Discrete time survival analysis of longevity in a colony of dog guides

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Objectives

- Development of a model for genetic evaluation of working life
- Variance components estimation for working life
- Calculation of breeding values

Data

- Longevity and pedigree data
  - 954 German shepherds
  - 1,592 Labrador retrievers
- All dogs worked as guides
- Pedigrees complete to founding
- Breeders selected on an index of hip quality and aptitude

Definition of working life

- Economics favor some measure of total working life
  - Longer working dogs are desired
- Three measures of working life
  - Graduation to 10 yr (TWL)
  - Graduation to 18 mo (EWL)
  - 18 mo to 10 yr (LWL)

Censoring (%) and working life (mo)

	GS		LR	
Trait	Censored	WL	Censored	WL
EWL	96.8	56	95.1	67
LWL	49.5	67	44.3	79
TWL	51.1	56	48.9	67

Analysis

- Fixed effects
  - Duration of time interval (mo or yr)
  - Sex of dog
  - Regression on inbreeding
- Random animal effect
- Breeds analyzed separately

Model

$$\lambda(t_i)=g\left(\sum_{j=1}^{k} x_{ij}\beta_j\right)$$

$\lambda(.)$ = the discrete hazard function

t_i = the observed time of retirement of individual *i*

$g(.)$ = link function (logistic or comp log-log)

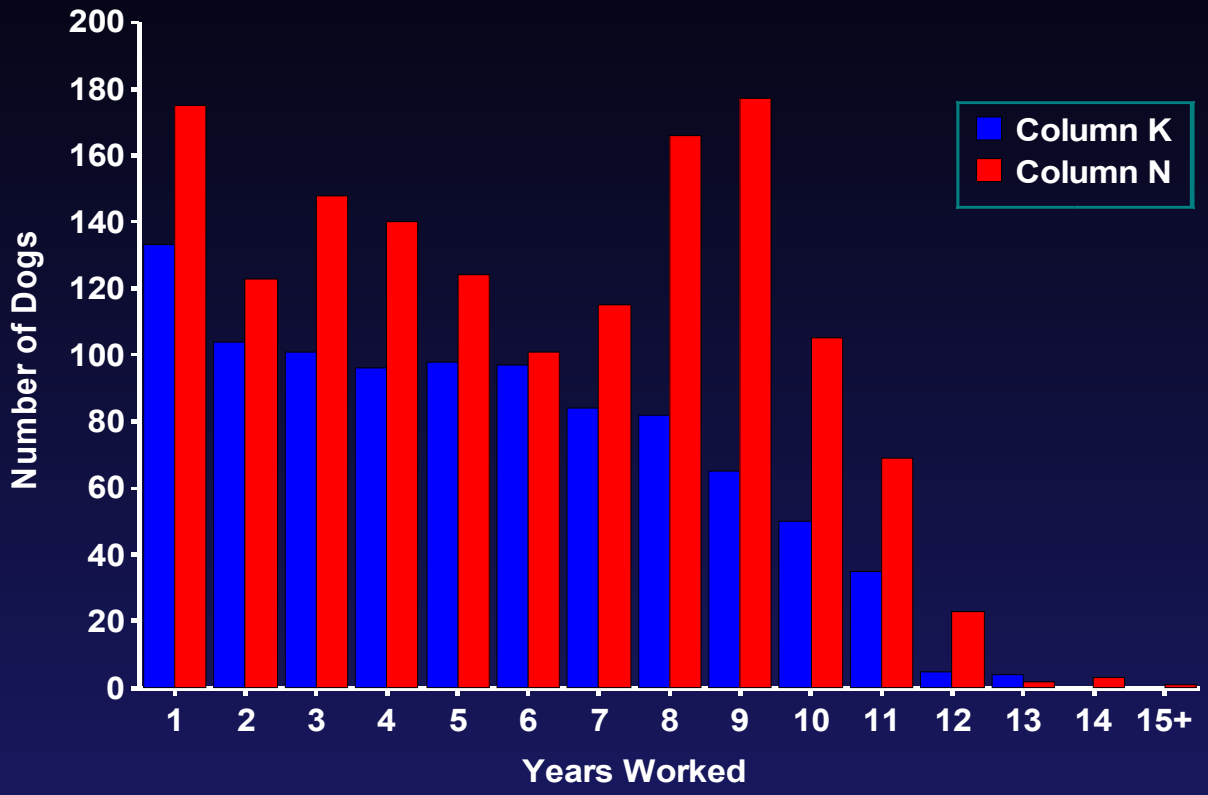
x_{ij} = the *j*th explanatory variable for animal *i*

β_j = the regression coefficient associated with the *j*th explanatory variable

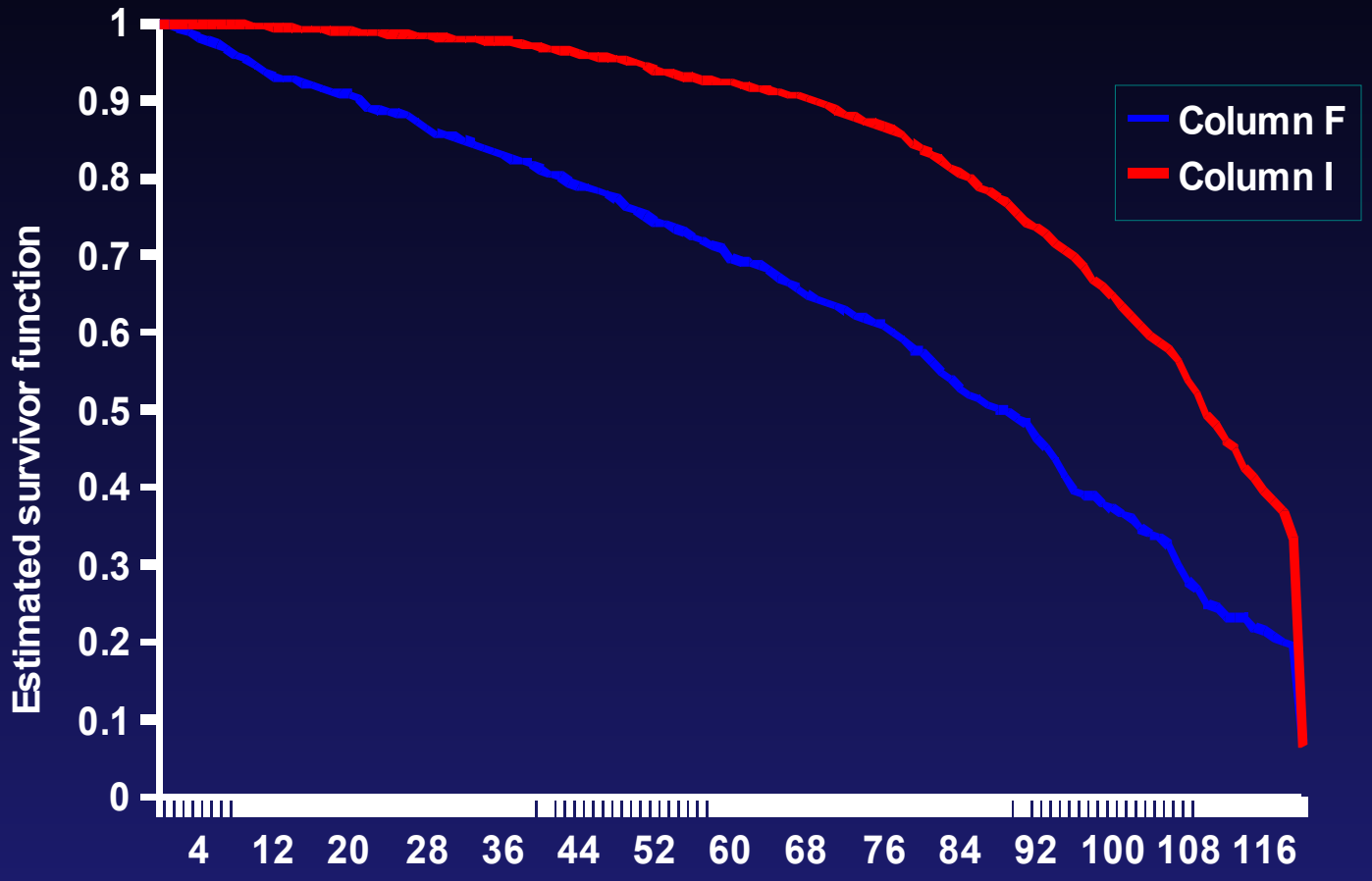
Survival models

- Logistic link
  - Proportional odds model
  - Variant to duration of the time interval
- Complementary log-log link
  - Proportional hazards model
  - Invariant to duration of the time interval
  - Weibull model when $\log_e$ of duration of the time interval is fit as a covariate

Phenotypic working life



Kaplan-Meier survival functions



Variances – early working life (GS)

Model	σ_a^2	σ_p^2	h^2
Proportional odds	0.3	3.6	0.09
Proportional hazards	0.2	1.9	0.12
Weibull	0.5	2.1	0.22

Variances – early working life (LR)

Model	σ_a^2	σ_p^2	h^2
Proportional odds	0.4	3.7	0.12
Proportional hazards	0.3	1.9	0.15
Weibull	1.1	2.7	0.39

Variances – later working life (GS)

Model	σ_a^2	σ_p^2	h^2
Proportional odds	0.6	3.9	0.16
Proportional hazards	0.7	2.3	0.29
Weibull	0.6	2.3	0.28

Variances – later working life (LR)

Model	σ_a^2	σ_p^2	h^2
Proportional odds	1.1	4.4	0.25
Proportional hazards	1.2	2.9	0.42
Weibull	1.2	2.8	0.42

Unequal use of parents (GS)

- Sires
  - 23 unique sires with 767 offspring
  - 3 had > 100 progeny
  - 3 had > 50 progeny
  - 9 had < 20 progeny
- Dams
  - 94 unique dams
  - 3 had > 20 progeny
- Inbreeding 0.14 ± 0.001, 0.0 - 0.38

Unequal use of parents (LR)

- Sires
  - 41 unique sires with 1,187 offspring
  - 5 had > 100 progeny
  - 2 had > 50 progeny
  - 9 had < 20 progeny
- Dams
  - 99 unique dams
  - 17 had > 20 progeny
- Inbreeding 0.07 ± 0.001, 0.0 - 0.25

Summary

- The discrete time method produced large estimates of heritability and allowed use of an animal model
- EBV for early working life may be biased due to censoring
- Results may reflect founder effects due to the small number of sires