Associations between EP-like lesions and pleuritis and post trimming carcass weights of finishing pigs in England

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Abstract

Herd health slaughter checks regularly identify enzootic pneumonia-like (EP-like) lesions and pleuritis. The aim of this paper is to determine the associations between these lesions and post-trimming carcass weight. Data were collected on the presence/ absence and severity of EP-like lesions and presence/ absence of pleuritis from pigs at the abattoir. Linear mixed models identified a significant association between an increase in EP-like lesion severity and a decrease in post-trimming carcass weight (P = 0.006) at the individual level. Each categorical increase in EP-like lesion severity (5 points step) was associated with a 0.37 kg reduction in post-trimming carcass weight. The presence of EP-like lesions in individual pigs, irrespective of severity (P = 0.034) and the presence of pleuritis (P = 0.038) were significantly associated with a reduction in post-trimming carcass weight of 1.26 kg and 1.25 kg respectively. The results confirm that the presence of these lesions at slaughter are associated with a significant decrease in production performance which can result in substantial economic implications for producers.

Keywords: associations; carcass weight; enzootic pneumonia; lesions, *Mycoplasma hyopneumoniae; pigs*

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1. Introduction

Mycoplasma hyopneumoniae is the primary etiologic agent of enzootic pneumonia (EP) of pigs and is also a key pathogen in porcine respiratory disease complex (PRDC) (Thacker and Minion, 2012). Lesions suggestive of *M. hyopneumoniae* infection are commonly identified at slaughter and are referred to as EP-like, as they are characteristic but not pathognomic (Amanfu et al., 1984).

One of the main pathogens associated with the development of pleuritis is *Actinobacillus pleuropneumonia* (*APP)* (Merialdi et al., 2012). Pleuritis can include both fibrous and fibrinous adhesions which can be either visceral (lobe to lobe) or parietal (lung to thoracic wall) (Jäger et al., 2012).

In England, the BPEX Pig Health Scheme (BPHS) was initiated in 2005. This voluntary scheme enables enrolled producers to have their pigs assessed at slaughter. BPHS assessments are carried out by trained and standardised swine veterinarian assessors. Up to 50 plucks (heart, lungs and liver) are assessed per batch of pigs for the conditions outlined in Table 1. Herd assessments are usually carried out on a quarterly basis and individual herd assessment reports, temporal analysis and benchmarking reports are sent to producers and their herd veterinarians. Recent analysis of the BPHS data showed that EP-like lesions and pleuritis are the most commonly recorded lung lesions affecting pigs at slaughter in the UK (Eze et al., 2015).

Economic losses associated with pleuritis can be attributed to slow growth and reduced feed conversion (Wellenberg et al., 2010). Infections with *M. hyopneumoniae* result in significant

losses to the pig industry through reduced weight gain, decreased feed efficiency and increased days to slaughter (Thacker and Minion, 2012) the most serious effects of which are seen in the finishing stages (Straw et al., 1989). Recent estimates on the effects of EP-like lesions on defined markers of production from English pigs have not yet been published.

The aim of this study was to determine the associations between EP-like lesion presence/absence and severity and pleuritis presence/absence on defined markers of production performance.

2. Materials and methods

A batch of pigs was defined as a group of finishing pigs originating from the same farm (same slapmark), reared as a group from weaning and selected for slaughter on the same day. A slapmark is a unique farm identification number tattooed onto the shoulder of each pig. Selection of batches was semi-randomised as they were selected for inclusion in the study on the basis that they were predicted to be delivering pigs for slaughter on predetermined dates (on which project veterinarians were available for abattoir pathology data collection). Batches were not selected on the basis of known susceptibility to EP-like lesions or pleuritis.

Every other pluck, up to a total of 50, from a single consignment of each batch were selected and assessed by the project veterinarian according to the BPEX Pig Health Scheme (BPHS) protocol (Jäger et al., 2012). Therefore, batches containing less than 100 pigs would have less than 50 pigs examined. Lungs were assessed for the presence or absence of EP-like lung lesions and scored according to the protocol developed by (Goodwin et al., 1969) with rounding of scores up to the nearest 5 to a maximum score of 55. Lungs and thoracic cavity

were also assessed for pleuritis presence or absence and scored as zero for no pleuritis, 1 for mild pleuritis (localised) and 2 for severe pleuritis (extensive).

Individual level data were collected at the abattoir from 29 batches of finisher pigs (total 1366 pigs) from Company A. Company A comprises all-in all-out pig (AIAO) farms which take pigs from 35kg through to finishing. Individual carcass weights (post-trimming, hot weight) were collected for each pig.

Batch level data were collected at the abattoir from 30 batches of pigs from Company A (37,720 pigs, total batch size ranged from 250 to 3,417 pigs per batch), 35 batches from Company B (50,386 pigs; total batch size ranged from 198 to 4781 pigs per batch) and 15 batches from Company C (total pigs 8581, total batch size ranged from 256 to 1057 pigs per batch). Company B comprises wean-to-finish AIAO farms and Company C comprises wean-to-finish continuous flow farms. Mean batch post-trimming carcass weights were supplied by the production companies when all pigs in the batch had been slaughtered. EP-like lesion presence / absence, mean EP-like lesion score, and pleuritis presence / absence were calculated from the (up to) 50-pig sample.

2.1 Data analysis

For individual level data, to determine the presence / absence of EP-like lesions, lungs with an EP-like lesion score of 0 or 5 were categorised as not having EP-like lesions (absent). Lungs with an EP-like lesion score of ten or more were categorised as having EP-like lesions (present). An individual lesion score of 5 could be considered insignificant and could be as a result of artefact, possibly as a result of processing. Therefore, a cut off of 5 was used.

Lungs with a pleuritis score of 1 or 2 were categorised as having pleuritis (present). Pigs could be classified as having both EP-like lesions and pleuritis.

For batch level data, to determine the presence / absence of EP-like lesions batches with an average batch EP-like lung lesion score of >1 were classified as being EP-like lesion affected (present). A cut off of 1 was used at batch level to reduce the likelihood of cranioventral consolidation which is not EP-like lesions being recorded. At batch level it would be expected that an average batch score under 1 could be due to other reasons. This cut off has been suggested by BPHS guidelines and has also been used in other studies which used BPHS data (Holt et al., 2011). Lungs with a pleuritis score of 1 or 2 were categorised as having pleuritis (present). Pigs could be classified as having both EP-like lesions and pleuritis.

2.2 Statistical analysis

Data were analysed using the SPSS program version 20 (SPSS, USA). For analysis of individual level data, three linear mixed models were used to assess the relationship between individual post-trimming carcass weight and EP-like lesion score or presence of EP-like lesions or presence of pleuritis. EP-like lesion score or presence of EP-like lesions or pleuritis were considered fixed effects and slapmark as a random effect. A linear mixed model was also used to assess the interaction between the presence of both EP-like lesions and pleuritis.

In addition, the presence of EP-like lesions and pleuritis were included in the same linear mixed effects model to evaluate whether they are independent predictors of post-trimming carcass weight.

At batch level, three separate linear regression analyses were used to assess the relationship between average batch post trimming carcass weight and average batch EP-like lesion score, presence of EP-like lesions or presence of pleuritis. Slapmark was considered a random effect.

Normality of the residuals was assessed by visual inspection of the histogram for both individual and batch analyses. The significance level was set at $P< 0.05$ for all statistical analyses.

3. Results

3.1 EP- like lung lesions

In the individual pig study, EP-like lesion scores for pigs ranged from 0 to 55, with a mean score of 2.63. One hundred and fifty-eight pigs out of the 1366 pigs assessed (12%) had an EP-like lesion score of ten or more.

In the batch level analysis, mean EP-like lesion scores ranged from 0 to 13. Sixty- four (80%) batches assessed had at least one lung with EP-like lesions. Batch prevalence ranged from 0 to 84%, with a mean within-batch prevalence, for batches with EP-like lesions, of 26%.

3.2 Pleuritis

In the individual pig study, 144/1366 pigs (11%) had lesions consistent with pleuritis. At batch level, 67/80 batches (84%) contained at least one pig with pleuritis. Within batch prevalence ranged from 0 to 46%, with a mean within batch prevalence of 10%.

3.3 EP-like lesions and pleuritis

At the individual level, 34/1366 (2%) of lungs had both EP-like lesions and pleuritis. At batch level, 45/80 (56%) batches contained at least one pig which had both EP-like lesions and pleuritis.

3.4 Effect of lung lesions on post-trimming slaughter weight

The individual pig-level model reported a statistically significant association between post-trim carcass weight and EP-like lesion score (P = 0.006) (Figure 1). Each categorical increase in EP-like lesion severity (5 points step) was associated with a 0.37 kg (95 % CI: 0.106 – 0.640) reduction in post-trimming carcass weight. The presence of EP-like lesions, irrespective of severity, was also associated with a reduction in post-trimming carcass weight (P = 0.034). This amounted to a 1.26 kg (95 % CI: 0.095 – 2.429) reduction in post-trimming carcass weight compared with pigs with no EP-like lesions. A statistically significant association was also found between the presence of pleuritis and post-trimming carcass weight (P = 0.038). Pigs with pleuritis were 1.24kg (95 % CI: 0.066 – 2.409) lighter compared with those without pleuritis. The model also calculated that having both EP-like lesions and pleuritis is associated with a statistically significant reduction in slaughter weight (P = 0.03), by 1.27 kg (95 % CI: 0.105 – 2.437) and 1.25 kg (95 % CI: 0.077 – 2.417) for EP-like lesions and pleuritis respectively. These effects are independent, indicating that simultaneous presence of EP-like lesions and pleuritis is associated with a 2.52 kg reduction in slaughter weight. No statistically significant interaction was identified between the presence of both EP-like lesions and pleuritis (P = 0.739) and therefore the model was run

without an interaction effect. At batch level, mean slaughter weights ranged from 54.5 kg to 83.1 kg for batches reporting no EP-like lesions or pleuritis and 71.8 kg to 82.3 kg for those batches that did report EP-like lesions and pleuritis. Each 1 score increase in mean batch level EP-like lesion score was significantly associated with a 0.36 kg decrease in post-trimming slaughter weight (P = 0.007, 95% CI: 0.104 – 0.623).

4. Discussion

The present study provides an updated assessment on the associations between EP-like lesion presence /absence and severity and pleuritis presence/absence on production parameters using individual and batch data.

EP-like lesions are areas of purple/grey consolidation located in the dependent regions of the cranial, middle and accessory lobes and also the cranial portion of the caudal lung lobes (Kobisch and Friis, 1996). In this study, EP-like lesions were scored using the system described by (Goodwin et al., 1969). Other scoring systems have been developed and a recent study identified good correlation between the different methods (Garcia-Morante et al., 2016).

EP-like lesions were commonly identified in this study with 80% of batches affected, which is consistent with a recent report by (Gomes, 2015) where 80-90% of batches assessed as part of the BPHS had at least one animal affected.

The results of previous studies investigating the impact of lung lesions on production performance have been inconsistent. Whilst a number of published studies failed to show a relationship between increase in severity of EP-like lesions and a decrease in performance (Wilson et al., 1986; Noyes et al., 1990; Scheidt et al., 1990) others have reported an

association between increased severity of EP-like lesions and reduced performance (Burch, 1982; Straw et al., 1989; Straw et al., 1990; Pagot et al., 2007; Henninger et al., 2014). A meta-analysis using data from the 1970s showed that an EP-like lesion score of ten was associated with a decrease in average daily gain (ADG) of 37.5g/day (Straw et al., 1989). (Pagot et al., 2007) found that for each increase in EP-like lesion score, weight was reduced by 0.7%. More recently, (Henninger et al., 2014) showed that increasing lung lesions scores were associated with weight loss which is consistent with the results of this study. The results of the present study showed a statistically significant decrease in slaughter weight was identified in pigs with EP-like lesions, pleuritis or a combination of these, compared to those with no lesions. Pigs with extensive EP-like lesion (score of 55) were predicted to weigh 3.73kg less compared with pigs with no lesions.

In England, average pleuritis prevalence from 2005 to 2015 has ranged between 11% and 15% (Gomes, 2015). This study indicated a prevalence of 11%, which is lower than European prevalence estimates of 29% and 47% (Fraile et al., 2010; Merialdi et al., 2012), but is consistent with levels within England. Pleuritis was found to affect 84% of batches, which is in line with English estimates of 78% to 82% for 2005 to 2015 (Gomes, 2015).

The presence of pleuritis, irrespective of severity of those lesions, has previously been associated with a reduction in weight gain (Hartley et al., 1988; Jäger et al., 2010; Wellenberg et al., 2010). In our study, pigs with pleuritis were on average 1.24 kg lighter than those without lesions at the individual level. A significant association was found between the presence of both EP-like lesions and pleuritis and a decrease in carcass weight, although only a low prevalence of 2% was identified for lungs with both these lesions. However, with a combined reduction of 2.52 kg post-trimming carcass weight for pigs with both lesions, these would represent significant losses to the producer. Uniformity within batches is also important for processing at the abattoir. In England, pigs are usually

slaughtered between 22 and 24 weeks (154 to 164 days) with a target weight of 100 – 105 kg live weight. Automated machines at the abattoir are 'set up' for these standard sized carcass'. Therefore, smaller, lighter pigs may cause delays, resulting in costs for the abattoir.

5. Conclusion

The results of this study highlight that EP-like lesions and pleuritis are routinely identified at slaughter and are significantly associated with a reduction in carcass weight. This study provides an updated estimate on the impact of these lesions and confirms that they remain economically significant.

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Conflict of interest statement

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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Fig 1. Scatterplot showing the post-trimming carcass weights for each increase (score 5) in EP-like lesion score at the individual level.

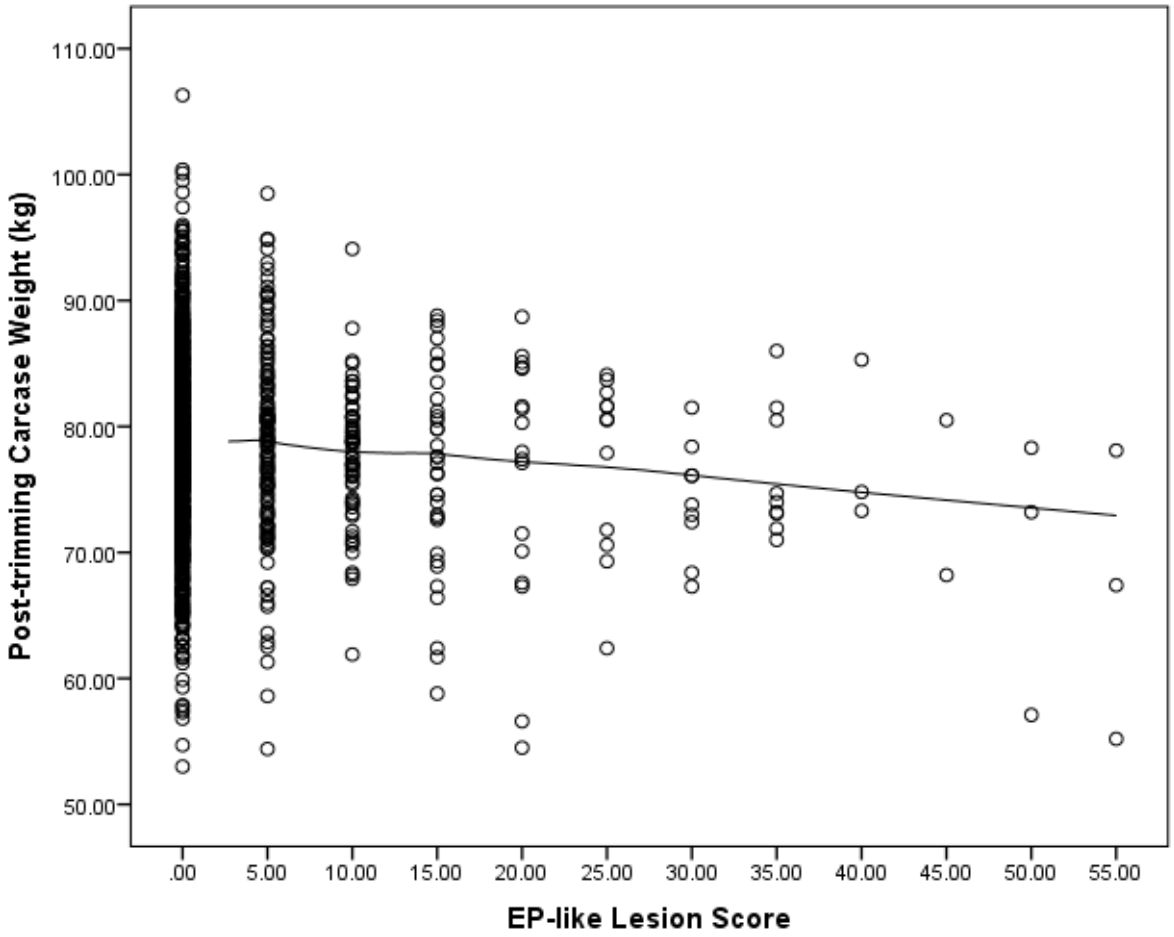
Table 1 Different pathologies identified as part of the BPEX Pig Health Scheme abattoir assessment (Eze et al., 2015).

Lung lesions	Pathology	Scoring	Main causative agent (s)
EP-like	Red-tan-grey consolidation affecting cranioventral regions of the lungs in a lobular pattern	Scored 0- 55 in 5 step increments (Goodwin et al., 1969)	*Mycoplasma hyopneumoniae*
Pleuritis	Fibrous or fibrinous pleural adhesions on lung or between lung and chest wall	0 (absent), 1 (discrete areas of pleuritis), 2 (lesions >20% lung surface area)	*Actinobacillius pleuropneumoniae*, *Pasteurella multocida*, *Haemophilus parasuis*, swine influenza, porcine reproductive and respiratory syndrome virus, porcine circovirus type 2

Pleuropneumonia like	Focal areas of lung consolidation with overlying pleuritis affecting middle and caudal lung lobes	Present (chronic or acute) or absent	*Actinobacillus pleuropneumoniae*, *Pasteurella multocida*, *Haemophilus parasuis*, swine influenza, porcine reproductive and respiratory syndrome virus, porcine circovirus type 2
Viral like	Lobular pattern of consolidation	Present or absent	*Actinobacillus pleuropneumoniae*, *Pasteurella multocida*, *Haemophilus parasuis*, swine influenza, porcine reproductive and respiratory syndrome virus, porcine circovirus type 2
Abscesses	One or more discrete abscesses within lung.	Present or absent	secondary bacteria
Pyemia	Multiple small abscesses detected in the lung parenchyma	Present or absent	

Highlights

- EP-like lesions and pleuritis are routinely identified in slaughter pigs in England.
- EP-like lesions and pleuritis are significantly associated with a reduction in carcass weight.
- Endemic pig respiratory diseases remain economically important.


Post-trimming Carcase Weight (kg)
110.00
100.00
90.00
80.00
70.00
60.00
50.00
.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
45.00
50.00
55.00
EP-like Lesion Score