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The capacity of ante-mortem inspection of pigs at the abattoir to predict post-mortem findings and associated financial implications: A study at batch level

Dayane Lemos Teixeira^{1,2}  | Laura C. Salazar³ | Laura A. Boyle⁴

¹Department of Animal and Agriculture, Hartpury University, Gloucester, UK

²Instituto de Ciencias Agroalimentarias, Animales y Ambientales (ICA3), Universidad de O'Higgins, San Fernando, Chile

³Departamento de Ciencias Animales, Pontificia Universidad Católica de Chile, Santiago, Chile

⁴Pig Development Department, TEAGASC Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland

Correspondence

Dayane Lemos Teixeira, Department of Animal and Agriculture, Hartpury University, Gloucester, UK.
Email: day.teixeira@hartpury.ac.uk

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Abstract

This study aimed to investigate the associations between severe ear, tail, and skin lesions, hernias, bursitis, and rectal prolapses and meat inspection finding in slaughter pigs, including carcass weight and financial implications associated with carcass condemnations at batch level. Data were collected from 13,296 pigs from 116 batches from a single abattoir. Spearman's correlation coefficients were calculated to analyze the degree of association between the prevalence of welfare issues and condemnation findings. The association between batch-level results of carcass weight, batch size, and the prevalence of welfare issues was analyzed using generalized linear mixed models. The prevalence of tail lesions was significantly associated with both entire ($r = 0.224$; $p = 0.0432$) and partial ($r = 0.276$; $p = 0.0120$) carcass condemnation. Batches with pigs affected by more than one welfare issue were 9.9 kg lighter than those without welfare issues ($p < 0.05$), which was equivalent to a potential loss of €11.28 per pig. Our findings indicate that ante-mortem inspection could be useful to predict post-mortem findings at batch level and that welfare issues in pigs represent a financial loss to producers, as they are paid on a per kg basis and have tight margins.

KEYWORDS

lesions, pigs, slaughter, veterinary, welfare

1 | INTRODUCTION

Ante-mortem inspection of animals on arrival at the abattoir is fundamental to guarantee food safety and to monitor animal health and welfare. It is an essential process for detecting conditions that cannot be detected at post-mortem inspection (Stark, 1996), such as lameness (EFSA, 2011). It also allows the restraint of unhealthy pigs that have, or are suspected of having, injuries or illnesses for closer examination. Based on the ante-mortem findings, the inspector (usually a veterinarian or veterinary technician) in charge of ante-mortem inspections at the abattoir can advise the inspector on the slaughter

line of animals requiring more detailed carcass and viscera inspections (as opposed to visual only).

Additionally, on-farm assessment of live animals prior to transport for slaughter can complement or facilitate, rather than replace, abattoir-based ante-mortem inspection (Teixeira, Salazar, et al., 2020). This can be by segregating sick or injured animals from others without visible lesions (Harbers et al., 1992) or preventing animals that are not fit for slaughter from being sent to the abattoir (EFSA, 2011). This process is helpful as pigs affected by gross abnormalities have an increased probability of showing post-mortem abnormalities (Harbers et al., 1992) and have a higher probability of having meat rejected at post-mortem

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inspection (Jackowiak et al., 2006). In this way, knowing the likelihood that the carcass of these sick or injured animals will be condemned could also justify on-farm euthanasia to avoid animal suffering.

Previously, the capacity of ante-mortem inspection to predict post-mortem findings in slaughter pigs was evaluated at batch (Ghidini et al., 2021) and animal (Teixeira et al., 2023) level. At batch-level assessments, dirtiness and skin lesions were ante-mortem findings positively associated with post-mortem conditions (Ghidini et al., 2021). Tail lesions and hernias were associated with post-mortem inspection findings at animal level (Teixeira et al., 2023). However, in the Ghidini et al. (2021) study, the authors focused on 13 conditions that were detected at two Italian abattoir receiving heavy pigs, irrespective of whether these conditions could be detected during on farm assessment as well. In the case of Teixeira et al. (2023), the authors focused on ante-mortem findings that could be detected both on farm and at the abattoir (i.e., ear lesions, tail lesions and skin lesions, hernias, bursitis, and rectal prolapses) to predict post-mortem inspection findings at animal level. Neither of these studies included financial implications associated with post-mortem condemnations. Therefore, the aim of this study was to investigate the associations between ear, tail, and skin lesions, hernias, bursitis, and rectal prolapses and meat inspection finding in slaughter pigs, including carcass weight and financial implications associated with carcass condemnations at batch level.

2 | MATERIALS AND METHODS

This study was part of a research project approved by the Scientific Ethics Committee for Animals and Environmental Care of the Pontificia Universidad Católica de Chile (protocol number 170529006) and by the Research Department Ethic Committee of the Universidad de O'Higgins (No. 002-2020).

This was an observational study whereby pigs were managed according to routine practices in a single abattoir. Data were collected over 45 days between October 2018 and May 2019. On each day, collection began at approximately 09:00 h and continued until the last batch was unloaded from the truck at the abattoir (approximately 13:00 h). Animals were transported and handled according to routine abattoir practices.

To ensure interobserver reliability, two observers (a veterinarian and a veterinary technician) were trained before starting data collection and then measured the degree of agreement between them while assessing the same animals/carcasses. Observers evaluated from one to seven batches per day. The assessments at ante-mortem inspection were conducted from outside the corridor where pigs were unloaded from the truck at the abattoir. This was in accordance with how stock people and veterinary inspectors commonly inspected pigs at this location (adapted from van Staaveren et al. (2018)). The batch size and the number of pigs affected by each welfare issue (ear, tail, and skin lesions, hernias, rectal prolapse, and lameness) were recorded according to Teixeira, Salazar, et al. (2020) (Table 1). Only severe cases of ear, tail, and skin lesions and lameness were considered. Unfortunately, it was

TABLE 1 Animal-based welfare outcomes recorded during welfare assessment on a commercial farm and a commercial abattoir (according to Teixeira, Salazar, et al. (2020)). Only severe cases of ear, tail, and skin lesions and lameness were considered.

Outcome	Description
Ear lesions	Bloody, swollen, and/or amputated ear
Tail lesions	Bloody, swollen, and/or amputated tail
Skin lesions	Presence of deep wound and/or hematoma
Hernia	Umbilical, scrotal, and/or inguinal hernia
Rectal prolapse	Internal tissue extrudes from the rectum
Lameness	Very reluctant to walk, minimal weight-bearing on the affected limb or inability to move

not possible to assess both sides of the pigs' body to detect the presence of certain welfare issues such as skin lesions.

Batch-level results of post-mortem meat inspection findings, including anatomical location of entire and partial carcass condemnation, and batch-level results of carcass weight and weights of condemnations (entire carcass, head, hand, feed, skin, tail, ham, rib, loin, hip, shoulder, leg) were obtained from abattoir records at the end of each day of data collection.

2.1 | Statistical analysis

A final study population was obtained after removing 12 batches of breeding boars, 34 batches of sows, and six batches of slaughter pigs due missing information. Therefore, only information from 116 batches of finishing pigs from six different farms was included in the study. It was not possible to record the sex of pigs and if they were castrated. Although the studies were carried out at the same abattoir during the same period, the dataset of pigs and batches from Teixeira, Salazar, et al. (2020), Teixeira et al. (2023), and the current study were not the same.

The observed prevalence of welfare issue and reasons for and anatomical location of carcass condemnations were calculated for the final study population using Microsoft® Excel 2011. For farms that sent batches on different days, each batch was considered separately. Statistical analyses were conducted using SAS 9.3. Differences were considered as statistically significant when $p < 0.05$ and as tendencies when $0.05 < p < 0.1$. Least square means (\pm SEM) are reported. Batch size was transformed from a continuous to a categorical variable on the basis of quartiles (Q1: 20–69; Q2: 70–100; Q3: 101–179; Q4: 180–200 pigs/batch). Batches were categorized as presenting none, tail lesions only, hernia only, or more than one welfare issues. General information about batches and farms and their prevalence of welfare issues and post-mortem findings are presented in Data S1.

Spearman's correlation coefficients were calculated to analyze the degree of association between the prevalence of each welfare issues and the entire and partial condemnation findings. Thirteen and 28 batches presented only tail lesions and hernia, respectively. Batches that presented pigs affected by more than one welfare issue

were discarded from the analysis. Only ear lesions were presented in one batch, and only skin lesions, only prolapse, and only lameness were not found, so their correlation with condemnation findings was not calculated.

The association between batch-level results of cold carcass weight, batch size, and the prevalence of welfare issues at ante-mortem inspection was analyzed using generalized linear models (Proc GLM). It was not possible to exclude carcasses that were partially condemned as information on carcass weight obtained from abattoir records was at batch level. Weight of condemned parts was not included in the analysis. Welfare issue and batch size were included as fixed effects. Interaction was not included as it was not significant and farm was not included as random effect as model failure to converge. Batch with skin lesions only was excluded from this analysis due to its low number.

For the economic analysis, the potential impact of welfare issues on carcass weight was considered. Also, the direct financial losses resulting from entire or partial carcass condemnation associated with tail lesions at the point of meat inspection were calculated by multiplying the number of carcasses that were either entirely or partially condemned by the average of the recorded weight of each part condemned (entire, head, hand, feet, skin, tail, ham, rib, loin, hip, shoulder, leg). This result was then multiplied by the average Chilean pig meat price at the time of writing up the study (€1.14 per kg) (ODEPA, 2020) using Microsoft® Excel for Mac 2011. The direct financial losses calculation was focused on tail lesions, as these were the only welfare issue associated with entire and partial condemnations.

3 | RESULTS

3.1 | Descriptive results

The description of the study population and the prevalence of welfare issues and of carcasses entirely or partially condemned are in Table 2.

Forty-one batches had no pigs affected by any of the welfare issue evaluated, whereas 33 batches presented pigs affected by more than one welfare issue. From the batches that presented only one welfare issue, one batch presented pigs only affected by skin lesions, 13 batches presented pigs only affected by tail lesions, and 28 batches presented pigs only affected by hernias.

Of the final study population ($n = 13,196$), 131 (1.0%) carcasses were entirely condemned. Four farms presented batches with at least one case of entire carcass condemnation. Partial condemnation made up 85% of the total condemnations (Table 2). All farms had a high prevalence of batches with at least one case of partial condemnation.

3.2 | Association between welfare issues and carcass condemnations

The prevalence of tail lesions was significantly associated with both entire ($p = 0.224$; $p = 0.0432$) and partial ($p = 0.276$; $p = 0.0120$)

TABLE 2 Description of the study population with respect to batch size and prevalence of welfare outcomes ($n = 13,196$), and prevalence of carcass entirely or partially condemned within condemned population ($n = 874$).

	Total	(%)
Number of batches	116	
Number of farms	6	
Number of pig slaughtered	13,196	
Batch size		
Min	20	
Max	200	
Mean	114	
Median	100	
Welfare outcomes ($n = 13,196$ slaughter pigs)		
Ear lesions	13	(0.10)
Tail lesions	565	(4.28)
Skin lesions	19	(0.14)
Hernia	81	(0.61)
Prolapse	7	(0.05)
Lameness	11	(0.08)
Carcass condemnations ($n = 874$ carcass)		
Entire carcass condemnations		
Min/batch	0	
Max/batch	39	
Mean/batch	1.1	
Median/batch	0	
Total	131	(14.99)
Partial carcass condemnations		
Min/batch	0	
Max/batch	27	
Mean/batch	6.4	
Median/batch	4	
Total	743	(85.01)

carcass condemnation (Data S2). Hernias were not significantly associated with entire carcass condemnations ($p = 0.073$; $p = 0.5120$) but tended to be associated with partial condemnations ($p = -0.213$; $p = 0.0552$) (Data S2). The association between entire or partial carcass condemnations and ear and skin lesions, prolapses, and lameness was not calculated due to the low number of pigs affected by these welfare issues at ante-mortem inspection.

3.3 | Carcass weight results

Batch size and the prevalence of welfare issues were significantly associated with carcass weight (Table 3). Batches with more than 101 pigs had heavier carcasses than smaller batches ($p < 0.05$). The carcass weight of pigs affected by tail lesions or hernias alone did not differ from pigs without the welfare lesions evaluated in this study

TABLE 3 Least square mean (\pm SE) carcass weight (kg) of pigs in each batch size ($n = 116$) and welfare outcome categories.

	No. of batches	Carcass weight
Batch size (quartiles)		
20–69 pigs	30	76.5 (± 2.07) ^a
70–100 pigs	33	78.9 (± 2.00) ^a
101–179 pigs	28	94.5 (± 1.94) ^b
180–200 pigs	25	96.3 (± 2.08) ^b
Welfare outcome		
None	41	89.1 (± 1.67) ^a
Tail lesions	13	90.3 (± 2.88) ^a
Hernia	28	87.6 (± 2.06) ^a
More than one welfare outcome	33	79.2 (± 1.82) ^b

^aCarcass weights differ significantly ($p \leq 0.05$).

^bCarcass weights differ significantly ($p \leq 0.05$).

($p > 0.05$). However, batches with pigs affected by more than one welfare issue were 9.9 kg lighter than those without welfare issues ($p < 0.05$).

3.4 | Economic analysis

The financial losses associated with the carcass (entire and partial) condemnations in the study population amounted to over €11,700, which equated to €0.89 per study pig (Data S3). When this calculation was focused on the 13 batches with pigs only affected by tail lesions, losses arising from the carcasses entire or partially condemned equated to 585 kg or €0.29 per pig slaughtered (Data S4). Finally, the potential loss associated with carcass weight of batches with pigs with more than one welfare issue was equivalent to 49,074.30 kg or €11.28 per pig, considering that the pigs in these batches were 9.9 kg lighter than pigs from batches with no welfare problem only.

4 | DISCUSSION

The findings from the present study indicate the capacity of ante-mortem inspection to predict post-mortem findings at batch level, especially in cases of tail lesions and hernias. At animal level, Teixeira et al. (2023) also reported that the presence of tail lesions and hernias in slaughter pigs triggers the veterinary inspector in charge of the post-mortem inspection attention rather than just visual inspection. There is a high likelihood that carcasses from pigs affected by tail lesions will be fully condemned and the affected carcasses are lighter (Harley et al., 2014). Hence, it could be argued to what extent tail lesion severity could justify euthanasia of affected pigs on farm, avoiding financial losses associated with reduced feed efficiency and treatment, unnecessary animal suffering and the potential misuse of antibiotics (Boyle et al., 2022).

Our results are in line with Teixeira, Salazar, et al. (2020) and Teixeira et al. (2023) who also found that tail lesions and hernias were among the most frequent conditions evaluated during ante-mortem inspection at batch and animal level, respectively. It is important to note that these two studies evaluated the same ante-mortem findings on-farm, during unloading at the abattoir (Teixeira, Salazar, et al., 2020) and between dehairing and evisceration processes on the slaughter line (Teixeira et al., 2023). Previous studies reported that dirtiness and skin lesions were the main conditions found at ante-mortem inspection at batch level (Ghidini et al., 2021) reported that the prevalence of hernia and skin lesions may vary among production systems (Kongsted & Sørensen, 2017). Although skin lesions were not frequently reported in our study, the main concern related to these lesions is the effect of mixing unfamiliar animals for transport from the farm to the abattoir (Driessen et al., 2020; van Staaveren et al., 2015).

Ghidini et al. (2021) and Teixeira, Salazar, et al. (2020) reported a lower prevalence of tail lesions and hernias compared to the current findings, but the prevalence reported in their studies was based on batch level, and, in the case of Ghidini et al. (2021), only umbilical hernias were included. In contrast, the prevalence of tail lesions and hernias was much higher in Teixeira et al. (2023). However, it is important to mention that, in the Teixeira et al. (2023), pigs from hospital pens were purposely mixed with others in lairage to increase the probability of finding welfare issues that would potentially associate with post-mortem findings. Also, it is well known that lesions and diseases are likely to vary with season (Elbers et al., 1992; Schrøder-Petersen & Simonsen, 2001), including ear and tail lesions (Blackshaw, 1981; Penny & Hill, 1974), suggesting that pigs suffering from heat and/or cold stress are more prone to perform damaging behavior (Schrøder-Petersen & Simonsen, 2001). However, as Teixeira et al. (2023) and the current study were carried out at the same abattoir during the same period, it is not possible to speculate a season effect in such comparison. Therefore, these comparisons need to be analyzed with care.

Only 1.0% of carcass was entirely condemned, whereas 5.6% were partially condemned. The prevalence of entire condemnation is in line with Teixeira et al. (2023) findings at animal level, but partial condemnations were much higher in the present study. This finding was not expected, as tail lesions were much higher in the study carried out by Teixeira et al. (2023). As Teixeira et al. (2023) and the current study were carried out in the same abattoir and at the same time of year, a possible explanation could be the effect of the veterinarian in charge of meat inspection as they can cause variation in the post-mortem evaluation and findings (Harley et al., 2012; Heinonen et al., 2021). Unfortunately, it was not possible to register the veterinary shift in the current study to allow further comparison.

As expected, batches with carcasses affected by tail lesions were associated with entire and partial carcass condemnations, corroborating findings from previous studies in Finland and Ireland (Harley et al., 2014; Valros et al., 2004). In fact, 50% of batches with pigs affected by tail lesions alone had carcasses entirely condemned.

When looking within batches that only had pigs with tail lesions, the majority of partial condemnations were associated with head, feet, and skin condemnations, again suggesting association with carcass abscessations (Heinonen et al., 2010; Huey, 1996; Teixeira et al., 2016; Valros et al., 2004; van Staaveren et al., 2016) but also with other inflammatory processes (Teixeira, Boyle, & Enríquez-Hidalgo, 2020; Valros et al., 2004).

Due to the high number of batches with at least one case of partial carcass condemnation (94%), it was not possible to exclude these batches from the analysis of the relationship between the welfare issues, carcass weight, and batch size. Therefore, it was not possible to determine whether carcass weight was reduced due to the association with the welfare condition, due to batch size, or due to partial condemnations. Also, we did not collect information regarding the herd size and environmental or management conditions of the six farms providing study batches; therefore, it is not possible to speculate which aspects played a role in the weight of the pigs.

The major financial loss was associated with carcass weight as batches with pigs affected by more than one welfare issue were nearly 10 kg lighter than those without welfare issues. Also, the potential financial implication associated with carcass condemnations was especially triggered by tail lesions, which corroborates findings from (Harley et al., 2014). All these confirm the assumption that animal welfare condition on farm is associated with productive performance.

The findings from this study confirm that the prevalence of tail lesions at ante-mortem inspection was associated with entire and partial carcass condemnation and that batches with pigs affected by more than one welfare issue were almost 10 kg lighter than those without welfare issues. Therefore, our findings indicate that ante-mortem inspection could be useful to predict post-mortem findings at batch level. Also, it confirms that welfare issues in pigs represent a financial loss to producers, as they are paid on a per kg basis and have tight margins. Such findings can be used to show the benefits of improving pig husbandry and welfare on farm.

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CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

ORCID

Dayane Lemos Teixeira  <https://orcid.org/0000-0001-5063-7972>

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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