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INVESTIGATING THE GENETICS OF CULLING TIME AND THE EFFECTS OF FEEDING LEVEL ON OSTEOCHONDROSIS IN SOWS

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SUMMARY

Pig improvement schemes have traditionally aimed at improving growth rate and meat quality. More recently reproduction and longevity of sows and survival of piglets have been included in the selection objective. Improving longevity of sows is hampered by the lack of accurate and early recording of factors that contribute to reduced longevity. A study on growing pigs revealed large proportions of pigs showing signs of osteochondrosis (OC) (Van Grevenhof *et al.*, 2009). OC is a major cause of leg weakness in sows and hence an important economic and welfare issue (Kirk *et al.*, 2008). However, little is known about OC in sows and its impact on longevity. Our hypothesis is that including OC status in breeding schemes offers a good opportunity to more effectively select for improved leg quality and longevity.

The aims of this paper are to quantify and understand the mechanism of longevity by analysing OC and the time of culling after last insemination. OC is determined by genetic and environmental factors (housing, feeding) acting through biomechanical and metabolic pathways. A better understanding of these factors will enable the design of more effective management and breeding strategies. Experimental results, where different feeding levels were applied to 211 gilts, show that there are significant age dependent effects of feeding levels on the occurrence of OC. Switching to a higher feeding level after 10 weeks of age, increases OC prevalence compared to restricted feeding (OR: 1.8 - 8.5). In practise, gilts are regularly fed restricted early in life, after which feeding is switched to *ad libitum* for optimal growth. The results show that time of culling after last insemination is a heritable trait that might be used in selection in addition to longevity. By combining improvement of culling time with improved longevity, economics and welfare will even further be increased.

INTRODUCTION

Osteochondrosis. After fertility problems, leg weakness is the second most important reason for culling of sows. Osteochondrosis (OC) is a heritable disturbance of the endochondral ossification during skeletal growth and is a major cause of leg weakness in pigs and hence an important economic and welfare factor (Jorgensen and Anderson 2000; Kirk *et al.*, 2008). Feeding levels may be associated with osteochondrosis (OC) in the epiphyseal growth cartilage in gilts. As there is a short time frame of OC development in young growing animals, influencing OC may have different effects depending on the age. Little is known about the development of OC in gilts and sows. A study on growing pigs revealed that a large proportion of pigs show signs of OC (Van Grevenhof *et al.* 2009). The hypothesis for this study is that including OC at a young age as a selection trait offers a unique opportunity to more effectively select against leg weakness in sows and should ~~to~~ improve longevity of sows.

Culling time. Improving longevity of sows is hampered by the lack of accurate and early recording of factors that contribute to reduced longevity. It is known that leg weakness and fertility are major causes for culling of crossbred sows (Serenius and Stalder 2006). However, the correlation between leg weakness and longevity cannot be established as accurate recording of culling reason is often lacking, although the moment of culling is known. Time after last insemination until culling (culling time), is hypothesised to be a useful predictor of the culling reason. In culling time, there appear to be two distinct peaks. The first peak after weaning is expected to be caused by detection of empty sows, while the second peak could be due to a mixture of culling reasons. Therefore, a genetic analysis was performed on culling time. Very little is known about the genetics of culling time, this study aims are to quantify and improve the understanding of the mechanisms of longevity by gaining insight into factors influencing time of culling after the last insemination.

MATERIAL AND METHODS

Osteochondrosis. This study will investigate age dependent effects of feeding levels, *ad libitum* versus restricted (80% of *ad libitum*), on the occurrence of OC in gilts at slaughter (26 wk of age). At weaning (4 wk of age), 211 gilts were subjected to 4 treatments of feeding levels. Gilts were administered either *ad libitum* feeding from weaning until slaughter (AA); restricted feeding from weaning until slaughter (RR); *ad libitum* feeding from weaning until 10 wk of age after which feeding levels were reduced to restricted feeding (AR); or restricted feeding from weaning until 10 wk of age after which feeding levels were increased to *ad libitum* feeding (RA) as often found in practice. At slaughter, the elbow joints, hock joints, and knee joints were collected. Joints were scored macroscopically for articular surface deformations indicative of OC. Analysis were done using PROC MIXED (SAS, 2010). The statistical model was Y = µ + treat + meas + (treat*meas) + *pen* + *meas* + e, where Y represents the bodyweight observation of a gilt. The mean is represented by µ, treat represents the fixed class effect of treatments administered. The time points at which bodyweights were measured is represented by the fixed class effect meas. Interaction between treatments and measurements is represented by the fixed class effect (treat*meas) to assess differences between treatments for each measurement. *pen* represents the random effect of the experimental unit pen nested within treatment and is used as the error term for the treatment effect. The time points at which bodyweights were measured for each gilt, were also added as the repeated measures variable and is represented by *meas.*

Culling time. Records form a total of 111,987 F1 (reciprocal) crossbred sows were analysed, made available by the pig breeding company Topigs. The sows descended from 24,815 dams and 1,372 sires, kept on 189 farms in the Netherlands. All sows were born and culled between 2005 and 2012. The maximum parity reached (longevity) was measured by the parity of the last insemination and varied between 1 and 16 with a mean of 4.3 (SD 2.6). The animal model to estimate genetic parameters is Y ~ mu + line + farm + YSbirth + sow + e, where Y represents the culling time (categorical 1-5) or longevity (1-18), mu is the intercept of the model, line is the fixed genetic (reciprocal) cross of sows, farm represents the fixed farm effect at which the sows are kept, YSbirth accounts for a fixed year-season effect of birth of the sows and sow is the random effect of identification of the sow. A logistic regression model was used for the binary traits of culling category 1 to 5 (culled or not for each class separately). Analysis of the data were performed using SAS (SAS, 2010) and genetic parameters with a linear animal model using ASReml (Gilmour *et al.* 2009).

RESULTS AND DISCUSSION

Osteochondrosis. Figure 1 shows the impact of the feeding treatments on the change of bodyweight. The different age related feeding treatments resulted in varying OC prevalence. The OC prevalence was 77%, 60%, 57% and 43% for respectively the RA, AA, AR and RR treatment. Results show that gilts in the RA treatment have significantly higher odds to be affected with OC than gilts in the RR and AR treatments in the elbow joint (Table 1). Results show that there are age dependent effects of feeding levels on the prevalence of OC. Switching to a higher feeding level after 10 wk of age increases OC prevalence as opposed to a restricted feeding level. Age dependent effects of feeding levels need to be taken into account to recognise its role in leg weakness and longevity of sows when a genetic analyses is conducted.

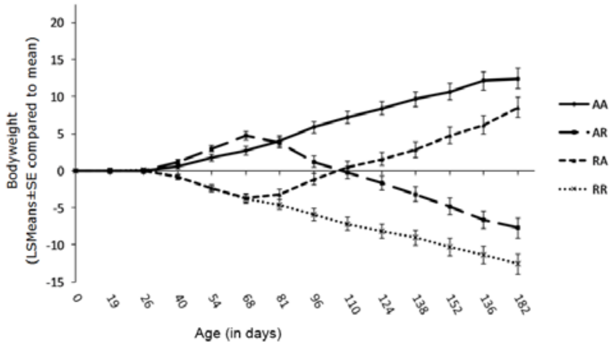

Figure 1. Bodyweight of treatment groups. Bodyweight (LSM +/- SE) profiles by treatment compared to the population bodyweight mean.

Table 1. Odds ratios (with P-values) of OC in elbow, hock and animal of different treatments compared.

	AR	RR
elbow RA	3.6 (0.04)	4.0 (0.03)
hock RA	3.3 (0.04)	8.5 (0.01)
animal RA	2.5 (0.01)	1.9 (0.01)
hock AA	5.3 (0.01)	

Culling time. Crossbred sows have the opportunity to express their full genetic potential for longevity. In contrast, purebred sows are replaced early to keep generation interval short to increase genetic response to selection. Results show that longevity, expressed as parity number of last insemination, has a heritability of 0.16 (SE 0.01) (Figure 2).

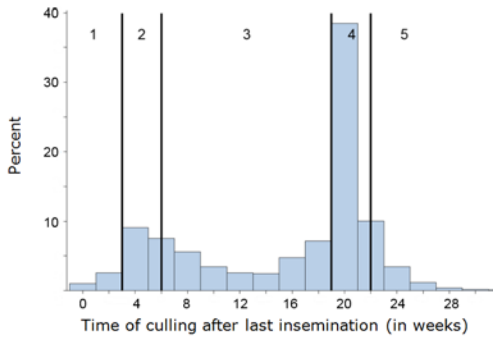

Figure 2. Time of culling after last insemination, expressed in weeks. The trait is divided into 5 culling time categories based on two distinct culling peaks in data, in categories 2 and 4.

Analysis revealed (Table 2) that culling time, expressed as time of culling after last insemination in 5 periods, has a heritability of 0.05. Combining longevity and time of culling in a bivariate analyses shows that the genetic correlation is 0.2 (not significantly different from 0), this suggests that these traits do not represent the same genetic mechanism, and that both traits can be combined in selection for improved sow performance. Heritabilities of the culling time categories 1 to 5 were found to be low, and varied between 0.03 and 0.10. The varying heritabilities possibly reflect the genetics of the main culling reasons at each time of culling. However the low heritabilities suggest that this threshold mechanism (due to censoring) by only taking a certain time period into account could cause bias and needs further analysis to fully understand the impact of these findings.

Table 2. Variances and heritabilities of traits related to time of culling after last insemination. The traits 'Culling time' and 'Longevity' are analysed using a linear animal model. The traits cullcat1-5 are expressed on a binary scale and analysed in a logistic regression model.

Trait	Scale	Var(a)	Var(e)	Var(tot)	h^2	SE
Culling time	1-5	0.035	0.737	0.772	0.046	0.004
Cullcat1	0-1	0.354	3.289	3.643	0.097	0.013
Cullcat2	0-1	0.158	3.289	3.447	0.046	0.006
Cullcat3	0-1	0.112	3.289	3.400	0.033	0.004
Cullcat4	0-1	0.100	3.289	3.389	0.029	0.005
Cullcat5	0-1	0.128	3.289	3.417	0.037	0.010
Longevity	1-18	0.730	3.827	4.557	0.160	0.010

CONCLUSIONS

The results show that time of culling after last insemination is a low heritable trait varying from 0.03 to 0.10 that might be used in selection in addition to longevity. Further analyses are needed to fully interpret the results and to relate the findings on culling time and longevity to observations of OC. By combining improvement of culling time with improved longevity, economics and welfare should benefit. Results showed that OC is influenced by feeding levels. In practise, gilts are regularly fed restricted early in life, after which feeding is increased to *ad libitum* for optimal growth. Age dependent effects of feeding levels need to be taken into account to recognise its role in leg weakness and longevity of sows when a genetic analyses is conducted.

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