits to increasing the size of the population through immigration and introduction of improved genetics, however there are significant risks through the potential introduction of new diseases or new strains of organisms (Févre *et al.* 2006; Lindstrom *et al.* 2010). The purchase of pigs from markets or from different breeding farms has

been shown to pose a significant risk to herds through the potential introduction of diseased animals (Beals *et al.* 1970; Pinto and Urcelay 2003). The movements of pigs, contaminated feed and fomites have also been shown to be significant risk factors for the spread of CSF (Dahle and Liess 1992; Terpstra 1987). In the current study it was found that introducing pigs during the 12-month period preceding the survey was strongly associated with seropositivity (P =0.01; OR=4.7; 95% CI 1.5, 15.7). It would be assumed that the introduced pigs have also introduced CSFV or new strains of the virus to the importing herds. Implementation of a closed herd system, which can be achieved in intensive piggeries and will reduce the likelihood of introducing the disease, is difficult to implement in village level systems due to the small number of pigs owned and hence poor selection opportunities for replacement animals.

Vaccination for the control of CSFV infection has been a useful tool in the disease's eradication (Terpstra 1991). However, the use of live vaccines, other than marker or differentiating infected from vaccinated (DIVA) vaccines, has a major disadvantage where the antibody response induced cannot be differentiated from that arising from natural infection with field virus (van Oirschot 2003). Consequently with vaccines currently used in Indonesia (live virus of C- strain) it is not possible to differentiate vaccine induced immunity from immunity arising from natural infection. In the current study, based on the data analysis, farmers which had vaccinated their pigs against CSF were 2 times more likely to have seropositive pigs than those who had not adopted vaccination (P=0.035; OR = 2.3; 95% CI 1.1, 5.1). This is not surprising as the vaccine induces protective immunity, which is detectable by the diagnostic ELISA used in this study. It is widely accepted that vaccination against CSF is an important step in the control of the disease, and the challenge in West Timor is to increase the level of acceptance and adoption of vaccination by farmers.

CONCLUSION

In the current study a higher seroprevalence was found in animals owned by tertiary educated farmers than by others. This higher seroprevalence was directly linked to the increased level of adoption of vaccination in this cohort of farmers. Education plays an essential role in the management of a successful farm including the prevention of disease. Control of disease in a small-holder system can be challenging due to low inputs and infrastructure. Based on the results from this study it is recommended that: a vaccination program be adopted widely in West Timor; educational programs be developed to increase the awareness of farmers about this disease; and low-cost practices to improve biosecurity be developed for small-holder systems.

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