Relation between EP-like lesions and pleurisy with pluck and gut lesions in slaughtered pigs in Northern Portugal

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Abstract

Respiratory diseases have a great impact in the swine production industry. Macroscopic lesions in lungs are often detected during routine post-mortem inspection in the slaughterhouse, with enzootic pneumonia-like lesions (EP-like lesions) and pleuritic lesions being the most common. EP-like lesions, which are primary related with *Mycoplasma hyopneumoniae* infection, are characterised by consolidation areas, demarcated purple or grey areas in the lungs. *Actinobacillus pleuropneumoniae* is a respiratory pathogen and the suggestive lesions associated with previous infections of this agent are commonly chronic pleurisy lesions located in the dorso-caudal regions from the lungs. This type of lesion is commonly evaluated by the Slaughterhouse Pleurisy Evaluation System (SPES). The aim of this study was to determine the occurrence of EP-like lesions and pleurisy in 2,142 finishing pigs from 18 different farms (central Portugal, southern Portugal, and northern Spain), the association between EP-like lesions and pleurisies, and the relationship with pluck lesions (lobe scars, emphysema, lung congestion, pericarditis, liver milk spots lesions, and steatosis) and gut lesions (splenitis, pancreatitis, enteritis). For this purpose, EP-like lesions were classified per lobe under the method of enzootic pneumonia–like lesions. Pleurisy lesions were classified under the SPES score method. The presence of other lesions such as pericarditis, liver milk spots, splenitis, pancreatitis, lymphadenitis, and enteritis were also evaluated. Descriptive and multivariate logistic regression analyses were carried out. A variable was considered statistically significant when its P-value≤ 0.05, i.e. its 95% confidence interval of the Odds Ratio (OR) does not contain 1. Among the sample, 41.1% pigs presented EP-like lesions (20.5% registered EP-like lesions scored 1–3, and 20.7% scored 4–24). Around 12% of the sample presented pleurisy, of which 4.8% were of a degree 4 level. Following the EP-like lesions and pleurisy, liver milk spots and pericarditis were the most frequent lesions (4.8% and 3.6%, respectively). In this study, the most affected lobes by EP-like lesions were the medial and cranial lobes. The higher the EP-like lesion score, the lower the incidence of presenting an SPES score of 4 (OR=0.38, P<0.001). The higher the SPES scores, the lower the incidence of an EP-like lesion score of category 1 (OR=0.86, P=0.031) or category 2 (OR=0.71, P<0.0001). Pericarditis was associated with a higher incidence of SPES scores 1 (OR=8.57, P<0.001), 2 (OR=7.29, P<0.001), or 4 (OR=26.55, P<0.001). Consolidated pneumonia lesions were the most common cause of partial rejection for human consumption, followed by pleuritic lesions, milk spot lesions, and pericarditis. This study reinforces the importance of monitoring respiratory findings of pig carcasses at the slaughterhouse. It is advantageous to assess the animal's production performance and welfare. Moreover, lung lesions are closely associated with other findings in tissues and organs with economic value, which can be subclinical or difficult to diagnose in live animals. Furthermore, to the best of our knowledge, this is the only study of its kind carried out in Portugal.

Key words: *pigs; slaughter; EP-like lesions; pleurisy; pluck lesions; gut lesions*

Introduction

Commission Implementing Regulation (EU) 2019/627 requires visual pluck examination at slaughter to ensure food safety, performing incision and palpation of tissues of the carcass and offal if the official veterinarian (OV) suspects any possible risks to human health, animal health or animal welfare. Furthermore, abattoir meat inspections and visceral lesion scoring are an excellent source of data for animal health and welfare monitoring, as a more cost-effective and useful tool for epidemiological investigations than on-farm observations (Merialdi et al., 2012; Nielsen et al., 2015; Karabasil et al., 2017; Scollo et al., 2017; Bottacini et al., 2021; Čobanoviç et al., 2021; Pallares et al., 2021; Pessoa et al., 2021).

Swine respiratory diseases cause substantial economic losses in the swine industry worldwide. These diseases can be associated with macroscopically visible pathological changes, such as lung lesions. Respiratory pathological findings can be detected at routine post-mortem inspection at the slaughterhouse and can be used as disease indicators (Scollo et al., 2017; Karabasil et al., 2017; Alawneh et al., 2018; Ferraz et al., 2020; Pessoa et al., 2021).

Porcine respiratory diseases are characterised by a combination of several environmental conditions, host factors and an interaction between primary infectious agents and opportunistic other ones (Merialdi et al., 2012; Čobanoviç et al., 2021; Pessoa et al., 2021). *Mycoplasma hyopneuomiae* is the primary agent of enzootic pneumonia (EP), a chronic respiratory disease associated with increasing medication costs, decreased growth rates, decreased feed conversion ratios, and higher susceptibility of infection by other respiratory pathogens (Merialdi et al., 2012; Hillen et al., 2014; Michiels et al., 2017; Ferraz et al., 2020; Pallares et al., 2021). Another important respiratory pathogen is *Actinobacillus pleuropneumonia* (APP) (Brewster et al., 2017). The principal respiratory viruses are Reproductive and Respiratory Syndrome virus (PRRSv), Influenza A Virus (IAv), Porcine Circo virus type-2 (PCV-2) and Porcine Respiratory Coronavirus (PRCoV) (Čobanoviç et al., 2021; Pessoa et al., 2021;). Several main secondary pathogens, which probably increase respiratory disease severity, are *Streptococcus suis*, *Haemophilus parasuis* and *Pasteurella multocida* (Pessoa et al., 2021).

Coughing and sneezing are the most easily assessed clinical signs of respiratory disease in pigs during ante-mortem examination (Pessoa et al., 2021) and lung lesions are the most frequently detected findings from pneumonia and pleuritis (Flabet et al., 2021). Enzootic pneumonic lesions consist of well-defined purple and grey areas of pulmonary consolidations located mostly at the cranioventral lung areas and sometimes in the anterior parts of the diaphragmatic lobe (Merialdi et al., 2012; Brewster et al., 2017; Ferraz et al., 2020; Pallares et al., 2021; Maes et al., 2023). APP lesions are associated with the development of pleuritis that can include lobe to lobe or lungs to thoracic wall fi-

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brous and fibrinous adhesions (Merialdi et al., 2012; Brewster et al., 2017). But not only lung lesions are related with respiratory diseases. Bottacini et al. (2021) found that there is a positive correlation between fibrinous pericarditis and severe pleuritis. Liver milk spots, that usually occur asymptomatically, may be associated with the increase the prevalence of EP-like lesions (Correia-Gomes et al., 2017; Andoni et al., 2023).

Although respiratory infections cause negative impacts in the swine industry, to the extent of our knowledge, there have been no studies to date on relating EP-like lesions with pleurisies and other important inspection findings in the pluck at slaughterhouses in Portugal. Furthermore, there is a lack of knowledge regarding the relationship between these lesions with other than pluck lesions. Therefore, the aim of this work was to study the occurrence of respiratory lesions detected during meat inspection of finishing pigs at the slaughterhouse, and determine the association with other lesions present in the pluck and gut.

Materials and methods

Data collection

The data used in this study were collected between October and December 2021 in a pig slaughterhouse in northern Portugal, fulfilling the relevant ethical and practical guidelines. In total, 2142 finishing pigs from 18 farms in the central and southern regions of Portugal, and in northern Spain were slaughtered and included in this study.

The average body weight was 80 kg. Animals from the same farm arrived at the slaughterhouse by road transport vehicles and were positioned in various stalls at lairage. No mixing of farm batches or overcrowding was reported. The average velocity of the slaughter line was 150 animals/hour.

Pluck and gut inspection

At the abattoir, records of clinical signs of respiratory disease and pluck and carcass lesions were documented during meat inspection, at ante-mortem and post-mortem inspection respectively. The post-mortem examination was performed in accordance with Commission Implementing Regulation (EU) 2019/627. This inspection was carried out by two veterinarians directly during the slaughtering process, from a platform immediately after the evisceration area. One veterinarian scored the presence of EP-like lesions, pleurisies, lymphadenitis (bronchial and mediastinal), pluck lesions (lobe scars, emphysema, lung congestion, pericarditis, liver milk spots lesions, and steatosis) and gut lesions (pancreatitis, splenitis, and enteritis). The second veterinarian evaluated the extension and evolution status of these lesions in the carcass, and scored the presence of lymphadenitis in the mandibular, inguinal, and mammary lymph nodes. Lesions were classified according to Tables 1 and 2.

The EP-like lesions score is related with the score according with the affection percentage of each lobe (cranial, medial and diaphragmatic) and the score can range from 0 to 4. EP-like lesions were scored as described by Madec and Kobisch (1982), Ostanello et al. (2007) and Scollo et al. (2017). The score of the right lung lobes were added to the correspondent score of lobes from the left lung, meaning that the considered classification to characterize the EP-like lesions in the lungs vary between 0-8, as the sum of the lobe lesion score of each lung. The accessory lobe was not classified, as performed by Scollo et al. (2017).

To evaluate pleurisies, suggestive of APP infections, the Slaughterhouse Pleurisy Evaluation System (SPES) was used, as described by Dottori et al. (2007) and Scollo et al. (2017). Figure 1 shows examples of lungs affected by EP-like lesions, pleurisy lesions, and correspondent scores according with the Table 1.

Statistical analysis

The statistical analysis was performed in R (version 4.3.0). Descriptive statistics were conducted (absolute and relative frequencies, cross relative frequency between EP-like lesions scores and SPES lesion scores), and to understand the possible links between EP-like lesions and SPES lesions with the other lesions found in the carcass, multivariate logistic regression models were created. The first model presents the EP-like lesion scores as the dependent variable and SPES score region, cough in the batch, sneezing in the batch, pericarditis, emphysema, blood congestion in the lungs, scars (in the cranial, medial and diaphragmatic lobes), milk spots, steatosis, enteritis, pancreatitis, splenitis, and lymphadenitis (mandibular, mediastinal, bronchial, inguinal, and mammary) as independent variables. The second model presents the SPES score as the dependent variable and EP-like lesion score region, cough in the batch, sneezing in the batch, pericarditis, emphysema, blood congestion in the lungs, scars (in the cranial, medial and diaphragmatic lobes), milk spots, steatosis, enteritis, pancreatitis, splenitis, and lymphadenitis (mandibular, mediastinal, bronchial, inguinal, and mammary) as independent variables. The analyses of multicollinearity, independence of observations, and comparison of fit with the null model

Table 1. Score classification of pleurisy and EP-like lesions (Adapted from: Madec and Kobisch, 1982; Ostanello et al., 2007; Dottori et al., 2007, and Scollo et al., 2017).

Score	SPES score (per lung)	Enzootic pneumonia–like lesions score (per lobe)
0	No adhesions	No lesions
1	Adhesions between cranioventral portions of cranial, medial and diaphragmatic lobes OR Unilateral mild adhesions at the ventral margin of a diaphragmatic lobe	<25% of the lobe surface affected
2	Adhesions with slight to moderate extensions into one of the diaphragmatic lobes	25 – 49% of the lobe affected
3	As score 2, but bilateral; in one of the diaphragmatic lobes; can be extensive	49 – 74% of the lobe affected
4	Severely extended lesions, at least 1/3 of both diaphragmatic lobes	>75% of the lobe affected

SPES - Slaughterhouse Pleurisy Evaluation System

Table 2. Classification of EP-like lesions, pleurisy (SPES score), pluck lesions (lobe scars, emphysema, lung congestion, pericarditis, liver milk spots lesions, and steatosis), gut lesions (pancreatitis, splenitis, and enteritis), and lymphadenitis (mandibular, mediastinal, bronchial, inguinal, and mammary lymphadenitis) (adapted from Scollo et al., 2017)

Lesions	Scale
EP-like lesions	Each lobe, except the accessory lobe, was scored from 0 to 4. The maximum possible total score is 24.
Pleurisy (SPES score)	0 – 4
Lobe scars	0 – Absence 1 – Presence (inclusion of the identification of the affected lobe(s))
Emphysema	0 – Absence 1 – Presence
Lung congestion	0 – Absence 1 – Presence
Pericarditis	0 – Absence 1 – Presence (Light and moderate pericarditis) 2 – Presence (Highly severe pericarditis)
Liver milk spots lesions	0 – Absence 1 – Until 5 lesions 2 - Between 5 and 10 milk spots lesions 3 – More than 10 milk spots lesions
Steatosis	0 – Absence 1– Presence
Pancreatitis	0 – Absence 1 – Presence
Splenitis	0 – Absence 1 – Presence
Enteritis	0 – Absence 1 – Presence
Lymphadenitis (mandibular, mediastinal, bronchial, inguinal, and mammary lymph nodes)	0 – Absence 1 – Presence (inclusion of the affected lymph nodes)

EP – Enzootic Pneumonia; SPES - Slaughterhouse Pleurisy Evaluation System

were performed, and the assumptions of the multivariate logistic regression of both created models were met. Backward selection was used to build the final models. Independent variables not considered significant in the original model were excluded one by one. The difference in deviations of the models produced was compared with the null model and with previous models, accepting the best model in which the difference obtained a test statistic whose *p-value* was less than 0.05 in the likelihood ratio test. The pseudo-R^2 from

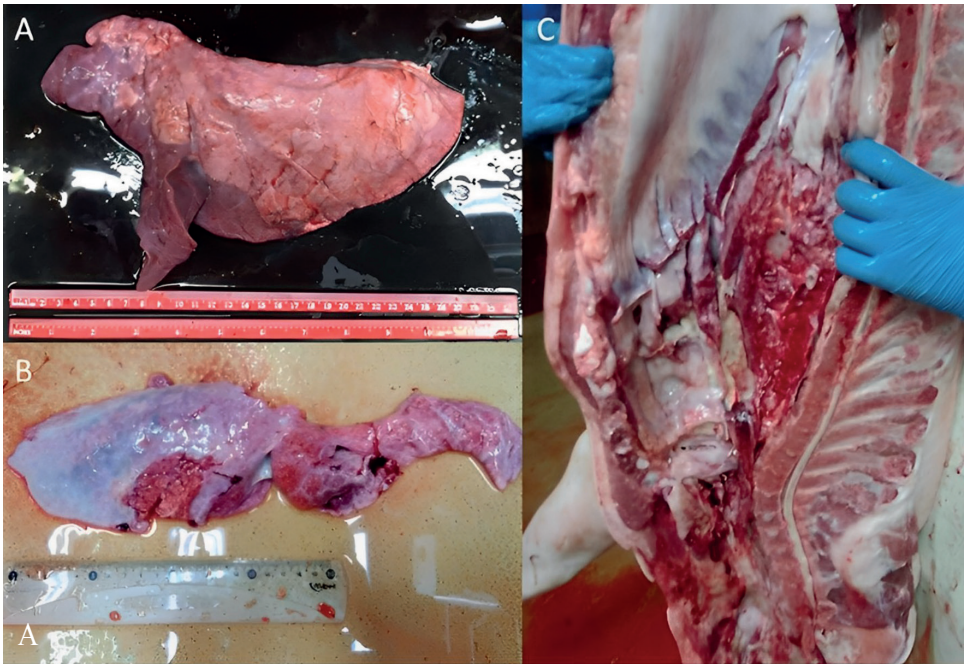

Figure 1. Lung affected with purple lesions related with EP-like lesions in the cranial (EP-score 4), medial (EP-score 4), and diaphragmatic lobes (EP-score 1) (A); Lung affected with APP lesions (pleurisy) SPES score 4 (B); Pleurisy of an adhered lung to the ribs, indicating SPES score 4 (C).

the best model with EP-like lesions score category as dependant variable was 0.26 and the pseudo-R^2 from the best model with SPES score as dependant variable was 0.17. Variables with a p-value ≤ 0.05 were considered significant. *P-values* between 0 and 0.001 were considered highly significant, between 0.001 and 0.01 very significant. To calculate the *Odds Ratio* (OR), a confidence interval of 95% was considered. Aiming to simplify the results and interpretations, in order to obtain a more homogeneous representativeness between the categories, the EP-like lesions scores were divided according with the three categories: scores as 0 were classified as category 0, scores between 1 and 3 as category 1, and scores between 4 and 24 as category 2.

Results

Characterisation of the sample and lesions

Between October and December 2021, a total of 2,142 finishing pigs from 18 different farms were slaughtered. Around 63.91% of pigs originated from southern Portugal, 20.9% from Spain and 15.2% from central Portugal (Table 3). Four pigs from Spain and four from Portugal died during transport and/or during lairage time.

The ante-mortem inspection data determined that 12.4% of the slaughtered pigs came from batches with reports of sneezing cases (Table 3). Among the sample, 10.6% were included in a batch with moderated coughing, and 7.6% included in a batch with a slight coughing (Table 3).

Table 3. Results from descriptive analysis: mean and relative frequency of each variable (region, cough in the batch, sneezing in the batch, emphysema, lobe scars, lung congestion, pericarditis, milk spot lesions, lymphadenitis, steatosis, pancreatitis, splenitis, enteritis, pleurisy, and EP-like lesions)

	Variable	Absolute frequency	Relative frequency (%)
Region	Spain	447	20.9%
	Centre Portugal	326	15.2%
	South Portugal	1369	64.0%
Cough	Moderate coughing batch	226	10.6%
	Light coughing batch	163	7.6%
Sneezing	Included in a sneezing batch	265	12.4%
Emphysema	Emphysema	3	0.1%
Lobe scars	Cranial Lobe	53	2.5%
	Medial Lobe	143	6.7%
	Diaphragmatic Lobe	8	0.4%
Lung congestion	Congestion	43	2.0%
Pericarditis		78	3.6%
	Severe pericarditis	3	0.1%
	Light and moderate pericarditis	75	3.5%
Milk Spot lesions		103	4.8%
	< 5 lesions	29	1.3%
	5–10 lesions	14	0.7%
	> 10 lesions	60	2.8%
Lymphadenitis	Mandibular lymph nodes	60	2.8%
	Mediastinal lymph nodes	11	0.5%
	Bronchial lymph nodes	74	3.5%
	Inguinal lymph nodes	53	2.6%
	Mammary lymph nodes	12	0.6%
Steatosis		5	0.2%
Pancreatitis		9	0.4%
Splenitis		16	0.8%

Enteritis		15	0.7%
Pleurisy lesions		278	13.0%
	SPES Score 1	67	3.1%
	SPES Score 2	73	3.4%
	SPES Score 3	35	1.6%
	SPES Score 4	103	4.8%
EP-like lesions (scores 1–24)		883	41.1%

EP – Enzootic Pneumonia; SPES - Slaughterhouse Pleurisy Evaluation System

Lymphadenitis scores report a mandibular reaction in 2.8%, bronchial reaction in 3.5%, and inguinal reaction in 2.5% of the sample (Table 3). The most affected lymph nodes were the bronchial, representing 38.0% of the recorded lymph nodes reactivities. Almost 4% of the sample recorded pericarditis (severe and light) (Table 3). The majority of livers that registered milk spot lesions were affected by more than 10 milk spot lesions (score 3), representing 2.8% of the total sample (Table 3). Around 0.2% presented steatosis, 0.7% enteritis, 0.4% pancreatitis, and 0.75% splenitis. Table 3 shows the relative frequencies of the occurrence of each variable.

Considering pleurisy lesions, 13.0% of animals registered these lesions, and according to the SPES score, 3.1% of the slaughtered animals presented with score 1, 3.4% presented score 2, 1.6% score 3, and 4.8% registered score 4 (Table 3).

Among these carcasses, 41.1% presented EP-like lesions (Table 3). In 20.5% of cases, the EP-like lesions score was between 1 and 3 (category 1), and in 20.7% the scores were between 4 and 24 (category 2). The medial one was most affected. At least one medial lobe was affected in 33.4% of slaughtered pigs, in 24.3% at least one cranial lobe was affected, and in 14.3% at least one diaphragmatic lobe was affected (Table 4).

It was observed that 37% of pigs that presented EP-like lesions did not show concomitant SPES lesions. Of pigs presenting EP-like lesions, only 1.2% presented a concomitant SPES score 1, 1.4% had a concomitant SPES score 2, 0.5% had a concomitant SPES score 3, and 0.7% with a concomitant SPES score 4 (Table 5).

Multivariate logistic regression results

In comparison with the Spanish pigs, Portuguese pigs had a higher incidence of presenting EP-like lesions. Pigs from central and southern Portugal were associated with a higher incidence of presenting EP-like lesions in score category 1 (*OR*=3.49, *P*<0.001; *OR*=2.44, *P*<0.001, respectively) and category 2 (*OR*=4.57, *P*<0.001; *OR*=2.63, *P*<0.001, respectively) (Table 6).

Pigs from batches with recorded coughing cases presented a higher incidence of EP-like lesions in score category 1 (*OR*=2.18, *P*<0.001) and category 2 (*OR*=5.43, *P*<0.001). The higher the SPES score, the lower the incidence of EP-like lesions in score category 1 (*OR*=0.86, *P*=0.031) and category 2 (*OR*=0.71, *P*<0.001). Bronchial lymph nodes reactivity was associated with a higher incidence of EP-like lesions score category 2 (*OR*=37.70, *P*0.001) (Table 6).

The higher the EP-like lesion score, the lower the incidence of presenting an SPES score 4 (*OR*=0.40, *P*<0.001). Compared with pigs from Spain, pig carcasses

Table 4. Results from the descriptive analysis: relative frequency of lobes affected by EP-like lesions and the respective scores, mean of the scores, relative frequency of each category of EP-like lesions scores and the mean of the general scores (classification scores between 0 and 24).

Variable		Relative frequency of affected lobes	Score (left and right lobe)	Relative frequency of scores
EP-like lesion score	Cranial lobes	24.3%	Score 0	75.7%
			Score 1	7.4%
			Score 2	5.5%
			Score 3	2.2%
			Score 4	3.1%
			Score 5	1.1%
			Score 6	2.1%
			Score 7	1.1%
			Score 8	1.7%
	Medial lobes	33.4%	Score 0	66.6%
			Score 1	9.7%
			Score 2	6.3%
			Score 3	3.1%
			Score 4	5.2%
			Score 5	1.3%
			Score 6	1.78%
			Score 7	1.4%
			Score 8	4.7%
	Diaphragmatic lobes	14.3%	Score 0	85.8%
			Score 1	7.3%
			Score 2	4.3%
			Score 3	1.2%
			Score 4	1.1%
			Score 5	0.1%
			Score 6	0.3%
			Score 7	0.0%
			Score 8	0.1%
EP-like lesion category	Category 0 (Score 0)			58.8%
	Category 1 (Score 1–3)			20.5%
	Category 2 (Score 4–24)			20.7%

*Mean in the scale score 0–24; EP – Enzootic Pneumonia

Table 5. Results of the cross descriptive analysis between SPES score and EP-like lesions score category

	SPES score				
	0	1	2	3	4
Absence of EP-like lesions (category 0)	49.6%	1.9%	2.0%	1.1%	4.1%
Presence of EP-like lesions:	37.0%	1.2%	1.4%	0.5%	0.7%
Category 1	18.3%	0.7%	0.8%	0.3%	0.5%
Category 2	19.1%	0.5%	0.6%	0.2%	0.2%

EP – Enzootic Pneumonia; SPES - Slaughterhouse Pleurisy Evaluation System

from southern Portugal were associated with a lower incidence of SPES score 2 (*OR*=0.33, *P*=0.001), score 3 (*OR*=0.40, *P*=0.020), or score 4 (*OR*=0.29, *P*<0.001). Additionally, pig carcasses from central Portugal compared with those from Spain were associated with a lower incidence of presenting an SPES score 3 (*OR*=0.20, *P*=0.023) or score 4 (*OR*=0.31, *P*=0.002). Pigs from batches that presented sneezing were more associated with a higher incidence of SPES score 1 (*OR*=3.55, *P*=0.006) or score 3 (*OR*=2.02, *P*<0.036). Pericarditis was associated with a higher incidence of SPES score 1 (*OR*=8.57, *P*<0.001), score 2 (*OR*=7.29, *P*<0.001), and score 4 (*OR*=26.55, *P*<0001). Enteritis was associated with a higher incidence of occurrence SPES score 3 (*OR*=16.9, *P*=0.001) or score 4(*OR*=9.30, *P*=0.004) (Table 7).

Discussion

Respiratory diseases have a great impact on animal health and welfare, causing substantial economic losses in intensive pig production (Meyns et al., 2011; Andoni et al., 2023; Petri et al., 2023). Surveillance and evaluation of risk factors are important means of monitoring and controlling these kinds of diseases and the slaughterhouse is a strategic point for data collection for this purpose (Merialdi et al., 2012; Correia-Gomes et al., 2017).

Enzootic pneumonia-like lesions and pleurisy are commonly found during the post-mortem inspection in the slaughterhouse (Holt et al., 2011, Merialdi et al., 2012). In the present study, about 41% of slaughtered animals presented with EP-like lesions and around 13% with pleurisy.

Enzootic pneumonia-like lesions, primarily related with *Mycoplasma hyopneumoniae* infection, are associated with ante-mortem non-productive cough and are characterised by consolidated areas, demarcated purple or grey areas in the lungs (Scollo et al., 2017; Lisgara et al., 2022). In the present study, lungs from animals included in batches presenting light and moderate cough ante-mortem, in average, presented a higher incidence of being affected by EP-like lesions in categories 1 and 2. The ventro-cranial region of the lungs is the main affected region (Vitali et al., 2021). In this study, the lobes most affected with EP-like lesions were the medial and cranial lobes (mainly low score lesions. The highest lesion score (score 8) was the fourth most frequent scores in the medial lobes affected by EP-like lesions, after the lowest score (score 1), score 2 and score 4. No significant correlation was found between lung scars and EP-like lesions score, although the medial and cranial lobes were the most scarred areas. Additionally, the bronchial lymph node was

Table 6. Multivariate logistic regression results for the model with the EP-like lesion score category as the dependent variable (Residual Deviance: 3582.505)

	EP-like lesions score category 1 (vs category 0)				EP-like lesions score category 2 (vs category 0)			
	OR	95% CI		*p*-value	OR	95% CI		*p*-value
		2.5%	97.5%			2.5%	97.5%	
(Intercept)		0.11	0.20	< 2.2e-16 **		0.06	0.12	< 2.2e-16 **
SPES score	0.86	0.75	0.99	0.031*	0.71	0.59	0.86	0.000 **
Centre Portugal (vs Spain)	3.49	2.26	5.24	9.41e-09 **	4.57	2.89	7.26	1.010e-10 **
South Portugal (vs Spain)	2.44	1.75	3.39	1.34e-07 **	2.63	1.81	3.84	4.699e-07 **
Cough in the batch	2.18	1.63	2.95	2.21e-07 **	5.43	3.61	6.13	< 2.2e-16 **
Sneezing in the batch	1.14	0.68	1.90	0.630	0.97	0.60	1.57	0.900
Pericarditis	0.52	0.25	1.09	0.080	0.73	0.32	1.63	0.440
Scar Medial Lobe	0.90	0.58	1.40	0.630		0.30	0.96	0.040 *
Milk Spots	0.97	0.77	1.23	0.830	1.14	0.91	1.44	0.240
Reactivity of the Mandibular Lymph nodes	0.40	0.16	0.97	0.040 *	1.08	0.54	2.16	0.830
Reactivity of the Mediastinal Lymph nodes	0.79	0.14	4.53	0.790	0.13	0.020	0.83	0.030 *
Reactivity of the Bronchial Lymph nodes	2.39	0.75	7.60	0.140	37.70	15.61	91.05	7.19e-16 **

Highly significant** ($p<0.001$); Significant * ($p<0.05$); OR – Odds Ratio; CI – Confidence Interval; EP – Enzootic Pneumonia; SPES - Slaughterhouse Pleurisy Evaluation System

Table 7. Multivariate logistic regression results for the model with SPES score as the dependent variable (Residual Deviance: 2130.495)

	SPES score 1 (vs score 0)				SPES score 2 (vs score 0)				SPES score 3 (vs score 0)				SPES score 4 (vs score 0)			
	OR	95% CI		*p*-value	OR	95% CI		*p*-value	OR	95% CI		*p*-value	OR	95% CI		*p*-value
		2.5%	97.5%			2.5%	97.5%			2.5%	97.5%			2.5%	97.5%	
(Intercept)	0.03	0.014	0.052	< 2.2e-16 ***	0.07	0.048	0.11	< 2.2e-16 ***	0,04	0.022	0.073	< 2.2e-16 ***	0,12	8.34e-02	1.76e-01	< 2.2e-16 ***
EP-like lesions score category	0.75	0.53	1.06	0.100	1.03	0.74	1.44	0.840	0.88	0.53	1.46	0.610	0.40	2.41e-01	5.92e-01	2.125e-05 ***
Centre Portugal (vs Spain)	1.21	0.51	2.86	0.670	0.60	0.30	1.21	0.150	0.20	0.05	0.80	0.020 *	0.31	1.47e-01	6.40e-01	0.002 **
South Portugal (vs Spain)	1.16	0.59	2.27	0.670	0.33	0.19	0.58	0.0001 ***	0.40	0.19	0.87	0.020 *	0.29	1.78e-01	4.85e-01	1.68e-06 ***
Cough in the batch	9.30	0.52	1.67	0.810	4.07	0.16	1.06	0.070	1.22	0.014	1.09	0.060	2.42	8.69e-38	6.74e+27	0.780
Sneezing in the batch	3.55	1.44	8.79	0.006 **	3.12	0.72	13.57	0.130	2.02	1.209	339.12	0.040 *	2.07	7.38e-28	5.83e+37	0.750
Pericarditis	8.57	3.92	18.72	7.04e-08 ***	7.29	3.24	16.41	1.58e-06 ***	4.06	0.95	17.45	0.060	26.6	14.63	48.21	< 2.2e-16 ***
Enteritis	2.41	0.27	21.90	0.430	3.53	0.42	29.60	0.250	16.93	3.29	87.22	0.001 ***	9.30	2.05	42.09	0.004 **

Highly significant*** ($p<0.001$); Very significant ** ($p<0.01$); Significant * ($p<0.05$); OR – Odds Ratio; CI – Confidence Interval; EP – Enzootic Pneumonia; SPES - Slaughterhouse Pleurisy Evaluation System.

correlated with a higher incidence of EP-like lesions scores from category 2 (scores between 4 and 24).

Actinobacillus pleuropneumoniae is a respiratory pathogen and suggestive lesions associated with previous infections of this agent are commonly chronic pleurisy lesions located in the dorso-caudal regions of the lungs (Vitali et al., 2021). SPES is a system to grade pleurisies during slaughter (Marruchella et al., 2019) and was the chosen method to evaluate this condition. The present study indicates that lungs from animals from batches with ante-mortem sneezing cases presented a higher incidence of being affected by adhesions between the cranioventral portions of the cranial, medial and diaphragmatic lobes or unilateral mild adhesions at the ventral margin of the diaphragmatic lobe. These animals also have a higher chance of bilateral adhesions with slight to moderate extensions into one of the diaphragmatic lobes.

Portuguese batches presented, on average, a higher incidence of being affected by EP-like lesions of categories 1 and 2, and a lower incidence of SPES scores 2, 3, and 4 compared with Spanish pigs. According to these results, it is possible to deduce that Portuguese batches were more affected by EP-like lesions and Spanish pigs were more affected by pleurisies. Unfortunately, it was not possible to link these results with the farm conditions, as that information could not be collected. It is known that in comparison with small farms, commercial farms are more likely to have higher EP-like lesions and pleurisy scores, as respiratory diseases are often associated with insufficient ventilation (Liao et al., 2017; Alawneh et al., 2018).

Another objective of this study was to correlate respiratory findings with other pluck lesions. Lesions such as pleurisies, pneumonia, pericarditis, and milk spots in the liver are the most common visceral lesions founded during post-mortem inspection and are indicative of animal health and welfare problems (Čobanović et al., 2019). Chronic pleurisies and EP-like lesions are commonly registered in the pluck (Petri et al., 2023).

Pericarditis affected 3.6% of the slaughtered pigs (78 cases). In the present study, pericarditis was associated with SPES scores 1, 2, and 4. Pleurisy is mostly related with inflammation of the lungs, though the pericardium can also be affected (Petri et al., 2023). Bottacini et al. (2021) also described a positive correlation between fibrinous pericarditis and pleurisy score 4 (the higher score), and suggested pericarditis as a secondary condition to the extension of the inflammation of the pleural sacs or a primary common origin. Liao et al. (2017) found a link between adhesive pericarditis and the occurrence of lungs with an SPES score 4. It was previously described that pericarditis can be considered a complication of EP (Correia Gomes et al., 2017) and associated with *Mycoplasma hyopneumoniae* (Rodrigues da Costa et al., 2020), though no evidence has been found of a corelation between the occurrence of pericarditis and EP-like lesions in this study.

Although liver milk spots were the third most common type of lesion among the slaughtered pigs (4.81% of the slaughtered pigs presented milk spots), following EP-like lesions and pleurisies, no relationship was found between lung lesions and liver milk spots, although this has been described in other studies. Once milk spots are related with *Ascaris suum*, larva can migrate to the lungs and induce lung lesions, increasing the prevalence of EP-like lesions (Correia-Gomes et al., 2017).

A possible link between SPES scores and EP-like lesions scores was assessed. In general, the study determined that the

higher the SPES score, the lower the incidence of having an EP-like lesion. Animals presenting a higher EP-like lesion score generally showed a lower incidence of having a higher SPES score. Tonni et al. (2022) also found no association between the presence of *Mycoplasma hyopneumoniae* and *Actinobacillus pleuropneumoniae*. However, Meyns et al. (2011) reported a correlation between increased pneumonia scores and higher SPES scores.

Another aim of this study was to determine a possible relationship between gut and lung lesions. Enteritis was associated with a higher incidence of SPES scores 3 and 4, though the absolute frequency was so low that this result must be considered with caution. No further associations were found between lung and gut lesions.

One of the limitations of the study is the rapid velocity of the slaughter line may influence a proper evaluation of the lesions, particularly mild ones. Only two researchers were involved in scoring different pluck and gut lesions in a short period of time, with the average post-mortem inspection for each pluck and respective viscera taking just 24 seconds. Furthermore, scoring EP-like lesions is a subjective method as it is not possible to calculate the percentage of the affected lobe with ideal precision. There may be a bias due to the fact that the farms were not uniformly represented and since the study was carried in a single slaughterhouse, the results only represent the animals slaughtered there.

Conclusion

To the best of our knowledge, this is the only study of its kind carried out in Portugal. In this study, consolidated pneumonia lesions represented the most common cause for partial rejection for human consumption, followed by pleuritic lesions. In addition to these types of lung lesions, milk spot lesions in the liver and pericarditis were common findings among the sample and may represent also an economic impact due to discard. The EP-like lesions and pleurisies can be associated with other pluck lesions, such as the case of pleurisy with pericarditis.

This study reinforces the importance of monitoring lung lesions at slaughter. Not only are these studies valuable for determining the economic impact of respiratory diseases, but they also give information on other organ and tissue pathological findings, giving an overview of general animal welfare, health and productivity. This information can be valuable to farmers, researchers and ultimately the consumer, as these studies give information that can be assessed to find solutions to issues in animal production and improving disease control.

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Odnos između lezija sličnoj enzootskoj pneumoniji (EP) i pleuritisa s lezijama srca, jetre, traheje i pluća te probavnog trakta u zaklanim svinjama u sjevernom Portugalu

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Respiratorne bolesti imaju veliki utjecaj na svinjogojsku proizvodnju. Makroskopske se lezije u plućima često detektiraju kod rutinskih razudbi u klaonicama s tim da su lezije slične enzootskoj pneumoniji (lezije slične EP-u) i pleuritične lezije. Lezije slične EP-u, koje su prije svega povezane s infekcijom bakterijom *Mycoplasma hyopneumoniae*, okarakterizirane su konsolidacijskim područjima, ograničenim ljubičastim ili sivim područjima u plućima. *Actinobacillus pleuropneumoniae* respiratorni je patogen, a lezije koje na njega ukazuju povezane s prethodnim infekcijama ovim uzročnikom obično su kronične pleuritične lezije koje se nalaze u dorzo-kaudalnom području pluća. Ovu vrstu lezija obično ocjenjuje „Sustav za procjenu pleuritisa klaonice" (SPES). Cilj je ove studije ispitati pojavnost lezija sličnih EP-u i pleuritisa u 2.142 svinje iz završne obrade koje dolaze s 18 različitih farmi (središnji i južni Portugal i sjeverna Španjolska), vezu između lezija sličnih EP-u i pleuritisa i vezu s lezijama srca, jetre, traheje i pluća (ožiljci na režnjevima, emfizem, kongestija pluća, perikarditis, lezije mliječno bijelih mrlja na jetri i steatoza) te lezije utrobe (splenitis, pankreatitis, enteritis). U tu svrhu, lezije slične EP-u su klasificirane prema režnju primjenom metode lezija sličnih enzootskoj pneumoniji. Pleuritične lezije su klasificirane primjenom metode SPES bodovanja. Procijenjena je i prisutnost drugih lezija poput: perikarditisa, mliječno bijelih mrlja na jetri, splenitisa, pankreatitisa, limfadenitisa i enteritisa. Provedene su opisne analize i multivarijatne logističke regresijske analize. Varijabla se smatrala statistički značajnom kada je njezina *P*-vrijednost ≤ 0,05, a omjer izgleda (OR) razmatran je s intervalom pouzdanosti 95 %. Od uzoraka, 41,1 % svinja imalo je lezije slične EP-u (za 20,5 % lezije sličnih EP-u bodovane su 1-3, a za 20,7 % rezultat je bio 4-24). Oko 12 % uzoraka imalo je pleuritis, a 4,8 % njih registriralo je stupanj 4. Nakon lezija sličnih EP-u i pleuritisa, sljedeće najučestalije lezije bile su mliječno bijele mrlje na jetri i perikarditis (4,8 %, odnosno 3,6 %). U ovoj studiji, režnjevi koji su bili najpogođeniji lezijama sličnih EP-u bili su medijalni i kranijalni režanj. Što je rezultat lezije slični EP-u bio veći to je bila manja

mogućnost za SPES rezultat 4 (OR=0,38, *P*<0,001). Što je bio veći SPES rezultat, to je bila manja mogućnost za pojavom lezija sličnih EP-u kategorije 1 (OR=0,86, *P*=0,031) i kategorije 2 (OR=0,71, *P*<0,001). Perikarditis je bio povezan s više mogućnosti za pojavom SPES rezultata 1 (OR=8,57, *P*<0,001), SPES rezultata 2 (OR=7,29, *P*<0,001) i SPES rezultata 4 (OR=26,55, *P*<0,001). Konsolidirane lezije pneumonije predstavljale su glavni uzrok djelomičnog odbijanja za ljudsku konzumaciju, nakon čega su slijedile: pleuritične lezije, lezije mliječno bijelih mrlja na jetri i perikarditis. U ovoj je studiji naglašena važnost nadziranja respiratornih nalaza lešina svinja u klaonicama. Nužno je procijeniti proizvodnu učinkovitost i dobrobit životinje. Lezije na plućima usko su povezane s drugim nalazima u tkivima i organima s ekonomskom vrijednošću koje mogu biti subkliničke ili teške za dijagnosticiranje u živih životinja. Prema našim saznanjima, to je jedina studija ove vrste provedena u Portugalu.

Ključne riječi: *svinje, klanje, lezije nalik EP-u, pleuritis, lezije srca, jetre, traheje i pluća, lezije probavnog trakta*