A baseline for characterising risk: conditions found in indoor versus outdoor fattening pigs at traditional meat inspection

I MCCRONE[1], C CORREIA-GOMES[2], RO ABASCAL[2], AW TUCKER[1], D ARMSTRONG[3], GJ GUNN[2], SC TONGUE[2]
[1]Department of Veterinary Medicine, University of Cambridge; [2]Epidemiology Research Unit, Future Farming Systems Research Group, Scotland's Rural College, UK; [3]Agriculture and Horticulture Development Board (AHDB) – Dairy, UK

*carla.gomes@sruc.ac.uk

Abstract
The primary surveillance purpose of meat inspection is for food safety and protection of human health; however, it also contributes to the protection of animal health and animal welfare. Regulation (EC) 854/2004 allowed pigs that were reared from birth in controlled housing, from integrated systems, to undergo visual inspection only. This was, based on the expectation that the level of risk would be lower than in other systems. Implementation of visual-only inspection by the UK pig industry was low due to the logistical difficulties of slaughtering a mixture of indoor and outdoor reared pigs on the same day.

To determine if the assumption of differential risk was valid, various conditions found at traditional inspection were compared between pigs from indoor and outdoor fattening (free range) systems. Inspection data for pigs slaughtered at one pig-only abattoir in the east of England from January 2010 to December 2011 was obtained and analysed. The prevalence of conditions detected on inspection of pigs submitted to slaughter from different fattening systems, were, generally, quite similar with most of the differences being predictable from knowledge of the housing and fattening systems. Most importantly the differences observed are in lesions that will be easily assessed using visual-only inspection method. This suggests that whatever the inspection system that was in place would likely be equally effective. The prevalence estimates were subsequently used as a baseline for characterisation of risk and evaluation of the outcomes of a field trial of inspection methods within this abattoir.

Keywords: *Baseline, pigs, meat inspection, risk, fattening*

Introduction
The inspection of live animals, their carcases and offal following slaughter plays a major role in the protection of human health by ensuring the provision of safe meat and meat products to the final consumer. In addition to this surveillance role for food safety and the protection of human health, the inspection can also contribute to the protection of animal health and animal welfare. The inspection procedures that have to be adopted in the European Union (EU) are detailed in Regulation (EC) 854/2004. This Regulation details the arrangements for inspection and the procedures that are required such as visual inspection, palpation and incision of the carcase and offal; details that are then transcribed into the national legislation of Member States. There are differences in what is necessary depending on the age and species of the animals submitted to slaughter. Prior to June 2014, there was a provision for pigs that have been reared from birth in controlled housing, from integrated systems, to undergo visual inspection only. This was based on the expectation that pigs from these systems are likely to have lower levels of pathology and so to be of less risk than other systems and therefore have a less onerous inspection procedure.. A desk-based qualitative risk assessment (1) of the comparative risks to public and animal health from visual inspection of indoor and outdoor pigs concluded that the risk was negligible for all pigs. However uptake of visual-only inspection by the United Kingdom (UK) pig industry had been low because slaughterhouses accept a mixture of indoor and outdoor reared pigs throughout the day and the latter still needed to be inspected by traditional means.

In order to provide an improved evidence-base for policy development, the Food Standards Agency (FSA) in UK funded research to assess if there were differences between indoor and outdoor pigs (FS145003) and to investigate the implications of changing the inspection method, from the traditional method to a visual-only method, for fattening pigs from non-controlled housing conditions in the UK. The starting point for these investigations in 2012-2013 was to establish a baseline of the expected frequency of animal health and welfare related conditions found in indoor versus outdoor fattening pigs at traditional meat inspection. This baseline would then be used in subsequent studies to characterise risk and the potential for changes in risk that would occur with changes in inspection methodology. Subsequently, in 2014 the Commission Regulations (EU) 218/2014 and 219/2014 led to the implementation of visual inspection for all pigs at EU level.

Materials and methods
Inspection data for pigs slaughtered at one pig-only abattoir in the east of England from January 2010 to December 2011 was obtained from the FSA. There were three datasets for each of the batches slaughtered. Data were available for ante-mortem inspection (AMI) of live animals, post-mortem inspections (PMI) of carcase inspection and offal inspection. The batches were categorised as being either from free range systems (fattened outdoors), or from indoor fattening systems. This was determined by the batch slap mark (identification), indicating the farm of origin, which was compared with a

list of the categories of suppliers of pigs obtained from the abattoir management. The data were inspected for errors and anomalies. A few of the conditions identified were of such low prevalence that they were combined with the "other condition" categories. Statistical analyses were conducted in STATA version 12. The prevalence of each condition in each batch was determined for the datasets by using the number of times the condition was identified as the numerator and the batch size as the denominator. The proportion of batches affected with a condition was determined by recoding the presence or absence of a condition in a batch as a binary outcome. The two types of finishing systems were then compared calculating confidence intervals and using a test for proportions (Z-test). Confounding by batch size and season was investigated by comparing odds ratios using the Mantel-Haenszel method. The batches in which the conditions were found were also compared for the two finishing systems. In this case the mean prevalence in the batches that were found to have the condition were compared between the systems using a T-test. Due to the number of analyses performed in the comparisons (n=82) any differences were considered statistical significant when P<0.0006 using Bonferoni correction. A batch was defined as pigs belonging to the same slap mark that were slaughtered in the same abattoir on the same date.

Results

The total data available for the analysis contained results from the inspection of 1,220,340 pigs from 7,410 batches from the different rearing and fattening systems.

In the analysis period, the mean number of pigs in each batch was 164 and 166 pigs for indoor and free range fattening systems respectively. Variation in the batch size for the different fattening systems was low. There was a degree of seasonal variation in the number of batches of pigs slaughtered, with fewer batches slaughtered in late spring and in the summer months (Figure 1). The proportion of the batches that were from free range systems was fairly consistent accounting for approximately a quarter (range 19.5-26.3%) of the batches of pigs slaughtered. Although batch size and seasonality were considered as possible confounders, when analysed they had no influence on the associations between the conditions found and the fattening systems.

Figure 1. The number of batches of pigs from each of the different fattening systems that were slaughtered at the abattoir during the analysis period (2010-2011).

Ante-mortem inspection data

The proportion of batches in which the various conditions were detected was similar for both indoor and outdoor fattening systems, except that there was a significant increase in tail bite and lameness in batches from indoor fattening systems. Indoor fattening systems had 26.4% of batches in which tail bite was identified, compared with 5.9% of free range batches, and 46.5% had lame pigs compared with 24.7% of free range batches. There were no differences between the two fattening systems in the mean prevalence of conditions within the batches where the conditions were present.

Post-mortem inspection

The conditions found during carcase inspection were again similar between the two fattening systems. There were differences in the proportion of batches with carcases showing oedema (Table 1). In indoor fattened pigs 25.7% of batches had carcases of pigs with oedema compared with 8.1% for free range batches. The prevalence of the conditions in pigs in which the various conditions were found was again similar for the different fattening systems.

Table 1. Pathological conditions found on *post-mortem* inspection of the carcases of pigs slaughtered from indoor and free range fattening systems (***statistically significant*** difference between systems)

	Percentage of the batches affected with the condition (95% CI)		**Mean prevalence (%) in batches in which the condition was present (95% CI)**	
	Indoor	**Free Range**	**Indoor**	**Free Range**
Anaemia	5.5 (4.7-6.4)	3.2 (1.8-4.7)	0.8 (0.7-0.8)	0.8 (0.4-1.7)
Jaundice	3.3 (2.7-4.0)	5.4 (3.5-7.3)	0.7 (0.6-0.8)	0.6 (0.5-0.6)
Tumours	0.6 (0.3-0.9)	0.5 (0.1-1.2)	0.6 (0.5-0.7)	0.7 (0.04-1.4)
Oedema	***25.7* (24.1-27.4)**	***8.1* (5.8-10.3)**	1.1 (1.0-1.2)	1.1 (0.5-1.6)
Poly-arthritis	8.0 (6.9-9.0)	9.7 (7.2-12.2)	0.9 (0.8-1.0)	0.8 (0.6-0.9)
Septicaemia	10.7 (9.5-11.9)	10.1 (7.6-12.6)	0.7 (0.7-0.8)	0.8 (0.6-0.9)
Pyaemia	75.5 (73.9-77.2)	71.1 (67.3-74.9)	1.5 (1.4-1.6)	1.1 (1.0-1.3)
Uraemia	1.0 (0.7-1.4)	1.1 (0.2-1.9)	0.6 (0.5-0.7)	0.6 (0.4-0.8)
Other Conditions	8.4 (7.3-9.4)	12.8 (10.0-15.5)	1.9 (0.8-0.9)	1.2 (0.7-1.6)

The comparison of the frequency of the pathological conditions found at post-mortem inspection of offal for the different fattening systems (Table 2) revealed that milk spot liver occurred in more batches of free range fattened pigs compared with indoor fattened ones (54.8% of batches affected compared with 23.4%). By contrast, pericarditis was found to occur in more batches of indoor fattened pigs than free range fattened pigs (60.6% of batches compared with 53.5%). The proportion of batches with other conditions was similar between the two fattening systems. When the prevalence of conditions, found at offal inspection in batches where the conditions occurred, were compared it was found that kidney pathology was significantly higher in indoor fattened pigs, whereas the within batch mean prevalence of

hepatitis, milk spot liver, peritonitis, pneumonia and other pathology was higher in free range fattened pigs. These differences were on the whole small except for milk spot liver in which a large difference was found. There was a mean of 21.1% of pigs affected in free range fattened pigs compared with 5.9% in indoor fattened pigs.

Table 2. Pathological conditions found during *post-mortem* inspection of offal from slaughter pigs from indoor and free range fattening systems (***statistically significant*** difference between systems).

	Percentage of the batches affected with the condition (95% CI)		**Mean prevalence (%) in batches in which the condition was present (95% CI)**	
	Indoor	**Free Range**	**Indoor**	**Free Range**
Abscess	23.7 (22.6-24.8)	24.2 (22.1-26.3)	2.5 (2.3-2.7)	3.3 (2.6-4.0)
Enteritis	24.3 (23.2-25.4)	24.3 (22.3-26.4)	1.7 (1.5-1.8)	1.8 (1.7-2.0)
Endocarditis	5.2 (4.6-5.8)	3.5 (2.6-4.4)	1.0 (0.9-1.1)	0.8 (0.6-0.9)
Hepatitis	35.8 (34.6-37.1)	34.1 (31.8-36.3)	***2.2* (2.1-2.4)**	***3.1* (2.5-3.6)**
Kidney Pathology	95.2 (94.7-95.8)	93.8 (92.6-94.9)	***7.2 (7.1-7.4)**	***6.7* (6.4-6.9)**
Milk Spot	***23.4* (22.3-24.5)**	***54.8* (52.4-57.2)**	***5.9* (5.2-6.6)**	***21.1* (19.5-22.7)**
Pericarditis	***60.6* (59.4-61.9)**	***53.5* (51.1-55.9)**	2.0 (1.9-2.1)	2.0 (1.9-2.2)
Peritonitis	57.7 (56.4-58.9)	58.6 (56.3-61.0)	***1.8* (1.7-1.8)**	***2.4* (2.1-2.6)**
Pleurisy	39.9 (38.6-41.2)	38.4 (36.0-40.7)	2.3 (2.2-2.4)	2.6 (2.4-2.8)
Pneumonia	86.6 (85.8-87.5)	88.9 (87.4-90.5)	***8.6* (8.4-8.9)**	***10.8* (10.2-11.4)**
Other Pathology	78.2 (77.1-79.3)	76.2 (74.2-78.3)	***4.9* (4.8-5.1)**	***6.0* (5.6-6.4)**

Discussion

The study only involved the inspection data from one abattoir, which is likely to have only obtained pigs from a discrete geographical region. Potentially this means that the results of the analysis cannot be generalised to pigs slaughtered in other regions, although most of the outdoor fattened pigs are produced in the region that supplies this abattoir.

The comparison of the different fattening systems revealed that the prevalence of conditions found at inspection were quite similar between the two. The finding of a higher frequency of batches with tail bite and lameness at ante-mortem inspection in the indoor fattening systems was not surprising. Tail biting in pigs is associated with poorer environmental enrichment (2) and lameness can be associated with poor flooring (3), so both of these conditions are associated with housing. When it occurred, however the within batch prevalence was not statistically significantly different between the two management systems. Of interest was the very much higher proportion of batches of pigs with oedema in indoor fattening systems. Oedema can have many causes including liver pathology, cardiac pathology and kidney pathology (4), however none of these were excessively elevated in the comparisons to explain this large difference. Again, the numbers of pigs affected within batches where the condition was found were similar between the two fattening systems. Milk spot liver occurred more frequently in free range fattened pigs, with it being detected in more than twice the number of batches of free range pigs compared with indoor fattened ones. In addition, more than a fifth of livers from pigs in which the condition was found were rejected from free range fattened pigs. Again, this is not unexpected as milk spot liver is caused by the migration of the larvae of the intestine worm *Ascaris suum* through the liver. The eggs of this worm are very resistant and so may persist for very many years in the environment, and so are more likely in pigs reared and fattened outdoors (5). Pericarditis was found to occur in more batches of indoor pigs, although this difference is unlikely to be biologically significant.

In conclusion, the prevalence of conditions detected on inspection of pigs submitted to slaughter from different fattening systems, are, on the whole, quite similar with most of the differences being predictable from the housing and fattening systems being used. Most importantly the differences observed are in lesions that will be easily assessed using visual-only inspection method. This suggests that whatever the inspection system that was in place would likely be equally effective.

The estimates of prevalence produced were then used as a baseline for characterisation of risk and evaluation of the outcomes of a subsequent field trial within this abattoir. The field trial compared inspection methods and the potential for changes in risk (6).

References

1. **Hill *et al.*** *Project FS245009 final report*, 2011 http://www.foodbase.org.uk//admintools/reportdocuments/695-1-1179_MC1002_FINAL_REPORT.pdf
2. **Schroder-Petersen DL, Simonsen HB.** *Vet J* 162, 196-210, 2001
3. **Straw BE**. *Diseases of Swine 9th edition*, 2006
4. **Taylor DJ.** *Pig Disease 6th edition*, 1995
5. **Katakam KK *et al.*** Parasit *Vectors* 9, 80, 2016
6. **Tongue *et al***. *Project FS145003 final report*, 2013 https://www.food.gov.uk/science/research/choiceandstandardsresearch/meatcontrolsprojects/fs145003