Short communication

Risk factors of lameness in sows in England

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A R T I C L E   I N F O

A B S T R A C T

Lameness in pigs is a major welfare concern and one of the most commonly reported reasons for premature culling of breeding sows. In this study, the prevalence of lameness in sows was estimated using data from 76 pig breeding units in England and risk factors associated with the occurrence of lameness were examined. The prevalence of lameness in sows was 4.5% (farm median 5.0%, range 0–40%), with at least one lame sow being observed at 54% of the 76 farms. Relative risk (RR) of lameness was determined by multivariable Poisson regression analysis. Farms with high producing sows had a lower rate of lame sows than farms with a medium level of production ($P = 0.01$). However, medium levels of production on a farm were associated with higher levels of lameness than farms having the lowest level of production ($P = 0.02$). Farms where the stockman had responsibility for more sows resulted in an increased risk of lameness ($P = 0.0062$). When indoor units were considered, the area of the pen and younger sows (two parities or less) had higher risk of lameness ($P = 0.001$ and $P = 0.026$ respectively). An increased awareness of the risk factors behind lameness is essential in farm management and can be useful when designing housing areas as well as developing future prevention plans for lameness.

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1. Introduction

Lameness, the clinical presentation of impaired locomotion or abnormal gait, is an important concern for animal welfare in the swine industry (KilBride et al., 2009a). It is an indicator of pain which can cause distress and restrict the animal from performing appropriate behaviour (KilBride et al., 2009b). Lame animals are also likely to feed less, leading to reducing growth rates and production. Lameness is the most commonly reported cause after reproductive reasons for premature culling of breeding sows (Anil et al., 2005; KilBride et al., 2009a).

Cross-sectional studies have detected prevalences of lameness in sows ranging from 8.8% in Finland (Heinonen et al., 2006), 15% in Denmark (Bonde et al., 2004, as cited by KilBride et al., 2009a) to 16.9% in England (KilBride et al., 2009a), possibly due to different housing and management systems (variation between herds within a study is not reflected in these summary statistics). A study carried out in England in 2003/2004 showed that 80% of sows were housed on solid concrete floor, 6% on partly slatted floor, 2% on fully slatted floor and 12% were kept outdoors (KilBride et al., 2009b). However, as nearly 40% of the English herds are kept outdoors, these studies are not comparable (RSPCA, 2013). Additionally, in England, sow stalls were banned in 1999 but have continued to be used in most other pig producing countries. In the European Union (EU), their use has been banned since 2013. There seems to be an increased risk of lameness in sows housed on slatted floor compared with sows housed on solid concrete floor with bedding or outdoors on soil (KilBride et al., 2009a). KilBride et al. (2009b) found that the prevalence of lameness was four times higher in pregnant sows housed on partly slatted or fully slatted floors compared with pregnant sows housed on solid concrete with deep bedding or sows in outdoor housing on soil. Identifying risk factors associated

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with lameness is essential to prevent clinical cases of lameness. Effective prevention and management of lameness in pig breeding farms would not only improve the welfare of breeding sows but also improve production and reduce the costs of treatment and culling of sows due to lameness. With increasing production costs in the British pig industry over the last ten years and increasing competition from other Member States of the EU (Environment, Food and Rural Affairs Committee, 2008), cost-effective farm management without compromising the welfare of the animals is essential.

The objectives of the following study were to estimate the prevalence of lameness in sows in England and to investigate risk factors associated with lameness in sows.

2. Methods

2.1. Study area and British pig industry

In 2009, the British pig population consisted of approximately 470,000 breeding sows. Modern commercial farms, defined as those rearing pigs primarily for slaughter, with an average pig herd size of 500 breeding sows, comprise approximately 92% of the pig population. The remaining 8% of pigs are kept on small-scale holdings and farms (Environment, Food and Rural Affairs Committee, 2008). According to English legislation, dry sows must be kept in group housing (Statutory Instruments, 2007).

2.2. Data collection

Data of lameness in dry sows were collected from 76 pig breeding farms in England in 2007 and 2008. Veterinary students collected the data during Animal Husbandry placements. All observers had received previous training and completed a virtual assessment (VA) in pig examination. Students ($n = 440$) were recruited onto welfare assessment training as part of a larger data collection exercise where the occurrence of lameness was one parameter collected. Inter-observer reliability assessment was completed on a subset of students before data collection (Wright et al., 2009; Wright, 2012). A further 32 students were assessed for inter-observer reliability (IoR). Cohen's Kappa values of <0.4 were considered slight or fair, 0.4–0.59 moderate and 0.6–1.0 substantial to near perfect. Results were compared with the VA. Data collected by students who failed the virtual assessment session were not included.

At each farm, a pen was randomly selected and a maximum of 20 sows were randomly chosen and observed as a group for 10 min as well as individually. The observer then walked through the pen to inspect pigs that had not moved during the observation period. Pigs were considered lame if they displayed shortened stride, swaggering of hindquarters while walking, reduced weight bearing on affected limb, reluctance to move or get up, arched spine when walking or standing or obvious head nods when walking.

For each group, housing conditions were recorded and the dimensions of the pen and building were measured.

Information about the herd profile and management system was obtained from the farm record and by consulting the farmer through standardised questions. The number of sows culled due to lameness was obtained from the farm records and used to estimate the yearly turnover rate of sows due to lameness.

$$\text{Culting rate} = \frac{\text{Number of sows culled due to lameness per year} \times 100}{\text{Total number of sows at assessed farms}}$$

It was assumed that the number of sows did not vary significantly over the year.

2.3. Data analysis

The number of lameness cases within a group of 20 sows examined on a farm was considered the unit of analysis. To identify risk factors associated with the occurrence of lameness in breeding pig farms, a Poisson regression model was fitted. Continuous risk factors were categorised into low, medium and high groups based on tertile cut-off points.

Univariable Poisson regression analysis was used to determine which risk factors were associated with lameness alone. Variables were included in the multivariable Poisson regression analysis if they were significant at $P < 0.1$. Explanatory variables considered are listed in Table 1.

The prevalence of lameness was assessed in farms with sows housed either indoors or outdoors. The effect associated with different housing conditions in indoor pens was then considered separately. For both datasets, variables contributing the least to the model were eliminated sequentially through backward selection to identify the most parsimonious model until only variables significant at $P < 0.05$ remained. Data were managed in Microsoft Access 2007 and statistical analyses were performed in R 2.12.1 (R Development Core Team, 2010).

3. Results

Inter-observer reliability was substantial or near perfect (Kappa value 0.6–1.0) for 25 of the 32 students assessed when observing individual animals. The remaining seven students had values between 0.4 and 0.59 and were graded 'moderate'. There was a significant correlation (Pearson, $R = 0.85$, $P = 0.03$) between the virtual assessment (VA) and the inter-observer reliability (IoR). Therefore, data from students were only included if the student had achieved a score of 60% or more in the VA.

In total, data were collected from 76 breeding pig farms. The mean herd size was 472 breeding sows (median 420 sows, range 16–2200 sows), and the mean number of pigs/pen was 42 (range 4–300). In 47% of the farms the sows were housed indoors, in 49% the sows were housed outdoors, and in the remaining 4% the housing was either mixed or not recorded. For farms where the pigs were kept indoors, 93% had solid flooring and 7% had partly slatted or fully slatted floors. There were written plans for preventing lameness in 50% of the 76 farms and 64% had written plans for treating lameness.

The overall prevalence of lameness was calculated from 1520 sows observed in this study, out of which 4.5% (farm

Table 1
Explanatory variables considered in the risk factor analysis of lameness occurrence in sows with the results from the univariable analysis for sows kept indoors or outdoors (left) and sows kept indoors (right). Variables were included in the multivariable Poisson regression analysis if they were significant at $P < 0.1$.

Variable	Indoor and outdoor P	Indoor P
Housing conditions		
Animals/pen	<0.0001	0.057
Area of pen	0.86	0.015
Stocking density	0.227	0.005
Floor type (solid or partly slatted/fully slatted[a])	0.037	0.029
Presence of bedding	0.499	0.714
Bedding type (straw or wood shawings)	0.317	0.557
Bedding coverage	0.298	0.373
Production		
Sows with more than six litters	0.11	0.053
Sows with less than two litters	0.141	0.036
Litters/sow/year	0.305	0.571
Piglets born alive/sow/year	0.015	0.178
Piglets weaned/sow/year	0.288	0.547
Farm management and prevention plans		
Sows in care of stockman	0.009	0.568
Total number of pigs in care of stockman	0.062	0.054
Written plans to prevent lameness present	0.117	0.089
Written plans for treating lameness present	0.601	0.631
Participation in any farm assurance scheme	0.794	0.871

[a] Partly slatted and fully slatted flooring types were combined due to the small number of samples.

median 5.0%) animals exhibited signs of lameness. The within-pen prevalence of lameness ranged from 0 to 40%. The prevalence of lameness was only slightly higher in sows housed indoors (4.7%) than in sows housed outdoors (4.5%). At least one lame sow was observed on 54% of the 76 farms.

A total of 56 out of the 76 farms (74%) had records of sows culled per year due to lameness. The estimated culling rate due to lameness was 3.9% (farm median 2%), ranging from 0% to 18% at individual farms, with a mean of sows culled/year due to lameness of 21 sows/farm.

3.1. Risk factors associated with lameness – univariable analysis

When indoor and outdoor sows were considered together, the number of sows with lameness on the farm increased with the number of sows in the pen ($P < 0.0001$). The productivity of the sows (number of pigs born alive/sow/year) and the number of sows for which the stockman had responsibility also influenced lameness levels ($P = 0.015$ and $P = 0.009$ respectively).

When indoor units were considered, the number of sows with lameness on the farm was higher where sows were housed on solid flooring than when they were kept on partly slatted or fully slatted flooring ($P = 0.029$), where the area of the pen was large ($P = 0.015$), stocking density was high ($P = 0.005$) or sows were of low parity (two parities or less) ($P = 0.036$).

3.2. Multivariable analysis

When both indoor and outdoor housed sows were considered, farms where more than 25.5 piglets were born alive/sow/year had a reduced rate of lameness compared with farms with a medium number of piglets (19.5–25.5) born alive/sow/year ($P = 0.01$; RR = 0.45; 95% CI = 0.25–0.83). Farms with a medium number compared to a low number of pigs born alive/sow/year had an increased rate of lameness ($P = 0.02$, RR = 2.04; 95% CI = 1.10–3.76). Where the stockman cared for a medium and high numbers of sows, the risk of lameness increased compared with where the stockman cared for fewer sows ($P = 0.027$, RR = 0.36; 95% CI = 0.19–0.70).

When indoor units were considered, a large pen size increased the risk of lameness compared with medium and small pens ($P = 0.016$, RR = 12.06; 95% CI = 1.58–91.94 and $P = 0.04$, RR = 3.18; 95% CI = 1.05–9.64). Lower parity sows (two parities or below) had an increased risk of lameness compared with sows of three to six parities ($P = 0.01$, RR = 0.25; 95% CI = 0.09–0.72).

4. Discussion

In this study, the prevalence of lameness in sows in England and its variation among herds was estimated and associated risk factors were assessed. Data used were collected by undergraduate veterinary students using a questionnaire designed to direct the students in appropriate observation and examination of animals on the farms. All students were trained before the data collection exercise and the number of students passing the virtual assessment (VA) determined the number of datasets included.

The estimated prevalence of lameness in sows (overall = 4.5%, median among herds = 5.0%) was lower than the overall prevalence of 16.9% in pregnant sows reported by KilBride et al. (2009a). Of the herds included in this study, 47% were housed indoors and 49% were housed outdoors. Nationally, 58% of breeding sows are housed indoors and 42% are kept outdoors (RSPCA, 2013). However, the

2003/2004 Warwick study (KilBride et al., 2009b) found that only 12% of gilts and pregnant sows were housed outdoors. In other studies, the prevalence of foot and limb injuries has been significantly higher in pigs housed indoors than outdoors (KilBride et al., 2009b). Outdoor sow numbers are still increasing in United Kingdom (UK) and our results are likely to represent a more up-to-date structure of the industry. Students collected lameness data which may have introduced some biases. Students have little experience of identifying lameness in animals and may have missed some slightly lame animals, especially in outdoor herds where it is not as easy to examine the animals. Nevertheless, although the prevalence of lameness was slightly higher in sows housed indoors than sows housed outdoors, the difference was not statistically significant. A small group of animals was examined and this may have biased estimates either by not taking into account spatial clustering of cases or by failing to identify lame animals that were present on that farm at that time. However, students were given guidance on pen selection and pens housing animals that had been removed from their usual pen, for example due to lameness, would not have been selected.

Some studies show that the prevalence of lameness is higher in the winter and the odds of a sow being culled due to lameness are higher in non-summer months than in summer months (Anil et al., 2005). In this study, 78% of the observations took place during the summer months (June–September) and the remaining 22% took place in the spring (March–April). The estimated prevalence of lameness may, therefore, be lower than if the study also had taken place in the winter months. Variation in prevalence estimates between studies may also depend on the case definition of lameness (KilBride et al., 2009a).

Lameness prevention plans are a requirement of many assurance schemes and include details of how a lame animal should be treated as well as prevention and corrective methods that should be considered. When sows housed both indoors and outdoors were considered, the presence of a written prevention plan for lameness was not significantly associated with the occurrence of lameness on a farm ($P = 0.068$). However this result warrants further investigation with the inclusion of a larger number of farms. It also suggests that farms registered with assurance schemes have a raised awareness of lameness prevention and this effectively reduces the prevalence of lameness in pig breeding units.

In high and low producing farms, lameness rates were lower than in medium producing farms. Farms with high production (>25.5 piglets/sow/year) need to be well managed with excellent stockmanship and would likely have prompt recognition of lameness on those farms. It is also possible that lameness may impact fertility, contributing to the lower number of piglets born alive/sow/year on the medium producing farms. Conversely, low production farms may use higher weaning ages (fewer piglets/year) and, therefore, the demand on the sows may be lower, giving rise to less lameness but more piglets/litter compared with medium producing farms.

In indoor units, lameness was higher in sows housed in larger pens. Stocking density and pen size could influence group behaviour as more aggression tends to occur in larger groups when the sows establish hierarchy ranks, especially at the time of regrouping (Arey and Edwards, 1998). In addition, it may be harder for the stockman to identify cases of lameness in a larger group of sows. Although a severely lame sow can be easily spotted, mildly lame sows might be difficult to distinguish from healthy sows (Anil et al., 2009). In units that recorded the cause of culling, the culling rate of sows due to lameness (3.9%) was lower than the prevalence of lameness in sows (4.5%). Other studies have reported annual removal rates of 11–14% due to lameness (reviewed in Engblom et al., 2007). Production systems are most profitable when the replacement rate is low, and the highest annual productivity is achieved when sows are removed due to old age (Engblom et al., 2007). In our study, the risk of lameness was increased in animals of two parities or less compared with older animals. Lameness can impede sows from reaching optimal breeding efficacy as sows culled due to lameness are often removed at a younger age than sows removed for other reasons, increasing the cost per weaned pig as the number of litters/sow/year and the number of piglets weaned/sow/year decreases (Anil et al., 2005).

The cost of pig production in the UK is high compared with other countries in the EU, with an average of 8 min more spent on each pig in labour/year (Fowler, 2008). This may reflect differences in husbandry systems and variation in performance, demonstrating the need to prioritise preventable health issues. The results of this study indicated that production levels, housing conditions and resources available to the animal, as well as management practices such as the number of animals in a stockman's care, can affect the probability of lameness occurring in sows, highlighting the importance of awareness and prevention activities to control lameness and improve welfare in sows.

Conflict of interest statement

Acknowledgments

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272

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