Predicting show jumping performance in Belgian Warmbloods using combinations of early life jumping traits

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Session 48: "Horse genetics and genomics"

Selection for show jumping performance

- Breeding goal: To **breed successful show jumping** horses

- Genetic evaluation for show jumping performance:
  - **Low heritability** (h^2=0.12, Chapard *et al.*, 2023)
  - Competition records **available late in life**

- ⇗ **Generation interval,** ⇘ **genetic progress** of the population

How can we select for show jumping performance from an earlier age?

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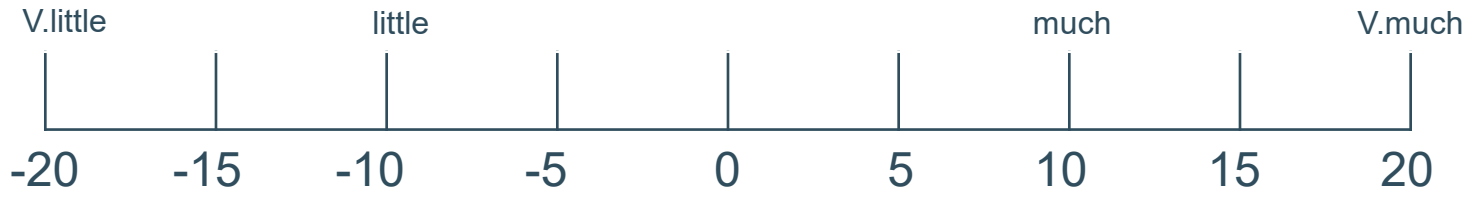
The BWP linear scoring scheme for early life jumping traits

- Assess horses' jumping capacity **freely (FJ)** or **under saddle (JS)** at early age



Jumping

(7 traits)

- Scope
- Take-off (power/quickness)
- Technique of forelegs
- Technique of back
- Technique of haunches
- Attitude (willingness)
- Carefulness

Canter

(4 traits)

- Stride length
- Impulsion
- Elasticity
- Balance

Early life jumping traits and show jumping performance

- **Early life jumping** traits (ELJ) are:
  - **Heritable**
  - **Genetically correlated** with **show jumping performance**
  - **Promising proxies** for show jumping performance

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ORIGINAL ARTICLE | Open Access

Early life jumping traits: Are they good proxies for success in show jumping competitions in Belgian warmblood horses?

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	Free jumping		Jumping under saddle	
	h^2	r_g	h^2	r_g
Scope	0.30	0.63	0.18	0.56
Take-off (power/quickness)	0.23	0.56	0.13	0.54
Technique of forelegs	0.18	0.49	0.11	0.49
Technique of back	0.16	0.44	0.14	0.49
Technique of haunches	0.21	0.56	0.18	0.49
Attitude/willingness	0.05	0.37	0.07	0.40
Carefulness	0.13	0.48	0.09	0.58
Stride length	0.18	0.51	0.27	0.49
Impulsion	0.23	0.49	0.23	0.55
Elasticity	0.11	0.48	0.16	0.47
Balance	0.18	0.53	0.19	0.45

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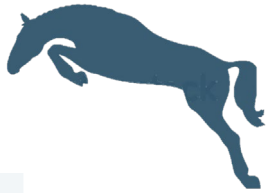
How to optimally combine proxies?

- **Little is known** on how to optimally **combine several proxies** to accurately **predict genetic merit for a complex trait**
- **Show jumping performance is** a **complex** trait
- **ELJ traits** are **promising proxies** for show jumping performance

Research objective: To find a suitable method to identify an optimal combination of ELJ traits to predict genetic merit for show jumping performance

Methodology



ELJ dataset

Animal ID	Scope	…	Elasticity of canter
1	5	…	10
2	0	…	0
3	0	…	-5
4	10	…	5
5	15	…	5

EBVs

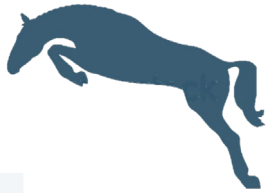
Animal ID	EBV show jumping performance
1	1.32
2	-0.63
4	6.62

Combined dataset

Animal ID	Scope	…	Elasticity of canter	EBV show jumping performance
1	5	…	10	1.32
2	0	…	0	-0.63
4	10	…	5	6.62

1. Combine **ELJ dataset** (FJ or JS) and dataset of **EBVs** for show jumping performance into a **combined dataset**

Methodology



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Ordinary least squares regression (OLS)

2.a. Use OLS method on **combined dataset** to regress ELJ traits onto EBVs

Animal ID	Scope	…	Elasticity of canter
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5	15	…	5

2.b. Sum ELJ traits

$$EBVs = \boldsymbol{f}(ELJ\ traits)$$

$$\mathbf{ELJ_{(baseline)}} = \sum \text{ELJ traits}$$

Methodology

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2.b. Sum ELJ traits

$$EBVs = f(ELJ\ traits)$$

$$\mathbf{ELJ_{(baseline)}} = \sum \text{ELJ traits}$$

Animal ID	Scope	Take-off	…	Impulsion	Elasticity of canter	$ELJ_{(baseline)}$	$ELJ_{(OLS)}$
1	5	5	…	10	10	80	7.24
2	0	5	…	0	0	20	6.97
3	0	0	…	0	-5	-5	6.72
4	10	5	…	5	5	95	7.42
5	15	15	…	15	5	110	7.76

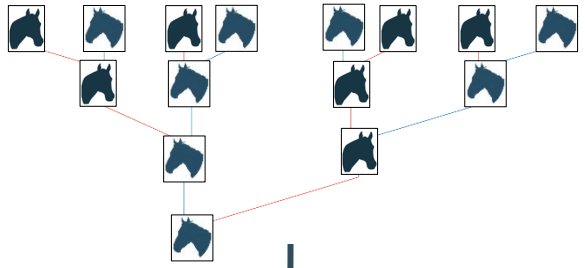
3. Calculate summarized ELJ traits using **models** obtained in **2.a.** and **2.b.** on **ELJ dataset**

Methodology

Summarized ELJ dataset

Animal ID	Sex	Age	Contemporary group	$ELJ_{(baseline)}$	$ELJ_{(OLS)}$
1	2	2	1	80	7.24
2	1	3	1	20	6.97
3	1	4	2	-5	6.72
4	1	3	3	95	7.42
5	2	5	3	110	7.76

Pedigree



Full competition dataset

Animal ID	Sex	Age	Rider	Show jumping performance
1	1	6	1	114.40
1	1	7	2	126.30
15	2	12	2	142.70

4. Estimation of **h^2** for summarized ELJ traits and their **genetic correlations with show jumping performance** using remlf90 program

Computation of EBVs

Methodology

Summarized ELJ dataset

Animal ID	Sex	Age	Contemporary group	$ELJ_{(baseline)}$	$ELJ_{(OLS)}$
1	2	2	1	80	7.24
2	1	3	1	20	6.97
3	1	4	2	-5	6.72
4	1	3	3	95	7.42
5	2	5	3	110	7.76

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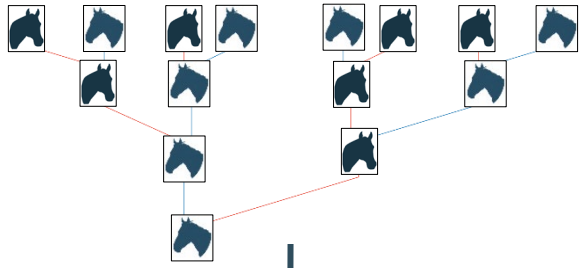

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Computation of EBVs

Validation

5.a. Competition **results of horses with ELJ scores are masked**

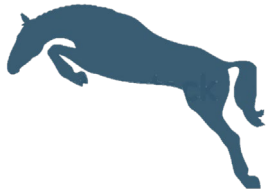
Masked competition dataset

Animal ID	Sex	Age	Rider	Show jumping performance
1	1	6	1	NA
1	1	7	2	NA
15	2	12	2	142.70

Validation

5.b. Computation of **Spearman's rank correlations** between **EBVs** for AFH obtained with the **full dataset** and those obtained with the **masked dataset**
Estimation of **EBV accuracies** obtained with the masked dataset

Data on early life jumping traits



- Number of **horses that also have an EBV for show jumping performance and no missing scores**:
  - 1190 FJ horses
  - 1502 JS horses

- **Trait "Balance" removed** from analyses because missing for most horses

	FJ	JS
n horses	2326	2273
Age		
2	138	0
3	2089	0
4	83	118
5	16	2058
6	0	97
Sex		
Male	808	1115
Female	1518	1158

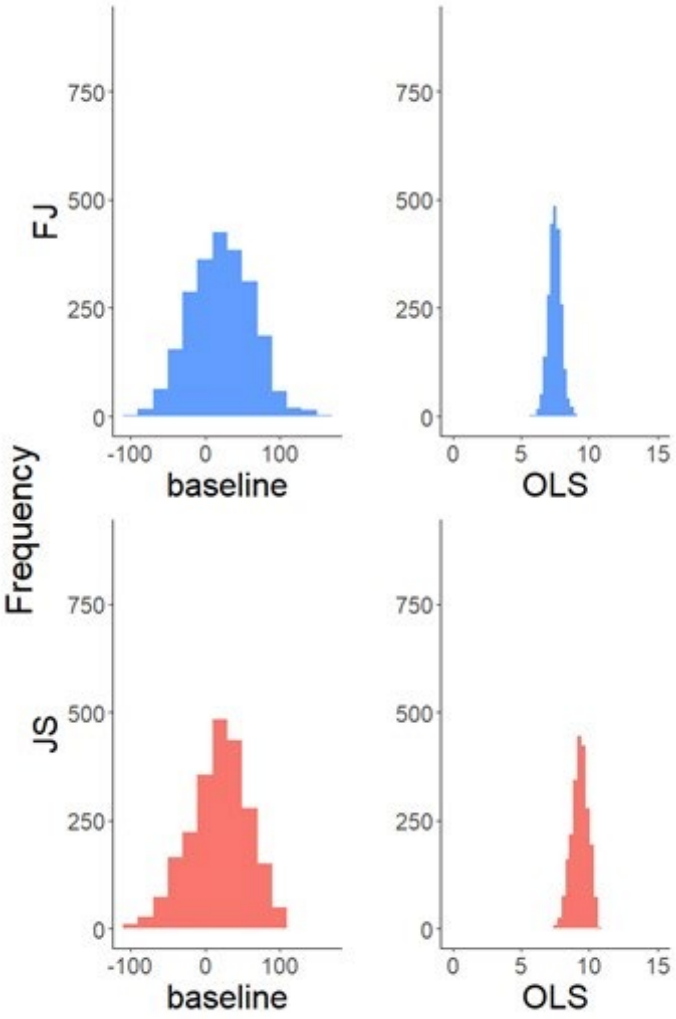
OLS regressions on FJ and JS datasets

- **Magnitude of regression coefficients** in absolute terms **varied from 0.005 to 0.083**
- **Magnitude** of regression coefficients **differed between FJ and JS**

	Regression coefficient	
	FJ	JS
Intercept	7.509 (0.142)	8.896 (0.111)
Scope	0.048 (0.028)	-0.005 (0.023)
Take-off (power/quickness)	-0.029 (0.032)	0.020 (0.027)
Technique of forelegs	0.031 (0.021)	0.021 (0.022)
Technique of back	-0.016 (0.023)	0.017 (0.021)
Technique of haunches	0.019 (0.025)	-0.011 (0.022)
Attitude/willingness	-0.083 (0.024)	0.036 (0.020)
Carefulness	0.018 (0.028)	0.039 (0.022)
Stride length	0.029 (0.027)	0.063 (0.021)
Impulsion	0.009 (0.032)	0.005 (0.024)
Elasticity	0.008 (0.027)	-0.023 (0.020)

Summarized early life jumping traits

	Mean (sd)	Min	Median	Max	h^2	r_g with AFH
$ELJ_{(FJ,baseline)}$	24.52 (40.98)	-105.00	25.00	170.00	0.25	0.52
$ELJ_{(FJ,OLS)}$	7.49 (0.47)	5.46	7.49	9.72	0.18	0.74
$ELJ_{(JS,baseline)}$	21.19 (38.69)	-105.00	25.00	115.00	0.15	0.52
$ELJ_{(JS,OLS)}$	9.31 (0.61)	6.87	9.34	10.89	0.14	0.75



- Summarized ELJ traits were:
  - **Lowly to moderately heritable**
  - **Moderately to highly genetically correlated with show jumping performance**

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Model validation

	$r_{Spearman}$	Mean EBV accuracy
$AFH\_ELJ_{(FJ,baseline)}$	0.89	0.61
$AFH\_ELJ_{(FJ,OLS)}$	0.76	0.58
$AFH\_ELJ_{(JS,baseline)}$	0.82	0.59
$AFH\_ELJ_{(JS,OLS)}$	0.81	0.58

- **Spearman rank correlations were high** (0.76-0.89)
- **EBV accuracies** ranged from **0.58** to **0.61**
- **Model using the "baseline" methodology performed better** than the one using **OLS regression for FJ**
- **No differences** between methodologies **for JS**

Conclusion

- **Summarized ELJ traits**:
  - **Are heritable** and **moderately to highly genetically correlated** with **show jumping performance**

- **Model using the "baseline" methodology performs better for FJ** than the ones using OLS regression but **no differences for JS**

- **Promising method** to find an optimal combination of proxies to predict genetic merit for a trait of interest

Next step:

- Test **other predictive modelling methods** to find an optimal combination of ELJ traits to predict genetic merit for show jumping performance
- Compare **efficiency of our model** with a reduced number of traits **with a multi-trait model**

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Thank you for your attention

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