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Tail biting and production performance in fattening pigs

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ABSTRACT

Tail biting is an important animal welfare problem that is known to negatively affect production performance. We studied how tail biting influences the production performance in fattening pigs. Production performance was measured as the average daily gain (ADG), gross feed conversion ratio (FCR), red meat percentage (Meat%). Pigs' genetic merit, gender and breed were taken into account in the analysis. In addition, differences between breeds and genders in the prevalence of tail biting were studied. The data were collected from a farm and they included individual records for 3190 pigs. Altogether, 11.4% pigs were identified as victims. Between boars, females and barrows there were not significant differences in the risk for being a tail biting victim. Yorkshire (Y) pigs were identified as victims more often than Landrace (L) pigs, 13.8% and 10.0%, respectively ($p = 0.001$). Non-victims had a greater ADG than victims (33.4 g/d difference in observed means but 10.8 g/d difference when adjusted to genetic merit). These values correspond to 1 to 3% reduction in ADG. By contrast, no significant differences between victims' and non-victims' FCR and Meat% were found. The results highlight the need to take into account genetics, breed and other factors affecting production performance when estimating the effects of a health disorder.

1. Introduction

Tail biting in pigs is a stress-induced behavioural disorder. It is one of the most important animal welfare problems in pig fattening in many countries (EFSA, 2007). In Finland, tail biting or other tail damage has been observed in 8–30% of pigs (Munsterhjelm, 2006; Tiilikainen, 2000; Valros et al., 2004). Pigs of all ages may suffer from tail biting, and there may be multiple causes, such as a lack of stimuli and disturbances in the production environment (e.g. EFSA, 2007).

Despite its importance, few studies have examined whether the production results of intact-tailed pigs differ from those of tail biting victims. Wallgren and Lindahl (1996) observed an 11% lower average daily weight gain in a short period after biting, and a 5% lower average daily weight gain from biting to slaughter for victims than non-victim pigs. The carcasses of victims also have elevated condemnation rates and an increased probability of infection (Huey, 1996; Valros et al., 2004). Impaired growth and feed conversion ratio, extra treatment and medication costs, increased carcass condemnations and mortality, if associated to tail biting, have the potential to cause economic losses to the producer.

It is important to take genetics, breed and gender of a pig into account when assessing the effect of tail biting on the production performance of pigs, because these factors are known to significantly impact the pig's growth, leanness, feed intake and other production traits, and because the same factors can be associated with tail biting. For instance, the odds of a castrated male pig being bitten are more than twice the odds of a female pig being bitten (Kritas and Morrison, 2004; Valros et al., 2004; Walker and Bilkei, 2006). Boars are also more likely to be bitten than female pigs (Penny et al., 1981). The measurement of effect of tail biting on production is difficult because it requires a large dataset with detailed measurement of parameters such as feed intake, growth and carcass leanness, and

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information on the pigs' genetics. The true impact of tail biting on production performance is therefore mainly unanalysed.

Our goal was to study how tail biting influences the production performance in fattening pigs during the entire fattening period. Production performance was measured as the average daily gain (ADG), gross feed conversion ratio (FCR) and red meat percentage (Meat%), which included loin thickness (Muscle) and back fat thickness (S1 and S2). We hypothesised that the interaction effect between tail biting and gender and breed would affect pigs' production performance but the direction was unclear. We assumed that tail biting as a main effect would lower the performance. The present study contributes to the literature by taking pigs' genetic merit, gender and breed into account in the analysis.

2. Material and methods

2.1. Animals and management

The data used in this study were individual animal records obtained from the Finnish progeny test farm at Längelmäki. The records were collected between 1 January 2007 and 1 December 2008, a period covering approximately two first years after the start of the farm. The pigs were boars, females and barrows of Finnish Landrace and Yorkshire (see Section 2.3). On arrival, the pigs were assigned to pens primarily according to their gender and secondly to their size. Occasionally, barrows were mixed with boars or females. The pigs were fed ad libitum with a three-phase feeding programme for 91 days on average, starting from approximately 30 kg body weight and ending at approximately 120 kg body weight (approximately 89 kg carcass weight). The first and second diets were served until 55 kg and 80 kg average body weight in the group, respectively, and the third diet thereafter until slaughter. The protein content of the feed slightly exceeded the Finnish feeding recommendations (see MTT, 2006). Feed ingredients of the diet varied during the study period, but as we had high number of observations (both victims and non-victims) from each feed batch, this does not influence the results of this study. The herd veterinarian visited the farm regularly, at least once every two months. Farm workers monitored the pigs 3 or 4 times a day. If health problems were observed, they started the necessary interventions according to the advice of the herd veterinarian to resolve the problem and recorded the pigs' health status, disease symptoms and treatments in a database. The health records did not show exceptional disease epidemics during the study period. The most common health notification was tail biting and the second most common locomotive problems. Pigs had undocked tails, as tail docking has been prohibited in Finland since January 2003.

The farm was able to house 1300 pigs in 14 compartments managed with all in – all out principle. Each compartment was filled individually every 14 weeks. Out of 8 pens in each compartment, 6 pens had an automatic single-space feeder (Schauer Spotmix, Schauer Agrotronic GmbH, Austria) and 2 pens a long trough with automatic feeding. However, data from long trough pens were not used in the present analysis. Approximately one-third of the total pen floor (16.8 m^2) was slatted. The flooring material was uncoated concrete. On average, there were 11 pigs per pen. The floors were insulated and a small amount of straw and sawdust was used as enrichment material. In addition, toys were provided in troublesome pens, due to pigs' behaviour, or in pens in which workers had observed tail biting. There were hospital pens for sick animals. They were considerably smaller than other pens, but otherwise their structure was similar. A hospital pen could house 1 or 2 pigs, which were fed manually in trough. Pigs in hospital pens were given much more straw and sawdust as enrichment than pigs in other pens.

In every compartment there was a return air fan that blew the exhaust air out of the building. The incoming air was supplied through ceiling air inlets on the edges of each compartment. A controller located in every compartment regulated the volume airflow of the return air fan and heating by regulating the magnet valve of heating pipe network. The volume airflow and temperature in the facility were controlled and monitored by a facility management system (Pellonpaja Oy, Finland). For every compartment there was a pre-programmed four-point control curve beginning from 23 °C at arrival and declining steadily to 16 °C before slaughter. Temperature in the compartments could not be lower than the outdoor temperature, since artificial cooling was not applied. There were two control schemes for lighting, daylight and nightlight. The daylight control scheme started at 7 am and ended at 5 pm, while the nightlight control scheme started at 5 pm and ended at 7 am.

2.2. Recording of tail biting and production performance

Animals were earmarked and manually weighed individually by farm workers upon arrival, on the slaughter date and on designated days in between if the pig was participating in a test. Besides performance testing, other experiments were also carried out at the farm. Designated weight measurement was carried out approximately every third week. The first back fat thickness measurement (S1) was taken between the 15th rib and the 1st lumber joint and the second back fat thickness (S2) and loin thickness (Muscle) measurements between the 12th and 13th rib. S1, S2 and Muscle were measured (Hennessy GP4, Hennessy Grading Systems Ltd., Auckland, New Zealand) at the slaughterhouse. The red meat percentage (Meat%) was calculated by an equation, which used S1, S2 and Muscle measures.

The average daily gain (ADG) was defined as the last weight minus the first weight measured for a pig divided by the number of days between the weight measurements. These data combined with information about feed intake were used to compute the feed conversion rate (FCR), which indicated the amount energy (MJ net energy) consumed per kg weight gain. Feed intake was defined as the amount of feed given by the feeding machine to the pig. The amount of feed consumed by individual pigs was measured automatically by the feeding system and a transponder connected to the ear of the pig. The pigs' genetic merit was based on estimated breeding values for ADG, FCR, Meat%, Muscle, S1 and S2, which were obtained from the database of the Finnish Animal Breeding Association.

A pig was considered to be a victim of tail biting, if it had the symptom record "tail was bitten." A tail was considered bitten if there were visible wounds (e.g. blood) indicative of tail biting. This symptom was based on observations made by farm workers alongside other routines. Workers were not asked to especially monitor tail biting. If workers observed a tail biting victim and had doubts that it could not survive in the pen (by suffering itself or causing suffering to other pigs in the same pen), it was moved to a hospital pen to recover. The moving was decided case by case; if symptoms were mild and were disappearing, the victim could stay in the pen. The victim was usually medicated with parenteral penicillin injections for 3–5 days. Sometimes the return to the original pen was not successful and the victim spent the rest of its life in the hospital pen. The biter, if identified, was placed alone in an isolation pen. If tail biting occurred, the tails of pigs in the pen were covered with tar and a small amount of pellet feed was given to the pigs to prevent further biting incidents in the pen.

2.3. Data on individual animals and statistical analyses

The data were analysed to find out differences in ADG, FCR and Meat% between victims and non-victims. There were individual phenotypic and genetic records for 3190 pigs, of which 1114 (34.9%) were boars, 1229 (38.5%) females and 847 (26.6%) barrows. The breeds analysed in the present study were Finnish Landrace (L) (2017 pigs, 63.2% of all pigs) and Yorkshire (Y) (1173 pigs, 36.8%).

Analyses of covariance (ANCOVA) by the GLM procedure were conducted to study the effects of tail biting, gender and breed on the pigs' production performance. The dependent variable was phenotypic measure (ADG, FCR or Meat%) and the covariate was its genetic estimate (ADG_{BLUP}, FCR_{BLUP} or $Meat\%_{BLUP}$). Only measures with statistically significant estimates were reported. Preliminary checks were conducted to ensure that there was no violation of assumptions normality, linearity, homogeneity of variances, homogeneity of regression slopes and reliable measurement of the covariate. The effect sizes for variation sources were measured with partial eta squared (η_p^2) and omega squared (ω^2) values. Pairwise comparisons were conducted for adjusted means and the effect sizes were measured (Cohen's d). Statistical analyses were performed using SPSS 19.0 for Windows (SPSS Inc., USA).

3. Results

Altogether 363 (11.4%) pigs in the dataset were identified as victims. Most victims had only one record of being bitten during their stay at the test farm (273 pigs, 8.6% of all pigs and 75.2% of victims). According to the records, 90 (2.9%) pigs had been bitten at least twice. On average there were 1.37

Table 1
Descriptive statistics of ADG, FCR and Meat% by tail biting status (victims TB = 1, non-victims TB = 0), gender and breed.

TB	Gender	Breed	ADG		FCR		Meat%		N
			Mean	SD	Mean	SD	Mean	SD	
0	Boar	Y	914	109	22.9	1.89	63.3	2.21	378
		L	937	113	23.1	1.77	63.4	2.27	600
		Total	928	112	23.0	1.82	63.4	2.24	978
	Female	Y	903	101	23.5	1.91	64.0	2.44	367
		L	929	106	23.7	1.78	64.6	2.40	725
		Total	920	105	23.7	1.83	64.4	2.43	1092
	Barrow	Y	963	108	25.0	2.27	61.6	2.60	266
		L	1010	112	25.1	2.03	61.6	2.56	491
		Total	994	113	25.1	2.12	61.6	2.57	757
	Total	Y	923	109	23.7	2.17	63.1	2.57	1011
		L	954	115	23.9	2.00	63.4	2.69	1816
		Total	943	114	23.8	2.07	63.3	2.65	2827
1	Boar	Y	902	111	23.1	2.03	63.3	2.13	73
		L	938	108	22.7	1.32	63.8	2.22	63
		Total	919	111	22.9	1.74	63.5	2.18	136
	Female	Y	855	115	23.9	2.00	63.7	2.48	55
		L	898	111	24.4	2.09	64.8	2.43	82
		Total	881	114	24.2	2.06	64.3	2.50	137
	Barrow	Y	926	104	25.6	2.61	61.9	2.04	34
		L	944	122	24.9	1.82	62.3	2.50	56
		Total	937	115	25.2	2.16	62.1	2.33	90
	Total	Y	891	114	23.9	2.34	63.1	2.33	162
		L	924	115	24.0	2.00	63.8	2.58	201
		Total	909	115	24.0	2.15	63.5	2.49	363
Total	Boar	Y	912	109	22.9	1.91	63.3	2.19	451
		L	937	112	23.1	1.74	63.4	2.26	663
		Total	927	112	23.0	1.81	63.4	2.23	1114
	Female	Y	897	104	23.6	1.93	63.9	2.44	422
		L	926	107	23.8	1.82	64.6	2.40	807
		Total	916	107	23.7	1.86	64.4	2.44	1229
	Barrow	Y	959	108	25.1	2.32	61.6	2.54	300
		L	1004	115	25.1	2.01	61.6	2.56	547
		Total	988	114	25.1	2.12	61.6	2.55	847
	Total	Y	919	110	23.7	2.20	63.1	2.54	1173
		L	951	116	23.9	2.00	63.4	2.68	2017
		Total	939	114	23.8	2.08	63.3	2.63	3190

victims per pen. The pens, where tail biting was observed, had on average 3.28 victims. Every fourth pen had two or more victims.

The pigs weighed on average 34.7 kg (±SD 5.33 kg) upon arrival at the test farm and 120.8±9.47 kg when leaving to slaughter. No significant differences in arrival weights were observed between non-victims (34.7±5.30 kg) and victims (34.7±5.50 kg) ($p=0.995$). No significant differences in slaughter weights were observed between non-victims (120.8±9.42 kg) and victims (120.3±9.98 kg) ($p=0.365$).

The prevalence of victims among boars, females and barrows was 12.2% (of pigs of same sex), 11.1% and 10.6% respectively, the overall prevalence being 11.4%. However, the differences between genders were not significant ($p=0.522$). There were differences between breeds examined. Tail biting prevalence among Y pigs was 13.8% whereas among L pigs it was 10.0% ($p<0.001$).

For all pigs in the dataset, the ADG was on average 939±114 g, the FCR was 23.8±2.08 MJ/kg gain and Meat% was 63.3±2.63 percentage points. The breeding values for pigs included in the data were ADG_{BLUP} 39.4±42.5 g, FCR_{BLUP} −1.65±0.87 MJ/kg gain and $Meat\%_{BLUP}$ 2.68±1.38 percentage points, where the values represent deviations from the average of L and Y pigs in Finland. Hence, pigs in the dataset consumed less feed, grew faster and were leaner than L and Y pigs on average.

The descriptive statistics of data are presented in Table 1. The differences in FCR and Meat% by tail biting status, gender and breed were small and statistically insignificant. However, non-victims had a greater ADG than victims (33.4 g/d difference, $p<0.001$) and we examined it more closely.

Because preliminary analysis of covariance suggested that interactions TB×Breed and Gender×Breed were not significant and did not contribute to the coefficient of determination ($F(1, 3177)=0.48$ ($p=0.490$) and $F(2, 3177)=3.23$ ($p=0.040$) respectively), they were excluded from the model. Eventually, the coefficient of determination (adjusted R^2) of the model was 62.1%. After adjusting for pigs' genetic merit (ADG_{BLUP}), there were significant main and interaction effects (see Table 2). All main and interaction effects had small effect size ($\eta_p^2<0.01$). The main effect of tail biting victim status (TB) and the interaction effects TB×Gender and TB×Gender×Breed each accounted for 0.1% ($\omega^2=0.001$) of the total variance in pigs' average daily gain.

The pairwise comparison was conducted for TB main effect (Table 3). The results suggest that after controlling for the effect of ADG_{BLUP}, non-victims had 10.8 g/d greater ADG, than victims ($p=0.009$). By contrast, observed mean difference in Table 1 was 33.4 g/d. The effect size of this adjusted mean difference was 0.15 (Cohen's d). Yorkshire had 24.6 g/d greater ADG than Landrace pigs ($p<0.001$), controlling for the effect of ADG_{BLUP}, with effect size of 0.35. By Breed, barrows had the greatest ADG (978 g/d) compared to boars (936 g/d) and females (913 g/d) ($p<0.001$). The effect sizes for these adjusted mean differences were 0.60, 0.92 and 0.32, respectively.

4. Discussion

This article examined differences between tail biting victims and non-victims in production performance of fatteners according to breed and gender taking into account their genetic merit. The results showed differences in production performance between victims and non-victims of tail biting. Besides the effect of tail biting, there were other more significant factors affecting the average daily gain, such as gender, breed and genetic merit on the pig. By contrast, no effect of tail biting on gross feed conversion ratio and red meat percentage was found. Compared to previous research, our data have the advantage of extensive animal-specific information on the feed intake, growth and leanness as well as the genetics of the pigs in the sample.

In this study, no classification of tail biting severity was carried out. A tail was recorded as bitten, if the farm staff observed wounds or blood on the tail. Valros et al. (2004) reported that 11.7% of pigs had marks of fresh tail biting and 1.3% of pigs of severe tail biting. Tiilikainen (2000) reported 8% of piglets in Finland to suffer from tail biting. Given the range of variation in reported values, the prevalence of tail biting victims in our data during the studied period was at the range of previously reported values.

We found no significant differences in arrival and slaughter weights between non-victims and victims. Kritas and Morrison (2004) found that severely bitten pigs were significantly lighter than less severely bitten and unbitten pigs. They also suggested that the rapidly growing, less active, and less anxious pigs could generally be less responsive to having other pigs nosing or chewing on their bodies, whereas smaller or sick pigs might be more reluctant to defend themselves against being bitten.

Our results suggest that tail biting victims have a lower ADG than non-victims. The greatest difference was within barrows, which is in line with Wallgren and Lindahl (1996), who found the daily weight gain to be lower in tail biting victim barrows compared to non-victim barrows. Victimised boars did not show as large a decrease in ADG as victimised barrows and females. The results suggest that besides breed

Table 2
Analysis of covariance for ADG by tail biting status (TB), gender and breed, controlling for ADG_{BLUP}.

Source	SS	df	MS	F	p	η_p^2	ω^2
TB	34,214	1	34,214	6.89	0.009	0.002	0.001
Gender	770,060	2	385,030	77.6	<0.001	0.047	0.018
Breed	172,183	1	172,183	34.7	<0.001	0.011	0.004
ADG_{BLUP}	21,912,534	1	21,912,534	4414	<0.001	0.581	0.524
TB×Gender	46,976	2	23,488	4.73	0.009	0.003	0.001
TB×Gender×Breed	61,910	5	12,382	2.49	0.029	0.004	0.001
Error	15,773,242	3177	4965				

Table 3
Pairwise comparison and effect size of ADG (g/d) by tail biting status main effect (victims TB = 1, non-victims TB = 0).

Group	Mean	Adjusted mean differences and effect size (Cohen's d)		
		Adjusted mean (99% CI)	TB = 0	TB = 1
TB = 0	943	948 (944…952)	–	
TB = 1	909	937 (927…947)	10.8 0.15	–

p = 0.009.

and gender, the victims had poorer growth rate also because of their genetic merit. In other words, when the analysis was adjusted to take into account the genetic merit of the pigs, the difference in ADG between victims and non-victims was reduced. The result highlights the importance of taking into account other factors that can affect production performance of pigs besides tail biting. By contrast, the results suggest that being a victim of tail biting does not affect FCR or Meat%.

Boars in our data were not bitten significantly more often than females or barrows. Gender has been mentioned to influence the prevalence of tail biting victims, but the literature provides mixed evidence on which gender bites the most (e.g. Breuer et al., 2003; Kritas and Morrison, 2004; Schrøder-Petersen et al., 2003). Also barrows have been reported to be more likely to be bitten than gilts (Hunter et al., 1999; Penny et al., 1981; Valros et al., 2004; Wallgren and Lindahl, 1996), and the odds of being a tail biting victim for barrows has been suggested to be more than twice as high as that for gilts (Kritas and Morrison, 2004; Walker and Bilkei, 2006).

Compared to previous studies, it is worth noting that there were data on three genders. Boars are often not included in studies, as they were in our analyses. Zonderland et al. (2010) had boar piglets included in their study and they reported several interactions between gender and mixing; boars in mixed-gender groups had a lower 40% tail damage incident point and a higher tail damage duration than females in mixed-gender groups. They also reported that female piglets are more likely to tail bite compared to male piglets. The divergence in results between studies may reflect the differences in the distribution of genders in pens as well as in total. In our study, the proportion of boars, females and barrows varied between pens, which may have affected the prevalence of tail biting within genders, as suggested in the study by Zonderland et al. (2010). However, our data were not suitable for taking into account the effect of gender distribution within pens on the results, and thus the effect of gender on the prevalence of tail biting must be considered with care in this study. Moreover, boars are currently usually not present in commercial production units, whereas in our test farm almost one-third of the pigs were boars. In the future, the situation may change if boars replace barrows as finishers because of the possible cessation of surgical castration. Our results suggest that the use of boars instead of barrows may slightly increase the prevalence of tail biting.

The results indicate that Yorkshire pigs are more likely to become victims than Landrace pigs. These findings are in line with Breuer et al. (2005) and Keeling and Larsen (2004). Jensen et al. (2004) reported that Danish Landrace boars (1.2%) were not bitten more than Yorkshire boars (1.5%), which both had more bitten tails than Duroc and Hampshire pigs (0.2%). In their review, Schrøder-Petersen and Simonsen (2001) concluded that there was no clear pattern in the effects of breed on tail biting. Taylor et al. (2010) also suggested that the influence of genetics on tail biting might be more relevant at the line/strain level than between breeds.

Feedback from the farm suggests that it is much more difficult to identify a biter than a victim. Hence, there is a need to study how to identify genetic, phenotypic and possibly other characteristics of tail biters. Our results could be used to examine economic losses caused by tail biting.

5. Conclusions

In conclusion, the average daily gain of tail biting victims is reduced by 1 to 3%. By contrast, the gross feed conversion ratio and the red meat percentage are not associated with being a victim of tail biting. From the methodological point of view, estimates regarding the effect of tail biting on growth may be biassed if the genetics of pigs are not taken into account. The gender does not significantly affect the risk of a pig becoming a victim of tail biting whereas the breed affects the risk.

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