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CHRONIC PLEURITIS IN PIGS FOR SLAUGHTER: ANALYSIS OF INFECTIOUS AND REARING SYSTEM-RELATED RISK FACTORS, ADJUSTING FOR EXTRABINOMIAL VARIATION IN THE DATA

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La prévalence de la pleurite chronique chez le porc, à l'abattoir, s'est accrue depuis plus de 10 ans au Danemark. Des facteurs de risque infectieux ainsi que liés aux conditions d'élevage ont été identifiés dans une étude réalisée par Mousing et al. (1990). cependant, des compléments d'information liés à de nouvelles données sérologiques ainsi que la nécessité de prendre en considération une variation extrabinomiale ont conduit à réanalyser les données. L'investigation a porté sur un échantillon aléatoire de 4800 porcs issus de 623 élevages danois. Chaque porc a été examiné pour rechercher la présence de pleurite chronique (CP) et de rhinite atrophique (PAR). Le sexe, le poids de carcasse et l'élevage d'origine ont été notés. Chaque porc a fait l'objet d'un prélèvement de sang pour rechercher la présence d'anticorps contre les sérotypes 2, 6, 7, 12 d'Actinobacillus pleuropneumoniae (AP) , Haemophilus parasuis, Mycoplasma hyopneumoniae (MYC) et l'influenza du porc (SI) type H1N1, souches 4744 et 6019. Un questionnaire a permis de collecter des informations sur le statut pathogène (conventionnel versus SPF), le type de production (naisseur-engraisseur versus engraisseur) et le nombre de porcs engraissés l'année précédente. L'unité d'étude était le porc. Le calcul du coefficient de corrélation intra-classe pour les données individuelles a montré des valeurs élevées (0,09-0,48) pour les facteurs infectieux indiquant qu'un ajustement pour une variation extrabinomiale était approprié. Les associations entre CP comme variable dépendante et divers facteurs de risque possibles ont été étudiées grâce à des régressions logistiques multiples avec et sans ajustement pour des effets aléatoires. Les sérotypes 2 et 6 d'AP, MYC, PAR, le poids de carcasse et le nombre de porcs engraissés l'année précédente étaient statistiquement liés à CP. Une interaction significative entre le sérotype 7 de AP et SI, ainsi qu'une interaction moyennement significative entre le sérotype 7 AP et PAR ont été observées.

INTRODUCTION

The prevalence of chronic pleuritis in Danish pigs for slaughter has been increasing during the last decade or more. Infectious and managerial risk factors have been identified in a study by *Mousing et al.* (1990). Complementation of the original investigation by new serological data and the need to formally adjust for extrabinomial variation due to clustering, as pointed out by *McDermott and Schukken* (1994) and *McDermott et al.* (1994), lead to a reanalysis of the data.

MATERIALS AND METHODS

The investigation comprised a random sample of 4800 pigs for slaughter originating from 623 Danish herds. Each pig was thoroughly examined for the presence of chronic pleuritis (CP) and progressive atrophic rhinitis (PAR). The sex of the pig (castrated male versus female), carcass weight (kg) and herd of origin were registered too. Each pig was bled and the blood samples were examined for seropositivity for *Actinobacillus pleuropneumoniae* (AP) serotypes 2, 6, 7, 12, *Haemophilus parasuis* (HP), *Mycoplasma hyopneumoniae* (MYC) and swine influenza (SI) subtype H1N1 (any of the strains 4744 and 6019). Information retrieved through a questionnaire included health status (conventional versus SPF), management (farrow to finish versus finishing herd), number of finishing pigs produced in the previous year (as a proxy variable of herd size) and vaccination procedures. The study design has been described in detail by *Mousing et al.* (1990).

ANALYTICAL METHODS

The pig was chosen as the unit of concern in the analysis. Pigs originating from the same herd made up a cluster since they could not be regarded as mutually independent. The intraclass correlation coefficient ρ, (ρ=(mean square between clusters - mean square within cluster) / (mean square between clusters + (mean cluster size - 1) x mean square within clusters)), was calculated for chronic pleuritis and the possible individual risk factors using the variance (ANOVA) estimator for continuous data (*Donald and Donner*, 1988). For each of the variables only clusters with one or more seropositive pigs or one or more pigs with pathological changes were included in the estimation. The calculation was performed by use of one-way ANOVA (*SAS PROC ANOVA, Statistical Analysis Systems*, 1990).

The associations between chronic pleuritis as the dependent variable and various possible infectious and managerial risk factors were investigated by univariable and multivariable logistic regression models using SAS PROC LOGISTIC (*Statistical Analysis Systems*, 1990). The associations were also investigated in random

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effects logistic regression models, matching observations by herd, using EGRET (*Statistics and Epidemiology Research Corporation*, 1988). The models specified in EGRET were logistic-binomial regression models for 'distinquishable' data, thus indicating that each pig had its own vector of explanatory covariates. Various model building strategies were applied combining models with and without random effects term. Pigs vaccinated against *A. pleuropneumoniae* serotype 2 and *H. parasuis* as well as pigs having questionable or missing results for one or more of the explanatory variables were omitted from the analyses.

RESULTS

An overview of the dependent and explanatory variables in the analysis is shown in Table I along with the estimates of the intra class correlation coefficient .

Table I
Intra class correlation coefficients (ρ) for the different individual-level factors included in the analysis

Individual-level recordings	MSB[1]	MSW[2]	Mean cluster size	ρ
Pathological findings[3]				
CP	0.68	0.18	10.17	0.21
PAR	0.26	0.12	11.19	0.09
Serological findings[4]				
AP serotype 2	1.04	0.11	9.24	0.48
AP serotype 6	0.71	0.14	9.50	0.30
AP serotype 7	0.67	0.17	9.30	0.24
AP serotype 12	0.60	0.14	11.77	0.21
HP	0.52	0.21	9.00	0.14
SI	0.82	0.17	9.05	0.30
MYC	0.29	0.14	8.15	0.12
Individual findings				
Sex	0.30	0.24	7.15	0.03
Weight (kg)	69.78	17.98	7.16	0.29
Herd level findings				
Conventional (vs. SPF)	1.28	0.0	7.81	1.0
Fattening unit (vs. sow herd)	1.93	0.0	7.76	1.0
Pigs per year	1.86×10^{7}	0.0	7.75	1.0

[1] Mean squares between herds.
[2] Mean squares within herds.
[3] Only herds supplying at least one pig with pathological findings.
[4] Only herds supplying at least one serologically positive pig to the sample.

The findings of the logistic-binomial regression model, including three serological variables (*A. pleuropneumoniae* serotypes 7 and 12, and *M. hyopneumoniae*) which were not in the original work by *Mousing et al.* (1990), are shown in Table II. Strata specific odds ratios for main effects involved in the interaction terms are shown in Table III. The interaction between *A. pleuropneumoniae* serotype 7 and progressive atrophic rhinitis was marginally significant (p=0.091) but was kept in the model. Comparing the models with and without random effects term yielded a significant (p<0.001) likelihood ratio statistic for extrabinomial variation.

Table II
Multivariable logistic-binomial regression on a sub-sample with complete data comprising 2718 pigs from 385 herds (clusters)

Parameter		SE( )	P (Walds test)	Odds ratio	95% CI
AP serotype 2	2.13	0.14	<0.001	8.44	6.36-11.20
AP serotype 6	0.51	0.18	0.005	1.66	1.17-2.37
AP serotype 7	-0.25	0.21	0.244	-[1]	-
MYC	0.55	0.14	<0.001	1.73	1.32-2.26
SI	-1.16×10^{-2}	0.14	0.908	-[1]	-
PAR	0.67	0.28	0.015	-[1]	-
(AP serotype 7 x PAR)	0.95	0.56	0.091	-[1]	-
(AP serotype 7 x SI)	0.83	0.27	0.002	-[1]	-
Weight (kg)	-0.42	0.18	0.019	-[2]	-
$(\text{Weight})^2$	2.86×10^{-3}	1.29×10^{-3}	0.027	-[2]	-
Pigs per year	1.26×10^{-4}	5.55×10^{-5}	0.023	-[2]	-

[1] Strata specific odds ratios for main effects contained in the interaction terms shown in Table 3.
[2] Not calculated for the continuous variables.

Table III
Strata specific odds ratios for main effects contained in the interaction terms

Effect	Strata	Odds ratio	95%CI
AP serotype 7	PAR (+), SI (+)	4.62	1.53-13.97
	SI (-)	2.01	0.67-6.03
	PAR (-), SI (+)	1.79	1.25-2.56
	SI (-)	0.78	0.51-1.19
PAR	AP serotype 7 (+)	5.03	1.91-13.29
	AP serotype 7 (-)	1.94	1.14-3.34
SI	AP serotype 7 (+)	2.26	1.41-3.64
	AP serotype 7 (-)	0.98	0.76-1.28

DISCUSSION

The estimated intra class correlation coefficients in Table 1 indicate that the individual-level recordings were to some extent clustered within herd. Not unexpectedly this is most pronounced for infectious agents as *A. pleuropneumoniae* serotype 2 and 6 and swine influenza which were in the range 0.30-0.48 exeeding the range judged as high (0.10-0.20) by *McDermott and Schukken* (1990). The intra class correlation coefficients indicate that an inflation of the estimated variances should take place if not accounted for in the analysis (*McDermott and Schukken*, 1994).

A reanalysis of the original data published by *Mousing et al.* (1990) showed larger standard errors (SE) of the coefficients in the random effects model by a factor 1.1-1.6. As a consequence two of the seven risk factors judged significant in the original study were not significant in the random effects model, thus we have confirmed the points made by *McDermott and Schukken* (1994) where they expected that three of seven variables would turn out non-significant when accounting for clustering.

The present investigation, where data about *A. pleuropneumoniae* serotypes 7 and 12 and *M. hyopneumoniae* were added onto the original analysis, identified *A. pleuropneumoniae* types 2 and 6, progressive atrophic rhinitis, carcass weight and the number of pigs produced the previous year as risk factors associated with chronic pleuritis. Additionally *M. hyopneumoniae* was shown to be a risk factor increasing the risk by 1.7. Finally an interaction was shown between *A. pleuropneumoniae* serotype 7 and swine influenza and a marginally significant interaction was shown between *A. pleuropneumoniae* serotype 7 and progressive atrophic rhinitis which support the evidence of respiratory diseases as multifactorial problems.

REFERENCES

Donald A., Donner A., 1988. The analysis of variance adjustment to Chi-square tests when there is litter or herd correlation in surveys or field trials. Proceedings of the 5th symposium of the international society for veterinary epidemiology and economics, Copenhagen, 490-492.

McDermott J.J., Schukken Y.H., 1994. A review of methods used to adjust for cluster effects in explanatory epidemiological studies of animal populations. Prev. Vet. Med. 18, 155-173.

McDermott J.J., Schukken Y.H., Shoukri M.M., 1994. Study design and analytic methods for data collected from clusters of animals. Prev. Vet. Med. 18, 175-191.

Mousing J., Lybye H., Barfod K., Meyling A., Rønsholt L., Willeberg P., 1990. Chronic pleuritis in pigs for slaugther: an epidemiologic study of infectious and rearing system-related risk factors. Prev. Vet. Med. 9, 107-119.

Statistical Analysis Systems, 1990. SAS/STAT^{R} Users Guide, Version 6, Fourth Edition, Volume 1 and 2, Cary, NC: SAS Institute Inc.

Statistics and Epidemiology Research Corporation. EGRET Users Manual 1988, SERC, Seattle, 98105 WA, USA.