Using data from electronic feeders on visit frequency and feed consumption to indicate tail biting outbreaks in commercial pig production

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ABSTRACT: The long term aim with this study was to identify predictors or early indicators of tail biting outbreaks using registrations from electronic feeders. This study is based on information about daily frequency of feeder visits (DFV) and daily feed consumption (DFC) recorded in electronic feeders from 460 noncastrated boars in tail biting pens (TB pens, n = 21) and matched control pens (Con pens, n = 21) from 10 wk before to 10 wk after the first injured tail in the pen. The results showed lower average DFV among pigs in TB pens compared with pigs in Con pens 6 to 9 wk before the start of the tail biting outbreak (first treatment for tail damage due to tail biting; P ≤ 0.1, df = 487) but a greater DFV for tail biting victims 2 to 5 wk before the start of the tail biting outbreak compared both to other pigs in the TB pen and to pigs in the Con pen (P < 0.1, df = 6,500). Tail biting victims had decreased DFC during and after the tail biting outbreak [wk 0 to 2 after the tail biting outbreak (P < 0.1, df = 6,500)]. In conclusion, information from electronic feeders can be used for surveillance of tail biting outbreaks in pigs. Due to common casual factors, low feeding frequencies observed on the group level can predict future tail biting in the pen as early as 9 wk before the first tail injuries. Moreover, increased feeding frequencies for individual pigs in potential tail biting pens may predict which pigs will become the victims in the tail biting outbreak. The results further support previous findings that pigs with tail injuries due to tail biting consume decreased amounts of feed.

Key words: animal welfare, feed consumption, feeding behavior, prediction, swine, tail damage

INTRODUCTION

The cause of tail biting in pigs is thought to be multifactorial (Schroder-Petersen and Simonsen, 2001; Taylor et al., 2010) and among others, both nutritional factors and foraging behavior have been suggested to be important (Bracke et al., 2004; Holmgren and Lundeheim, 2004; Taylor et al., 2012).

Most of the predictors of tail biting damage reported previously have been observed the last few days or hours before the start of the tail biting outbreak (Statham et al., 2009; Zonderland et al., 2009; Zonderland et al., 2011) and are most likely indicators of already ongoing tail biting behavior. However, in a previous study we found increased frequencies of hostile social interactions, foraging behavior away from the feeder, and shorter feeding durations several weeks before the start of the tail biting outbreak (Wallenbeck et al., 2010). Therefore, there seems to be a disrupted feeding behavior among pigs in groups developing tail biting long before the first injured tail is observed.

Electronic feeding automats are becoming more common in commercial animal husbandry, and the information they generate has been found useful for detecting health disorders in several farm animal species (Svensson and Jensen, 2007; Cornou et al., 2008; Gonzalez et al., 2008). Electronic feeders have been used for growing–finishing pigs in nucleus herds.
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and test stations for decades, and the data generated has the potential to serve as a tool for the surveillance of social behavior of pigs (Hoy et al., 2012).

The long-term aim of this study was to identify predictors or early indicators of tail biting outbreaks feasible for use in commercial pig production. The specific aim was to investigate frequency of feeder visits and feed consumption recorded in electronic feeders over time in relation to the start of tail biting outbreaks.

MATERIALS AND METHODS

This study is based on information about pure bred Yorkshire (York), Landrace (Land), and Hampshire (Hamp) boars kept at the boar testing station of the breeding company Nordic Genetics (Hörby, Sweden). The boar testing station is located in the southern part of Sweden and the pigs kept in the herd originate from 20 nucleus herds. The boars arrived to the herd when they were approximately 12 wk of age (25 kg BW) and were kept in the same pen from arrival until slaughter or until transfer to AI stations at approximately 24 wk of age (110 kg BW). The test station consisted of 8 stables with a total area of 15.7 m² (4.9 by 3.2 m) with a slatted dunging area along the back of the pen (4.9 by 0.9 m) and a solid concrete lying area. Each pen had 1 water nipple in the slatted area and approximately 1 kg of straw per pen provided daily. An electronic automatic feeder (ACEMO 48; Acemo, Pontivy, Cedex, France) was located in the front of the pen. The feeder was 0.6 m wide, and the total length was 2.2 m. The feeder included a feed trough and a pig stall. Feed allowance and feed residues were weighed and registered at each visit. The gate to the stall opened when the pig pushed it and closed behind the pig. Other pigs could not open the gate or interact with the pig inside the feeder during the feeding event. The pig entering the feeder was individually identified through an electronic ear tag. Pigs were fed individually ad libitum from the feeder with a Swedish standard dry feed composed according to Swedish nutrition norms for growing–finishing pigs (Andersson and Lindberg, 1997). The boars were not castrated and, in accordance with the Swedish animal welfare legislation, tails were not docked.

The data analyzed included information registered in the feeder on individual pigs about daily frequency of feeder visits (DFV; number of visits to the feeder/24 h) and daily feed consumption [DFC; feed (g)/24 h]. Moreover, data from the herd routine recordings were available (for individual pigs) regarding breed, date of birth, date and BW at arrival, medical treatment for tail damage caused by tail biting (reason for treatment and date), and culling due to tail damage caused by tail biting (reason for culling and date). Whether or not tail damage was caused by tail biting was judged by the herd staff. The judgment was based on the severity of the wounds on the tail (the damage had to be severe enough to need medical treatment) and the observation of tail biting behavior in the pen. At the testing station, all staff were experienced and educated animal keepers, and all pigs were checked for wounds regularly; thus, the judgment was more standardized and the recording more systematic than usual in conventional production herds.

The analyses included information on boars raised at the testing station from October 2004 to July 2007. During that period, 70 batches of a maximum of 80 boars per batch arrived at the test station (4,400 pigs in total). For each batch, all pigs arrived within 1 or 2 successive days and were kept in the same stable. Analyses were performed on both pen and pig level. For analyses on pen level, all pens in which at least 1 pig was medically treated or culled due to tail damage caused by tail biting were categorized as tail biting pens (TB pen). For each TB pen, 1 matched control pen (Con pen) from the same batch with no registered tail damage was selected. Control pens were selected to match the TB pens based on group size and location in the stable; the aim was that matched TB pens and Con pens had the same number of pigs and were located next to each other in the stable. For the analyses on pig level, the individual pigs in these pens were divided into 3 categories based on their involvement in tail biting activities: victims (treated or culled for tail damage due to tail biting), nonvictims in TB pens (pigs kept in TB pens but not treated for tail damage due to tail biting), and controls in Con pens. As the identification of pigs performing tail biting was time consuming, only a few tail biters were identified, and therefore we could not include tail biter as a category in the analyses.

The information on DFV and DFC analyzed ranged from 10 wk before to 10 wk after the first treatment of tail damage due to tail biting. The timing of outbreaks of tail biting in relation to the time of arrival of pigs at farms is shown in Fig. 1. The definition of the start of the tail biting outbreak is when the first pig in the pen was treated for tail damage due to tail biting.

Statistical Analyses

Statistical analyses were performed using the SAS software (SAS Inst. Inc., Cary, NC). Descriptive statistics were obtained with the procedure MEANS and analysis of variance was performed using the procedure MIXED. Residuals of the dependent y-parameters were examined for normal distribution using the procedure UNIVARIATE, considering Shapiro-Wilks test for normality and a normal probability plot, and no significant differences from normality were found.
For analyses on pen level, the dependent $y$-variables were average DFV and DFC per pen and week, expressed as average number of visits to the feeder and grams of feed/pig per 24 h, respectively. The statistical model included the fixed effects of pen type (TB pen or Con pen), breed combination in the pen (York–Land–Hamp, York–Land, York–Hamp, or York), week in relation to first treatment of tail damage due to tail biting ($–10$ to $10$ wk), year when the tail biting outbreak started, month when the tail biting outbreak started, interaction between pen type and week, and the random effect of matched pen pair of TB pen and Con pen. Number of pigs in the pen was included as a continuous covariate.

For the analyses on pig level, the dependent $y$-variables were average DFV and DFC per pig and week, expressed as average number of visits to the feeder and grams of feed/pig per 24 h, respectively. The statistical model included the fixed effects of pig category [victim, nonvictim (TB pen), or control (Con pen)], breed (York, Land, or Hamp), week in relation to first treatment of tail damage due to tail biting ($–10$ to $10$ wk), month when the tail biting outbreak started, interaction between pig category and week, and the random effect of the individual pig and matched pen pair of TB pen and Con pen in which the pig was held. Number of pigs in the pen that the individual pig was kept in was included as a continuous covariate.

**RESULTS**

The data analyzed included information from a total of 460 noncastrated boars in either TB pens or matched Con pens from the 21 batches where tail damage due to tail biting was registered, 42 pens in total (TB pens, $n = 21$; Con pens, $n = 21$). This means that in the data analyzed there were no batches with more than 1 observed tail biting outbreak. Of the 225 pigs in the TB pens, 56 were victims. There were no significant differences in age or BW at arrival between pigs in pens where tail biting developed and neighboring Con pens where tail biting did not develop or between pigs that later became victims of tail biting and pigs not becoming victims of tail biting (Table 1).

Tail biting outbreaks developed during all parts of the growing–finishing period, from when the pigs were 12 wk of age (approximate age at arrival to the boar testing station) until 24 wk of age (approximate age at departure from the boar testing station to slaughter or transfer to AI station) with a peak at 5 to 6 wk after arrival (Fig. 1). As a result of this timing and occasional missing values, all pen pairs did not contribute data for all weeks analyzed. The number of matched pen pairs contributing data for each week in the analyses was 2, 3, 3, 5, 7, 13, 14, 16, 17, 18, 21, 21, 19, 19, 19, 17, 16, 12, 8, and 5 for wk $–10$ to $+10$, respectively.

<table>
<thead>
<tr>
<th>Pen category</th>
<th>TB pen (mean ± SD)</th>
<th>Con pen (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of pens</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>No. of pigs per pen</td>
<td>10.7 ± 1.42</td>
<td>11.2 ± 1.7</td>
</tr>
<tr>
<td>Pig category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Victim</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonvictim (TB pen)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control (Con pen)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of pigs</td>
<td>56</td>
<td>169</td>
</tr>
<tr>
<td>Age at arrival, d</td>
<td>77.9 ± 7.96</td>
<td>77.2 ± 7.19</td>
</tr>
<tr>
<td>Weight at arrival, kg/pig</td>
<td>25.2 ± 2.70</td>
<td>24.6 ± 2.74</td>
</tr>
</tbody>
</table>

**Pen Categories**

Taking the whole period from 10 wk before to 10 wk after the first treatment for tail damage into account, pigs in TB pens had an overall lower DFV compared with pigs in Con pens ($26.4 ± 1.12$ vs. $30.6 ± 1.16$ visits/pig per 24 h, respectively; $F = 19.5, df = 487, P < 0.001$). In more detailed studies of differences per week in relation to first treatment of tail damage due to tail biting, it was found that this difference was mainly due to a reduced DFV for pigs in the TB pens 6 to 9 wk before the first treatment (Fig. 2). The average DFC over the whole period was less for pigs in TB pens compared with pigs in Con pens ($1,811 ± 106.8$ vs. $1,892 ± 107.6$ g/d, respectively; $F = 8.2, df = 487, P < 0.004$). This difference was mainly due to a reduced DFC in TB pens the last weeks before and during the tail biting outbreak (Fig. 3).

There was a significant effect of breed combination in the pen indicating a decreased DFV in pens with mixed breeds ($P < 0.001, F = 22.54, df = 487$). Daily frequency of feeder visits decreased with increased group size in the pen ($P < 0.001, F = 34.48, df = 487$).
Pig Categories

Pairwise comparisons of the 2 categories of pigs in the TB pen and pigs in the Con pens showed that victims visited the feeder more frequently than both other pig categories 2 to 5 wk before the start of the tail biting outbreak (Fig. 4). The only difference seen between the other 2 categories of pigs was a reduced DFV among nonvictim pigs in TB pens compared with control pigs in Con pens 6 wk before the start of the tail biting outbreak \( (P = 0.0251, t = 2.24, df = 6,500) \).

There was a trend that victims had a decreased average DFC compared with both of the other pig categories during the tail biting outbreak (0 to 2 wk after the start of the tail biting outbreak; Fig. 5). Pairwise comparisons also showed other differences among pig categories but with a less clear pattern; control pigs in Con pens tended to have a greater average DFC 3 wk before the start of the tail biting outbreak compared with both other pig categories \( (P < 0.1, t > 1.65, df = 6,500) \). Nonvictim pigs in TB pens had a lower average DFC 2 wk before the start of the tail biting outbreak compared with both other pig categories \( (P < 0.05, t > 2.11, df = 6,500) \), and nonvictim pigs in TB pens had a greater average DFC 6, 8, and 9 wk after the start of the tail biting outbreak compared with control pigs in Con pens \( (P < 0.1, t > 1.79, df = 6,500) \).

Pigs of the Hamp breed had a reduced DFV and DFC compared with York and Land pigs \( (P < 0.001, F = 27.59, df = 6,500 \text{ and } P = 0.001, F = 8.05, df = 6,500, \text{ respectively}) \). Daily frequency of feeder visits decreased with increased group size in the pen \( (P = 0.025, F = 5.01, df = 6,500) \).

DISCUSSION

Week 6 to 9 before the tail biting outbreak, the DFV among pigs in pens later observed to have tail damage due to tail biting were 23 to 51% less than the DFV frequency observed in neighboring Con pens where tail biting did not develop. Our interpretation of these results is that in cases where pigs are fed ad libitum in automatic feeders, decreased DFV can predict tail biting outbreaks as early as 9 wk before the start of the tail biting outbreak, possibly due to common casual factors. Factors related to nutrition and foraging behavior, for example changes in feed composition and feeding technique for the pigs at arrival to the test station or poorly functioning feeders, are likely causes of the reduced DFV and also likely causes of tail biting as a secondary effect. In line with previous findings (Hoy et al., 2012), these findings emphasize the potential for electronic feeders to monitor not only pig feed consumption but also pig behavior and thus indicate deviations in both the physical and social environment in a pen. The results of the present study additionally suggest that surveillance of pig behavior through automatic feeders, either monitored in the data log by the animal keeper or even by an automatic alarm set at greater than usual deviations in DFV, could be used to trigger preventive measures long before a full scale tail biting outbreak develops. Relevant preventive measures such as additional supply of straw or other rootable material or removal of individuals disturbing the social dynamics of the group have been suggested by the European Food Safety Authority (EFSA, 2007). However, further long-term studies on commercial farms are needed to assess the benefits of such surveillance for production economy and animal welfare.
The differences in DFV between pens that later develop tail biting outbreaks and neighboring Con pens raises the question of whether the high (as in Con pens) or the low (as in TB pens) initial DFV is “normal.” Frequencies of feeder visits are difficult to compare between studies as they are dependent on factors such as the age of the pig, pen design, type of feeding automat, diet composition, pen, and group size. However, a pilot study (Andersson, 2006) investigating associations between feeding behavior and aggressive behavior at the same boar testing station and performed within the time period represented by the data analyzed here reported a mean DFV of 30 to 35 visits/pig per day during the first and the fourth week after arrival to the test station. In our study the average DFV varied between 20 and 27 visits/pig per day in TB pens and between 35 and 41 in Con pens 6 to 9 wk before the start of the tail biting outbreak. This indicates that Con pens were closer to a “normal” DFV at this boar testing station. Moreover, as pigs grow older their feed consumption capacity, both per day and per feeding event, increases. Therefore, the expected development is for the frequency of feeder visits to decrease as pigs grow older, which was observed for pigs in Con pens but not for pigs in the TB pens. This again supports that the pattern of feeder visits for TB pens was abnormal rather than the pattern in the Con pens.

The definition of the start of the tail biting outbreak in the present study is when the first pig in the pen was treated for tail damage due to tail biting. When tail damage is on a level where it is medically treated, tail biting behavior has in most cases been going on for some time (Schroder-Petersen and Simonsen, 2001). Two to 5 wk before the start of the tail biting outbreak, pigs that would later becoming victims of tail biting had a 33 to 47% greater DFV compared with pigs in the same pen who would not become victims of tail biting. These future victims also had a 24 to 29% greater DFV compared with pigs in neighboring Con pens where tail biting was not developing. This suggests that future tail biting victims could be identified by increased individual feeding frequencies. Our interpretation of this result is that the increased DFV 2 to 5 wk before the start of the tail biting outbreak among pigs later treated for tail damage is related to already ongoing tail biting, possibly mild tail biting not yet causing damage to the tail but with disrupted social dynamic in the pen and increased restlessness among victims, as described by Zonderland et al. (2011). The increased frequency of visits to the feeder could be a way for the victims to hide from the biters, especially as they did not consume more feed even though they visited the feeder more frequently. It could also be the other way around, that the pigs in the group visiting the feeder often were easy targets for tail biters during queuing to enter the feeder.

The average DFC over the whole growing–finishing period was on average 4% less among pigs in TB pens compared with pigs in Con pens, but the difference did not change over time; therefore, there were no clear deviations that could indicate the upcoming tail biting outbreak. Tail biting victims consumed on average 6 to 14% less feed during the tail biting outbreak (0 to 2 wk after the start of the tail biting outbreak) compared with pigs in the same pen not being victims of tail biting and 7 to 16% less feed compared with pigs in neighboring Con pens where tail biting did not occur. This decreased DFC among tail biting victims is in line with the reduced growth reported among tail biting victims after the tail biting outbreak (Wallgren and Lindahl, 1996; Niemi, 2011). These results do not indicate that deviations in feed consumption can predict a tail biting outbreak but that there is probably already tail biting going on.
The finding that Hamp pigs had a decreased DFV and DFC compared with York and Land pigs may be due to the fact that the Hamp breed is a sire breed and York and Land are dam breeds. Hampshire pigs have been bred for generations for a breeding goal with greater emphasis on feed conversion compared with the breeding goals for York and Land pigs (Solanes et al., 2004).

As feed consumption and feeding behavior is of great economic importance in commercial pig production, it is usually closely monitored by the farmer. These factors are therefore feasible for surveillance of pig behavior in commercial pig production. The results of the present study indicate that surveillance of deviation in the feeding behavior and feed consumption of the group and individual pigs can indicate and to some extent even predict tail biting outbreaks. Such early indications give the animal keepers a chance to implement preventive or treatment measures (e.g., additional straw or other rootable material or removal of tail biting pigs) at an early stage of a tail biting outbreak, which have potential to reduce the negative impact of tail biting on production economy and pig welfare.

In conclusion, the results of the present study suggest that information from electronic feeders can be used for surveillance of tail biting outbreaks in pigs. Due to common casual factors, reduced feeding frequencies observed on pig group level may predict pens that will have tail damage due to tail biting as early as 9 wk before the actual tail damage is observed. Moreover, increased frequencies of feeder visits for individual pigs may predict which pigs become victims of the tail biting. The results further support previous findings that pigs with tail injuries due to tail biting have decreased feed consumption.

**LITERATURE CITED**


European Food Safety Authority (EFSA). 2007. The risk associated with tail biting in pigs and possible means to reduce the need for tail docking considering the different housing and husbandry systems. EFSA J. 61:1–13.


