Maffezzini, N., Khayatzadeh, N., Turner, S., Roehe, R., Pong-Wong, R., D'Eath, R. (2026) Genetics of maternal defensive aggressiveness in Swiss Landrace sows, *Proceedings 13th World Congress on Genetics Applied to Livestock Production*
23997: https://doi.org/10.31274/wcgalp.23997 ©2026 Maffezzini, et al. CC BY-NC-ND

Genetics of maternal defensive aggressiveness in Swiss Landrace sows

N. Maffezzini[1,3], N. Khayatzadeh[2], S. Turner[1], R. Roehe[1], R. Pong-Wong[2], and R. D'Eath[1]

[1]SRUC, Edinburgh, UK; [2]SUISAG, Sempach, Switzerland; [3]University of Edinburgh, Edinburgh, UK; [*]Corresponding author: nicole.maffezzini@sruc.ac.uk

Introduction

Maternal behaviour plays a large part in ensuring piglet survival (Blomberg, 2010). During lactation, a sow's innate drive to defend her litter may escalate into aggressiveness towards potential threats, especially during the first two weeks after giving birth (Eguchi *et al.*, 2000; Marchant Forde, 2002). Studies report as many as 19% of sows showing signs of stockperson-directed aggression during the first week after the birth of their offspring (Baude *et al.*, 2023). In light of the current trend in European countries of substituting crates with more sow-friendly farrowing pens, there is a need to identify the best-suited individuals for less restrictive lactation environments, with the aim of increasing sow welfare while ensuring piglets' survival and stockpersons' safety (Neu *et al.*, 2021). If maternal defensive aggression is heritable, it would be possible to introduce this trait into breeding programs, leading to permanent, cumulative benefits at a limited cost (Vangen *et al.*, 2005). The aim of this study was to use a standardised 'Piglet Handling Test' and a 'Farmers' Aggressiveness Score' to quantify maternal defensive aggression in commercial farming conditions and to explore its genetic basis in a population of Swiss Landrace sows in a free farrowing system. To quantify the impact of selection for the maternal traits on production traits we also estimated their correlations with two piglet-survival traits: number of crushed piglets and proportion of piglets alive at weaning.

Materials & Methods

Data were collected during the periods October 2023 – December 2023 and May 2024 – August 2024, at four different nucleus farms of the Swiss pig breeding company SUISAG.

Animals and housing. The four farms operated on a three-week farrowing cycle. The total number of breeding sows per farm varied between 70 and 140, and the number of pens per farrowing unit varied between 8 and 37. Each batch of farrowing sows consisted of between 18 and 30 animals. Sows were kept in single pens from around 5 days before farrowing until weaning which occurred when the piglets were three to four weeks old (median = 26 days, IQR = [24, 29]). In all farms, pens (2.2m × 3.2m), had a nest area with a solid floor and a dunging area with a slatted floor. Sows were not confined in a farrowing crate and were allowed to move freely within their pen during their time in the farrowing house. At the time of the experiment, all legal requirements under Swiss law (Swiss Federal Council, 2008/2025) for housing conditions were met.

Behavioural tests. Reaction of sows to handling of their piglets was assessed through the Piglet Handling Test (PHT). This test was adapted from the Dummy Arm Test used on crated sows by Kecman *et al.* (2022) and Neu *et al.* (2021). With the sow awake and alert, the experimenter approached the pen, and a piglet was picked from the creep which invoked a squeal. A dummy arm was then presented to the sow, holding it inside the pen. The dummy

arm consisted of a plastic handle (length=1m), at whose extremity a plastic glove filled with cotton was attached. The first part of the handle was covered in a sleeve to simulate an arm in overalls. It was made sure that the sow could see the piglet being picked up and held by the experimenter. The sow's reaction to the arm and the squeal was classified according to 5 different categories, from 1 ("indifferent", i.e. no expression of the trait) to 5 ("extremely aggressive reaction", i.e. full expression of the trait). The test was conducted on average 10.4 days post-partum (median = 9, IQR = [5, 15]). We conducted 1,347 tests on 569 different sows. To assess a more practical and scalable way to measure maternal defensive aggressiveness on farm, the stockpersons were asked to score the behaviour of each sow within the first 7 days after the birth of her piglets, from 1 ("calm") to 3 ("aggressive"). In total, 1,558 Farmers' Aggressiveness Scores from 705 individual Swiss Landrace sows (in three of the four farms) were collected between 1st October 2023 and 15th July 2025. Of these, 423 were scored in more than one parity and 273 had undergone the PHT within the same parity.

Data analysis. Univariate Bayesian analyses fitting a threshold model were run for both the Piglet Handling Test and the Farmers' Aggressiveness Score to estimate their variance components to account that they are categorical traits (Sorensen *et al.*, 1995). All analyses were based on the following mixed model: $\mathbf{y} = \mathbf{Xb} + \mathbf{Z_i u} + \mathbf{Wpe} + \mathbf{e}$, where **y** is the vector of latent variable of each trait, **b** is the vector of model-specific fixed effects (PHT: parity, day of lactation, farm × year; FAS: day of lactation, farm × year), **X** is the design matrix linking the phenotypes to **b**, **pe** is the vector of permanent environmental effects and **W** is the incidence matrix linking these effects to the individuals' phenotypes, **u** is the vector of additive genetic effects and $\mathbf{Z_i}$ is the incidence matrix linking them to the phenotypes. **e** is the residual variance. The additive genetic effects ***u*** were assumed normally distributed as $\sim N(0, \mathbf{A}\ \sigma^2_a)$ where **A** is the Numerator Relationship Matrix computed using pedigree information (6 generations, Piglet Handling Test: 1,654 individuals, Farmers' Aggressiveness Score: 1,915 individuals) (Henderson, 1976). Narrow-sense heritability was computed as the ratio of the additive genetic variance to the total phenotypic variance. Correlations between the two measures of maternal defensive aggression and between them and reproduction traits (number of piglets dead due to crushing: mean = 0.75, IQR = [0, 1], min = 0, max = 7; and proportion of piglets survived at weaning: mean = 0.88, IQR = [0.82, 1.00], min = 0.00, max = 1.00) were estimated by using bivariate generalised linear mixed models.

Ethical approvals. The SRUC Animal Ethics Committee (RPR 2023-002 PIG; AEX 2023-019 PIG; AEX 2024-010 PIG) and University of Edinburgh R(D)SVS Veterinary Ethical Review Committee (VERC reference 87.23) approved the experiment. Because of the involvement of stockperson scoring, additionally the University of Edinburgh Human Ethical Review Committee (HERC reference: HERC_2023_079) and SRUC Social Science Ethics Committee approved the experiment.

Results

The sow was scored as aggressive or extremely aggressive in 114 Piglet Handling Tests (8.5%) and 54 Farmers' Aggressiveness Scores (3.5%). The estimated heritability of the Piglet Handling Test was 0.44 (95% Credibility Interval = [0.22, 0.69]), while the heritability of the Farmers' Aggressiveness Score was 0.24 [0.04, 0.45].

The Piglet Handling Test and the Farmers' Aggressiveness Score were highly genetically correlated (r_g = 0.70[0.34, 1.00]).

The posterior distributions of the genetic correlations between the Piglet Handling Test and the two piglet-survival traits were centred around 0 (number of piglets dead due to crushing: r_g = 0.01[-0.76, 0.82]; proportion of piglets alive at weaning: r_g = 0.05[-0.75, 0.91]) (Table 1). The Farmers' Aggressiveness Score had a negative correlation with the number of piglets dead due to crushing (r_g = -0.51 [-0.97, 0.00]) and a positive correlation with the proportion of piglets alive at weaning (r_g = 0.28 [-0.59, 0.98]) (Table 1).

Table 1. Means and 95% Posterior Density Intervals (in square brackets) of the posterior distributions of the genetic correlations between the Piglet Handling Test, the Farmers' Aggressiveness Score and the two piglet-survival traits.

	FAS	Number dead due to crushing	Number alive at weaning
PHT	0.70[0.34, 1.00]	0.01[-0.76, 0.82]	0.05[-0.75, 0.91]
FAS	-	-0.51[-0.97, 0.00]	0.28[-0.59, 0.98]

Discussion

The heritability of the Piglet Handling Test is in line with the realised heritability in an artificial selection experiment for increased maternal defensive aggression in a line of outbred house mice (Gammie *et al.*, 2006). The heritability estimates of both Piglet Handling Test and the Farmers' Aggressiveness Score were higher than other previous studies which measured aggressiveness in lactating sows (e.g. Gäde *et al.*, 2008: heritability ± SE= 0.06 ± 0.03; Grandinson *et al.*, 2003: 0.08 ± 0.06). This can be explained by the different test situations and methodologies, which affect the inter-individual variance observed. For example, Kecman *et al.* (2022) employed a fake arm to assess the level of sow aggression towards humans, where they estimated a heritability for the trait of 0.17 ± 0.05. However, in their case, the tests were conducted in temporarily crated animals, and the piglet being handled was not in sight of the sow.

From our results, a strong positive genetic association between the Piglet Handling Test and the Farmers' Aggressiveness Score emerged, indicating that the two measures are likely to reflect the same underlying trait, i.e. maternal defensive aggression. Even if the Piglet Handling Test has the advantage of purportedly eliciting an aggressive response of the sow by handling one of her piglets (which likely led to its higher heritability), the Farmers' Aggressiveness Score has lower labour requirements and therefore it is the most practical way to assess the level of human-directed aggressiveness under commercial farm conditions on an ongoing basis for SUISAG's breeding programme. The estimated genetic correlations between the Piglet Handling Test and the proportion of piglets surviving to weaning and the number of piglet deaths due to crushing were close to zero, being in line with findings previously reported by Grandinson *et al.* (2003). On the other hand, we found a strong unfavourable correlation (r_g = -0.51), between the Farmers' Aggressiveness Score and the number of piglets that died due to crushing, and a moderate unfavourable correlation (r_g = 0.28) with the proportion of piglets alive at weaning. This suggests that selection using the Farmers' Aggressiveness Score to reduce stockperson-directed aggression may lead to a reduction in piglet survival. These unfavourable genetic correlations between the Farmers' Aggressiveness Score and the two piglet-survival traits which emerged from our data support the hypothesis of an adaptive role of maternal defensive aggression in pigs (Maestripieri, 1992). The different correlations of the two survival traits with the Piglet Handling Test and the Farmers' Aggressiveness Score despite their high genetic correlation could be due to the structure of the data, where the Piglet Handling Test had multiple repetitions per parity, while the Farmers' Aggressiveness Score had one, as the two piglet-survival traits do.

Conclusion

The aim of this study was to investigate the genetic basis of maternal defensive aggression in loose-housed Swiss Landrace sows, using practical on-farm measures, and to estimate its correlation with economically relevant piglet-survival traits.
Maternal defensive aggression was genetically determined. In particular, the additive genetic variance of the score of the Piglet Handling Test explained almost half of the total variance of the trait. Albeit less heritable, the employment of a Farmers' Aggressiveness Score seems to be a more practical less labour-intensive way to phenotype maternal defensive aggression in a commercial setting, which allows the collection of a higher number of phenotypes compared to most behavioural tests. Our results suggest that direct selection against maternal defensive aggression in pigs is possible, however a moderate impact on economically and welfare relevant piglet-survival traits is likely. Improvement of both survival of the piglets and behaviour of the sows towards the stockpersons can still be achieved either by using a balanced breeding index, which takes into account both traits, or by selecting for sows with an intermediate response to the handling of their litter (i.e. responsive but not aggressive). Under the current trend pushing for less intensive and more animal-friendly livestock production systems, our results demonstrate the opportunity for breeding companies to support this transition by including traits that have been overlooked until now but that are beneficial to both stockpersons and animals. Further research including a higher number of individuals and production traits is advised to further investigate the impact of introducing calmer behaviour towards humans during lactation in selection indices.

Acknowledgements

This study was carried out as part of the PhD thesis of NM. We would like to thank all the farmers for providing access to the pigs, participating in the research, and for their help.

References

Blomberg M. (2010) Uppsala: SLU, Dept. of Animal Breeding and Genetics. https://stud.epsilon.slu.se/1435
Eguchi Y., Tanaka T., and Yoshimoto, T. (2000) Nihon Chikusan Gakkaiho 71(5):509-514.
Gäde S.D., Bennewitz J., Kirchner K., Looft H., Knap P.W., et al. (2008) Livestock Science 114(1):31-41. https://doi.org/10.1016/j.livsci.2007.04.006
Gammie, S.C., Garland, T. and Stevenson, S.A. (2006) Behavior Genetics 36(5):713–722. https://doi.org/10.1007/s10519-006-9071-x
Grandinson K., Rydhmer L., Strandberg E., and Thodberg K. (2003) Livestock Production Science 83(2):141–151. https://doi.org/10.1016/S0301-6226(03)00095-2
Henderson, C.R., (1976). Biometrics 32(1):69-83. https://doi.org/10.2307/2529339
Kecman, J., Neu, J., Göres, N., Voß, B., Rosner, et al. (2022) animal 16(7):100559. https://doi.org/10.1016/j.animal.2022.100559
Maestripieri, D. (1992) Canadian Journal of Zoology 70(6):1069–1077. https://doi.org/10.1139/z92-150
Marchant Forde, J.N. (2002) Applied Animal Behaviour Science 75(2):115–132. https://doi.org/10.1016/S0168-1591(01)00170-8
Neu, J., Göres, N., Kecman, J., Voß, B., Rosner et al. (2021) Animals 11(9):2547. https://doi.org/10.3390/ani11092547
Sorensen, D. Andersen, S. Andersen, D. Gianola, and I. Korsgaard. (1995) Genetics Selection Evolution 27(3):229-249
Vangen, O., Holm, B., Valros, A., Lund, M.S. and Rydhmer, L. (2005) Livestock Production Science 93(1): 63–71. https://doi.org/10.1016/j.livprodsci.2004.11.007