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Twin birth rate in German Holsteins: related to increased milk yield and fertility level?

Project motivation / Introduction

- Twin births are undesired due to their negative impacts on cows and calves
- A twin birth is very likely to cause high economic losses
- Many farmers are reporting increasing twin birth rates
- Relationship with milk and fertility (multiple ovulation) is often reported

Objective: using population-wide data of German Holstein cows to characterize the trait twin births
- **Estimation of variance components**
- **Calculate genetic correlations of twin births with milk, fertility, longevity**

Conclusion

Twin births are lowly heritable

Although a phenotypic relationship between twin births and milk traits is observed, there is **no genetic correlation**

Low genetic correlations with fertility and longevity

Selection against twin births could be possible without having undesired indirect selection effects

Results

- No phenotypic trend of twin births over the last 20 years

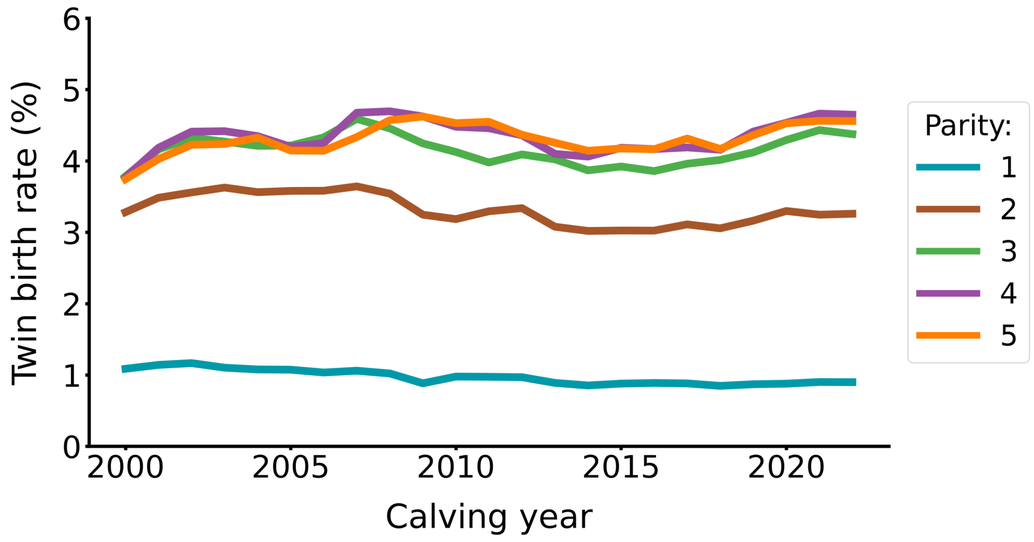

Figure 1: Phenotypic trend of twin births per parity (N=37,144,489 calvings)

- Prevalence is much higher for ≥2nd parity. h^2 is larger in higher parities
- Genetic correlation is 0.879 between 1st and higher parities and even stronger among higher parity numbers (0.986)

- No genetic correlation to production traits – but high phenotypic relationship
- Low genetic correlation to fertility and longevity

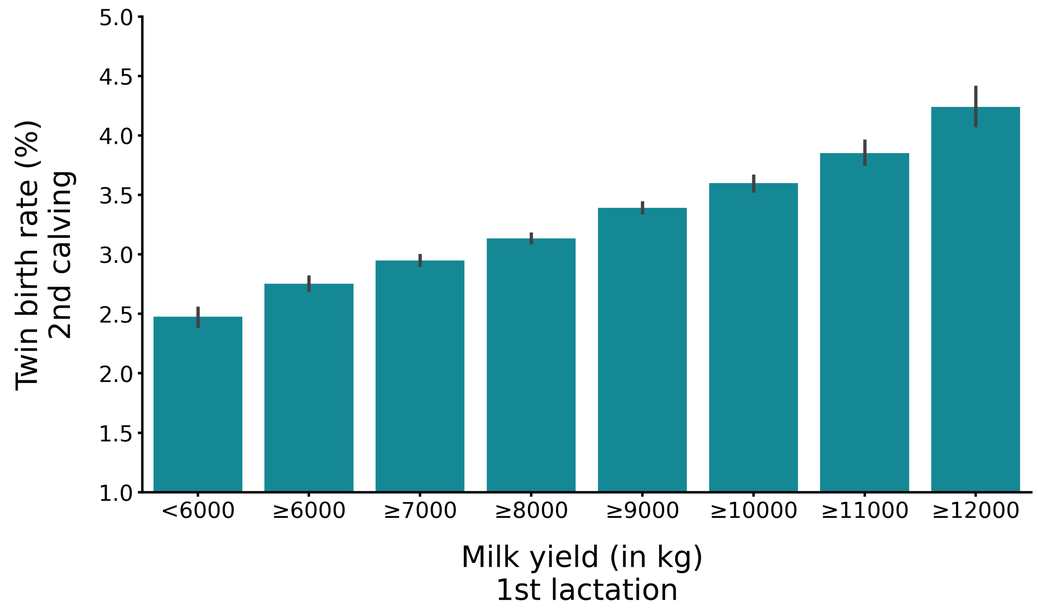

Figure 2: Twin birth rate in 2nd parity per production level of 1st lactation

Table 1: Characteristics and heritability of the two twin birth traits

	1st parity	≥2nd parity
Calvings (N)	4,276,644	9,189,834
Prevalence (%)	**0.87**	**3.83**
h^2_{linear}	**0.008** (± 0.0004)	**0.026** (± 0.0008)
$h^2_{Dempster\text{-}Lerner}$[a]	0.128 (± 0.0062)	0.138 (± 0.0042)
Genetic correlation	0.879 (± 0.0117)	

Table 2: Genetic correlation of twin birth (1st parity/≥2nd parity)

Milk	Milk yield (kg)	Fat (kg)	Protein (kg)
1st parity	0.048	-0.008	0.053
≥2nd parity	0.062	0.004	0.106
Fertility	**First to sucessful insemination**	**Non-Return-Rate 56**	**Longevity**
1st parity	0.154	0.004	-0.156
≥2nd parity	0.121	0.004	-0.122

Material and methods

The phenotypes of **13,466,478** Holstein cows were used to calculate pedigree-based variance components and genetic correlations using the software ASReml[b].

Twin births were defined as two traits:
- Twin births in 1st parity
- Twin births in ≥2nd parity (repeated measures)

A bivariate mixed linear sire model was used:

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Za} + \mathbf{Ep} + \mathbf{e}$$

y: twin birth in 1st parity or ≥2nd parity (0/1)
b: fixed effects: herd-year, year-season, sexed semen for ≥2nd parity additionally: calving number
a: random effect: sire additive genetic effect, $a \sim (0, A\sigma_a^2)$
p: for ≥2nd parity: permanent environmental effect, $p \sim (0, I\sigma_p^2)$
e: error term, $e \sim (0, I\sigma_e^2)$
X, Z, E: incidence matrices

Literature

[a] Dempster, E.R., and I.M. Lerner. 1950. Heritability of Threshold Characters. Genetics 35:212–236.
[b] Gilmour, A. R., Gogel, B. J., Cullis, B. R., Welham, S. J. and Thompson, R. (2014): ASReml User Guide Release 4.1 Structural Specification, VSN International Ltd, Hemel Hempstead, HP1 1ES, UK www.vsni.co.uk

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