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Genetic constraints underlying human reproductive timing in a pre-modern Swiss village

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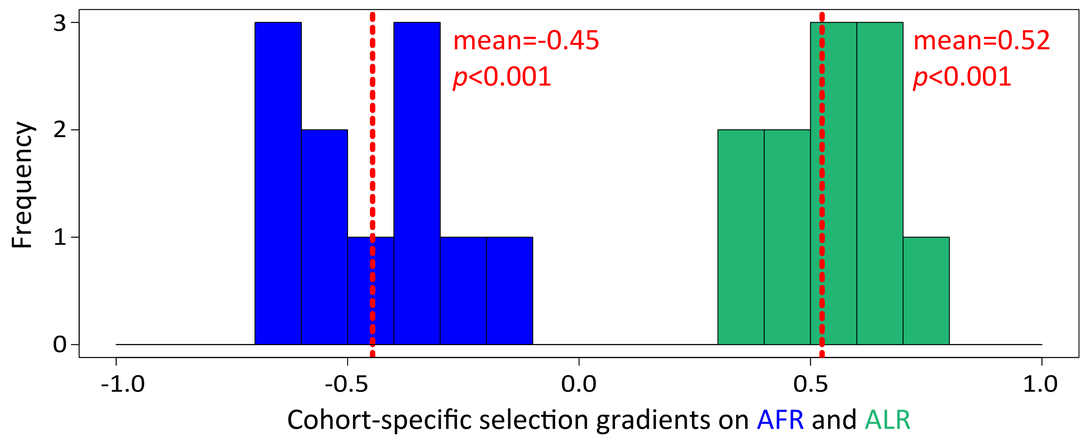
Introduction

Trade-offs between reproductive output in early and late life are central to life-history theory. However, the specific trade-off between age at first reproduction (AFR) and age at last reproduction (ALR) has received little attention, especially in long-lived species with a pronounced reproductive senescence such as humans. Based on Catholic parish records we reconstructed genealogies for most inhabitants of a 19th-century, medium-sized, rural village in Switzerland (800-1300 inhabitants), and use these data to

Aims

1. quantify natural selection acting on reproductive timing
2. estimate the underlying additive genetic (co)variances
3. use these to predict evolutionary responses to selection
4. test for signs of reproductive ageing in both men and women

1. Natural selection on age at first reproduction (AFR) and age at last reproduction (ALR)



- Strong and significant linear selection for an earlier first and later last reproduction in both men and women

2. Additive genetic variation and covariation

	Women h^2	Women AFR	Women ALR	Men h^2	Men AFR	Men ALR
AFR	**0.45**	**1518**	0.85	**0.81**	**4977**	**0.91**
ALR	0.22	1197	1321	0.54	**4926**	5855

in bold: $p<0.05$

Narrow-sense heritabilities | Genetic variances | Genetic covariance | Genetic correlation

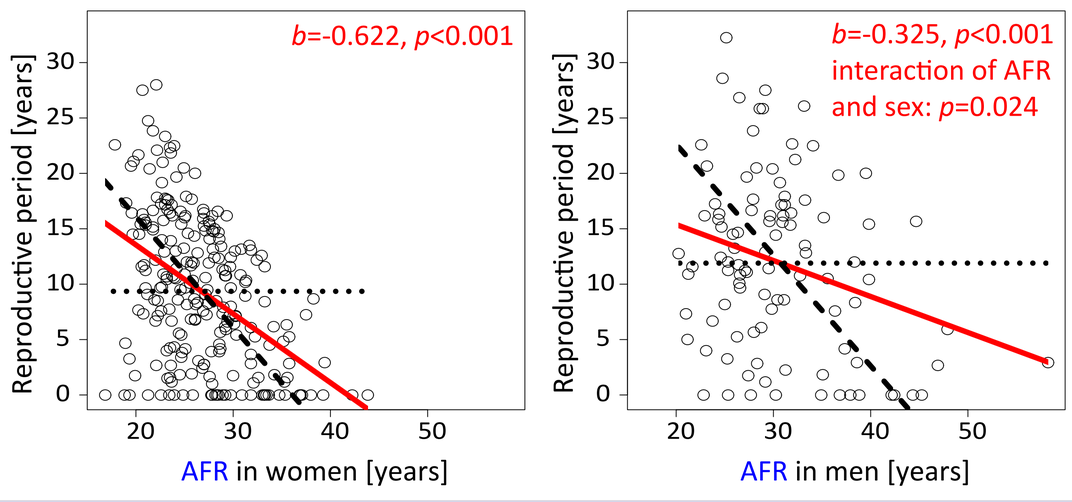
- Significant genetic variation in AFR in both sexes
- Significant and strongly positive genetic correlation between AFR and ALR in men

3. Predicted phenotypic responses to selection in months per generation

	Direct response AFR	Direct response ALR	Total response AFR	Total response ALR
Women	-12.0	9.1	-3.8	-0.4
Men	-33.7	35.1	-4.1	1.8

- AFR predicted to decrease in both sexes (adaptive)
- ALR predicted to decrease in women (maladaptive) and increase in men (adaptive)
- Substantial genetic constraints in both AFR and ALR because direct predicted responses exceed total responses by far

4. Evidence for reproductive ageing



- Postponing AFR shortens the reproductive period in both sexes
- However, this reduction is twice as strong in women

- When correcting for variation in the reproductive period, selection favors both an early AFR and ALR (data not shown)
- This indicates reproductive senescence also before the onset of reproductive cessation

Conclusions

- Due to substantial selection on AFR and ALR (1) and a genetic correlation between the two traits (2), reproductive timing in the study population is strongly constrained (3)
- This constraint might provide an ultimate explanation for the signs of reproductive ageing we found (4)
- By increasing the costs of reproducing late, a genetic correlation between AFR and ALR will cause a further decrease in ALR

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Photograph of study village: www.ugs-linth.ch