Survival analysis of White Leghorn laying hens in the early and late production period

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What is survival analysis?

- Definition
  - It is a statistical analysis used to examine either the length of time an individual survives or the length of time until an event occurs

- How is it useful?
  - It combines both censored and uncensored observations in a single analysis
  - Accounts for non-normality of the residuals and the particularly skewed nature of survival data

Aim of the study

1. Evaluation of fixed effects such as line, cage members, cage levels and mortality of back cage neighbors on laying hen survival

2. Compare survival in the early laying period versus late laying period

3. Estimate genetic parameters: heritability and genetic correlations

Materials & Methods

Data

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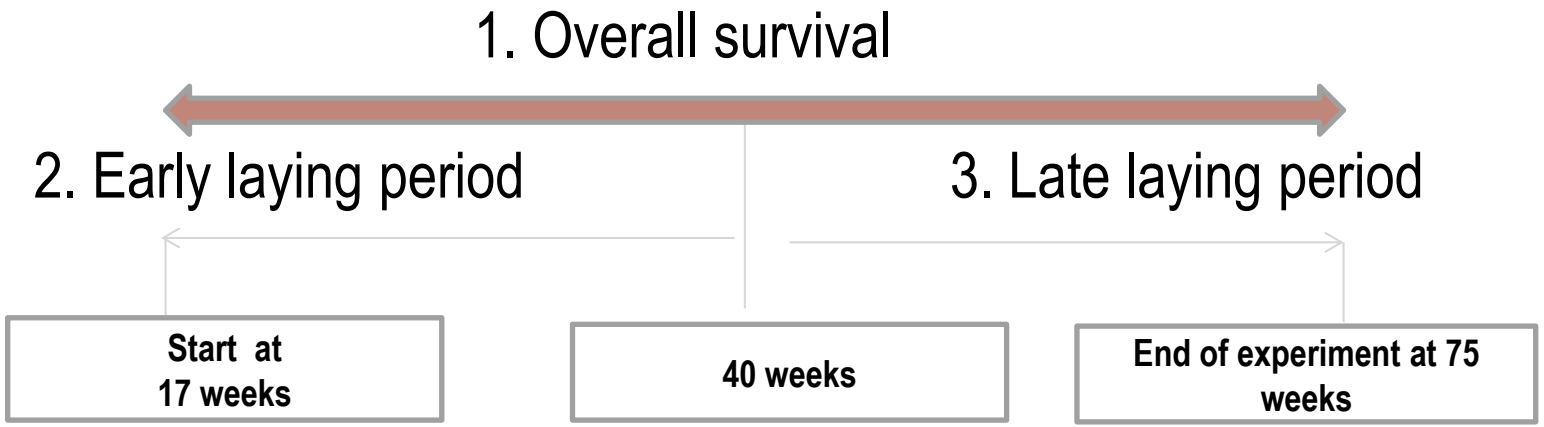
Institut de Sélection Animale B.V, the Netherlands
- Collaboration between WUR and BOKU
- 16,694 records
- Pedigree information available
- 3 Purebred White Leghorn layer lines: W1, WB, WF

Materials & Methods

- Trait measurements

Survival time (weeks) considering censoring status



Materials & Methods

- Data analysis
  - Survival Kit software (Mészáros – Sölkner – Ducrocq, 2013)

- Statistical model
  - **Animal Model**
    - $\lambda(t) = \lambda_0(t) \exp$ (Stable * Corridor + Cage level + mortality of back neighbors + layer lines + *animal*)
  - **Sire model**
    - $\lambda(t) = \lambda_0(t) \exp$ (Stable * Corridor + Cage level + mortality of back neighbors + layer lines + *sire*)

Materials & Methods

Genetic parameters

- **Heritability** (Yazdi et al., 2002, Mészáros et al., 2010)
  - **Animal Model:** $h^2 = \frac{\sigma_G^2}{\frac{1}{p} + \sigma_G^2}$
  - **Sire model:** $h^2 = \frac{\sigma_G^2}{\frac{1}{p} + \frac{\sigma_G^2}{4}}$

Where:

σ_G^2 = the genetic variance

p = proportion of uncensored records

Materials & Methods

- **Reliability**

$$R = 1 - PEV / \sigma_G^2$$

Where: PEV = prediction error variance

Results and Discussion

Analysis of stable * corridor interaction

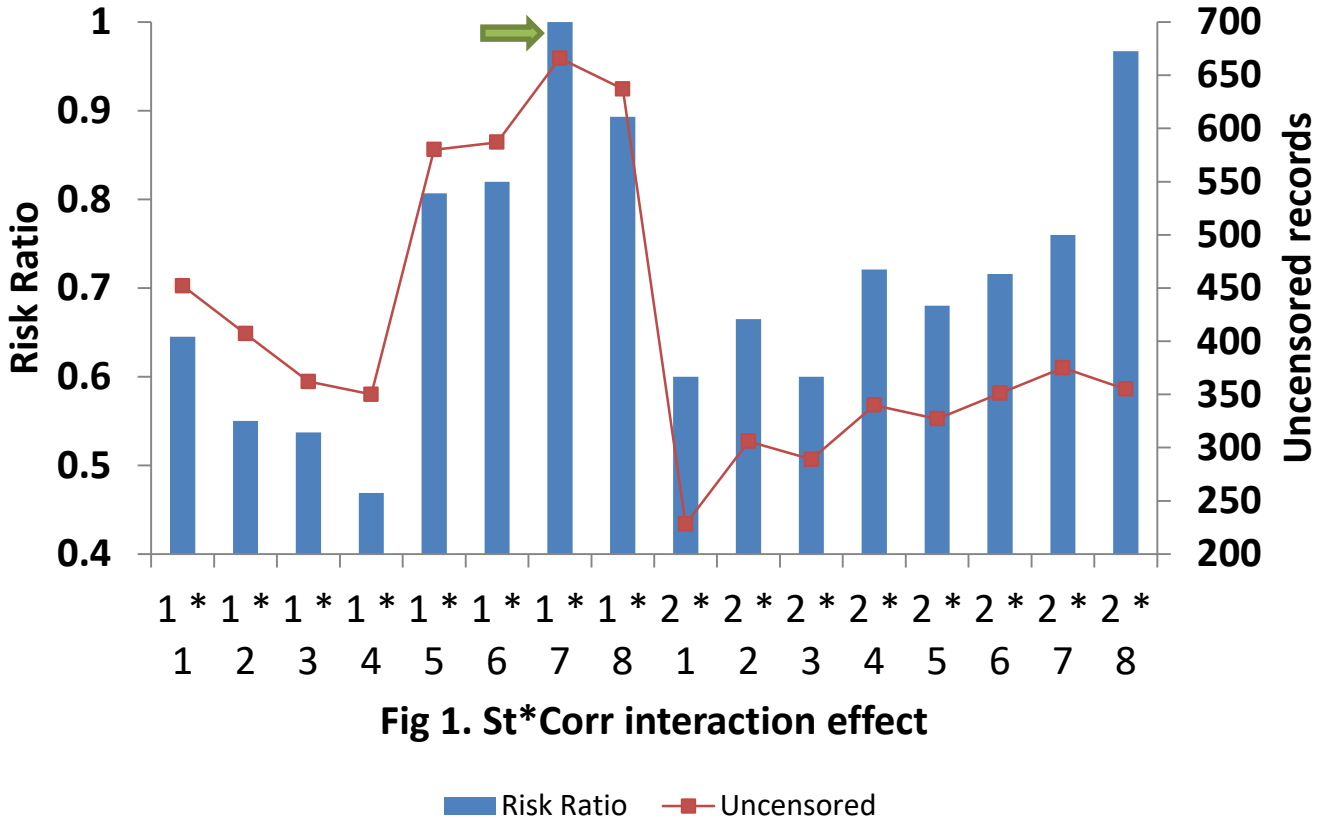


Fig 1. St*Corr interaction effect

- Stable 1 experienced daylight effect
- Light intensity in stable 1 was lower

Analysis of cage level

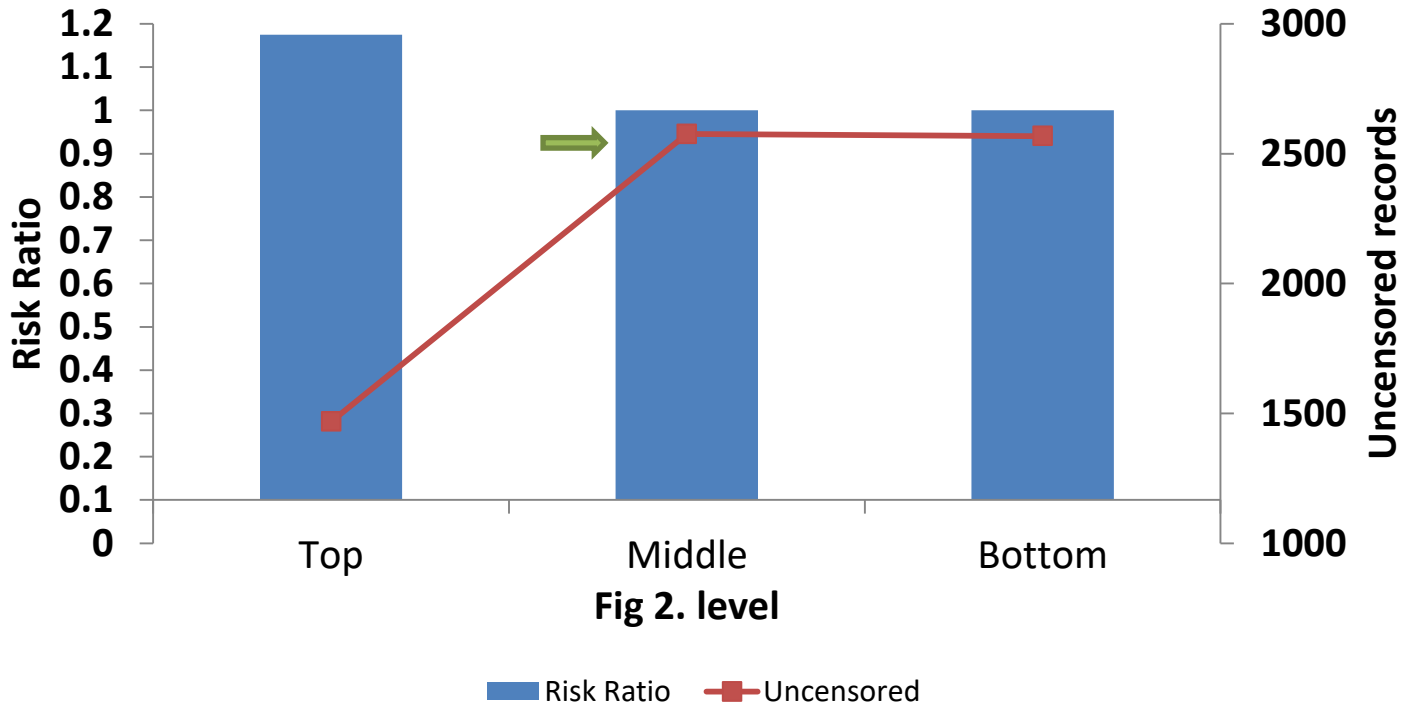


Fig 2. level

- Top level is close to the light
- More time interacting

Analysis of back mortality

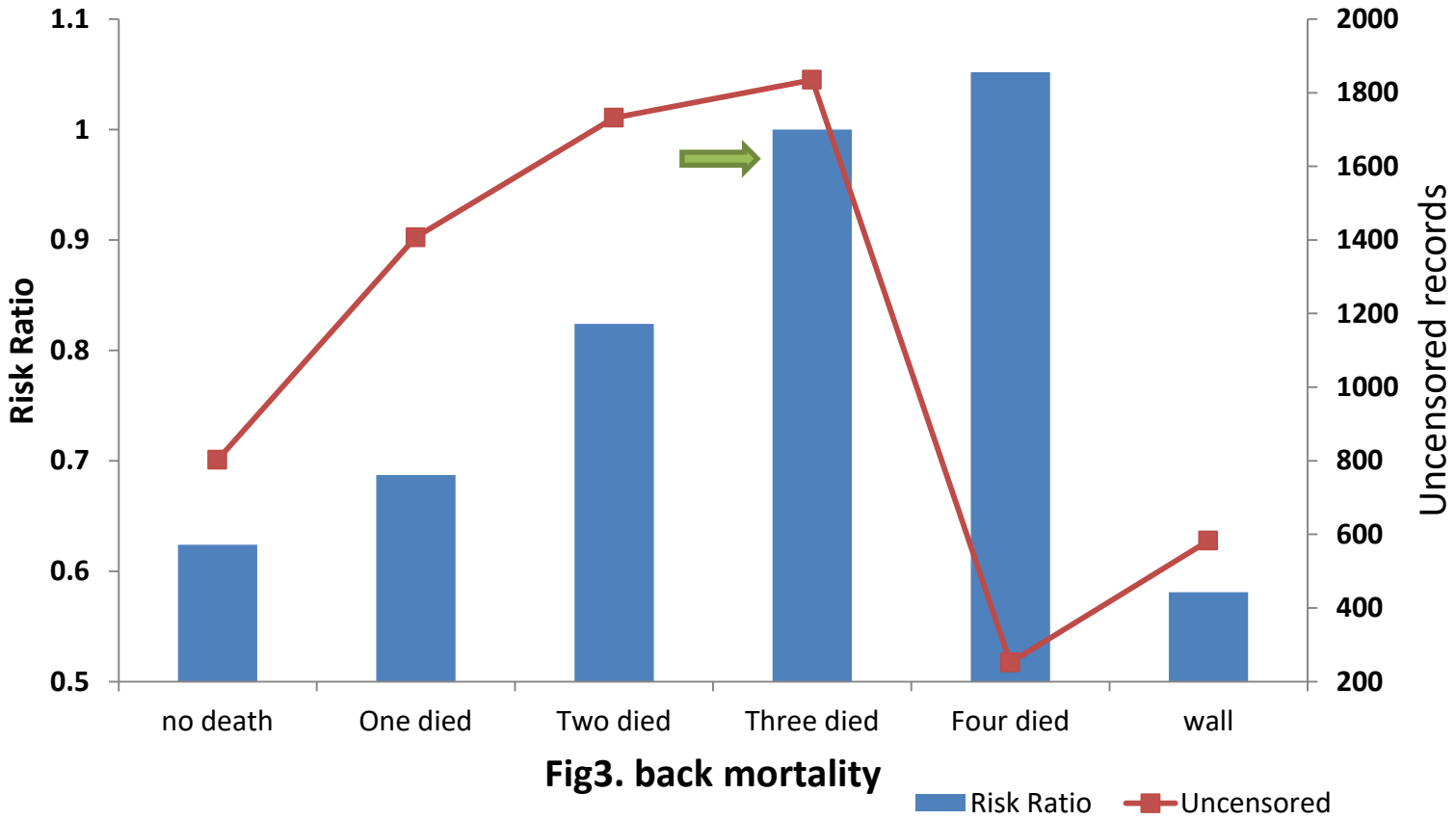


Fig3. back mortality

- Increased risk of culling with more deaths in the back cage
- Presence or absence of back neighbors has significant effect on the survival of neighboring back cage

Analysis of layer line

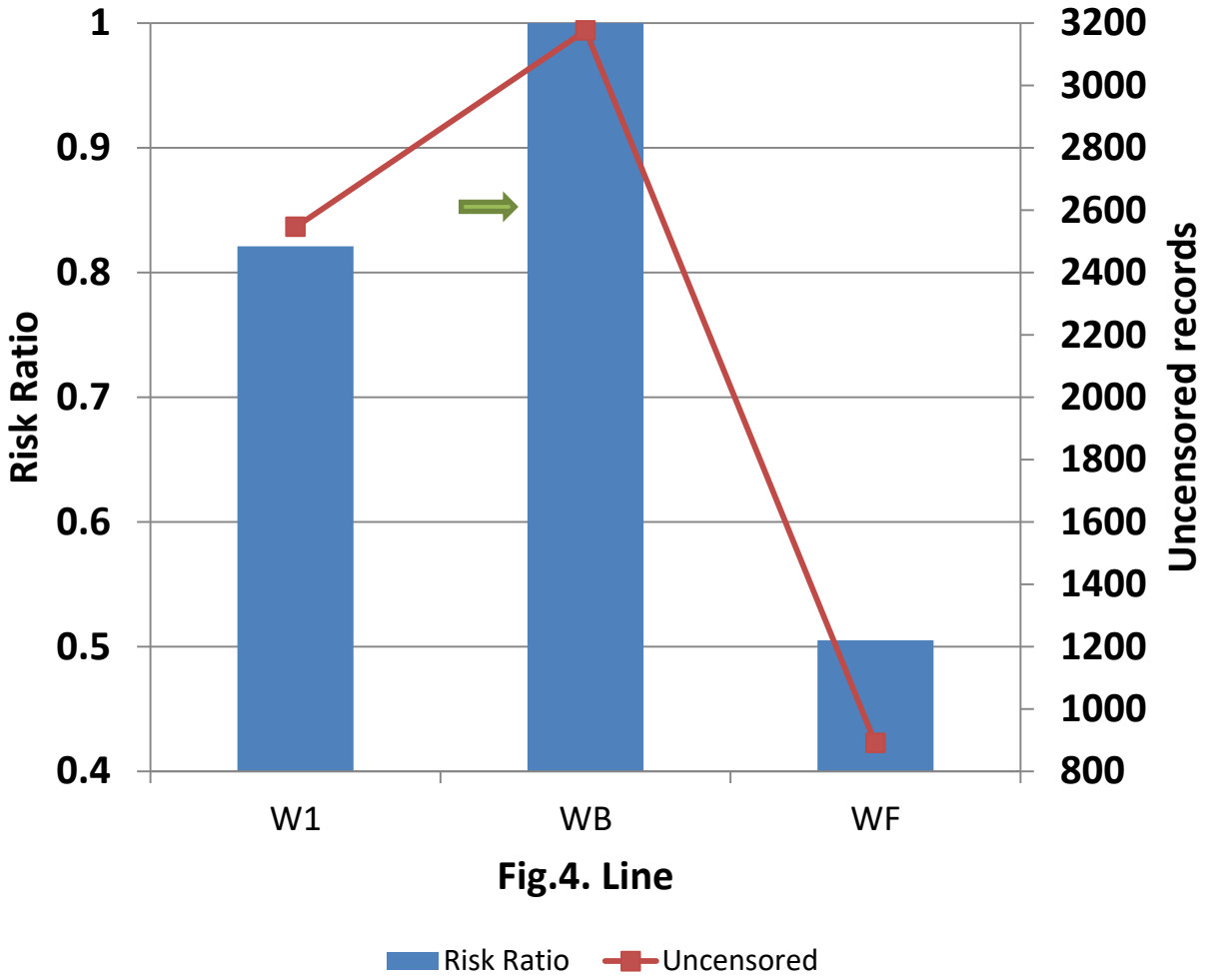


Fig.4. Line

Genetic parameters

Traits	Censored records	Model	Genetic variance	Heritability h^2	Mean reliability
Overall survival	10082 (60.4 %)	Animal	0.328	0.11	0.28 (0.12)
		Sire	0.057	0.09	0.74 (0.08)
Early laying period	14210 (85.1 %)	Animal	0.541	0.07	0.24 (0.11)
		Sire	0.068	0.04	0.58 (0.10)
Late laying period	10073 (70.9 %)	Animal	0.593	0.15	0.29 (0.12)
		Sire	0.071	0.08	0.70 (0.09)

Genetic parameters

Pearson's correlation coefficient between EBVs – Sire model

	Early laying period	Late laying period
Full data set	**0.835**	**0.929**
Early laying period		**0.579**

- Productive life is influenced by genotype of the hens
- Re-ranking of animals

Genetic parameters

Pearson's correlation coefficient between EBVs – Animal model

	Early laying period	Late laying period
Full data set	**0.788**	**0.873**
Early laying period		**0.404**

- Animal and sire model produced similar results
- Re-ranking of animals
- Selection decision could be for survival in the early laying period

Conclusions

- Stable*corridor interaction, cage level, mortality of back cage neighbors and layer lines were all significant
- There was higher survival in the early than in the late laying period
- Low heritability of survival traits
- Genetic correlations of partial to full survival times were high, but moderate between early and late laying period

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