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Principal Component Analyses
Application to conformation traits

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Background - feed

- Feed costs: large proportion of total costs
  - biological and economic efficiency
  - consider genetic variation

- Feed intake: energy and protein requirements
  - maintenance
  - growth
  - production
  - pregnancy

Background - body weight

- Maintenance requirements depend on body weight
- Body weight is also heritable
  - selection possible
- Weighing animals on large scale is not common practice
  - lack of data
- Useful predictors defined out regular recording scheme

Aims of the study

- To estimate variance components for traits related to body weight, using observations on body measurements and linear type traits
- To select a subset of 3 traits that captures most of the variance-covariance structure of the original matrix, using principal component analyses

Data editing

The dataset included only lactating heifers

- Known pedigree
- Reasonable ages at first calving
- Sires with >4 daughters
- HY-classes with >4 cows

Final datasets

- Holstein : 67,839; in 2054 herds
- Brown Swiss : 173,372; in 7835 herds
- Simmental : 53,784; in 4808 herds

Selected traits related to body weight

- Stature (ST)
- Heart girth (HG)
- Body depth (BD)
- Rump width (RW)
- Dairy character (DC) or Muscularity (MU)
- Body condition score (BCS) (Holstein only)

Statistical model

- ASREML
- Fixed effects
  - classifier
  - season, age, days in milk, and pregnancy stage at classification
- Random effects
  - Sire
  - Herd-Year
  - Residual

Holstein - correlations

	ST	BD	HG	RW	DC
BD	0.63				
HG	0.45	0.67			
RW	0.25	0.22	0.13		
DC	0.52	0.65	0.22	0.28	
BCS	-0.02	-0.22	0.41	-0.29	-0.67

Brown Swiss - correlations

	ST	BD	HG	RW
BD	0.13			
HG	0.34	0.72		
RW	0.09	0.06	0.56	
MU	-0.21	-0.05	0.56	0.62

Simmental - correlations

	ST	BD	HG	RW
BD	0.22			
HG	0.54	0.30		
RW	0.27	0.39	0.32	
MU	-0.31	-0.61	0.28	-0.12

Principal component analyses

- Genetic correlations between all traits in matrix
- Eigenvalues and Eigenvectors decomposed
- Subset maximally capturing the variance of whole set
  - Selecting the 3 traits most heavily weighted in the 3 main Eigenvectors
  - Predictive ability checked by computing amount of non-explained variance for non-selected traits

Holstein - eigenvectors

ST	-0.46	0.18	-0.02	-0.83	-0.06	0.23
BD	-0.54	0.15	-0.18	0.29	-0.67	-0.34
HG	-0.35	0.57	0.05	0.44	0.32	0.51
RW	-0.27	-0.20	0.93	0.06	0.00	-0.11
DC	-0.50	-0.31	-0.27	0.06	0.64	-0.42
BCS	0.22	-0.70	0.15	-0.15	0.19	-0.62

Brown Swiss - eigenvectors

ST	0.21	-0.55	0.73	0.29	0.18
BD	0.38	-0.52	-0.55	-0.20	0.49
HG	0.63	-0.13	-0.16	0.16	-0.73
RW	0.48	0.34	0.37	-0.71	0.12
MU	0.43	0.53	-0.05	0.59	0.41

Simmental - eigenvectors

ST	-0.47	0.26	0.66	-0.35	0.39
BD	-0.53	0.29	-0.21	0.62	0.45
HG	-0.38	0.65	-0.01	0.37	-0.55
RW	-0.45	0.07	-0.67	-0.59	0.02
MU	0.39	*0.65*	-0.27	0.11	0.59

Optimal subsets

- Holstein
  - Body depth, rump width, body condition score
- Brown Swiss
  - Heart girth, stature, body depth
- Simmental
  - Body depth, heart girth, rump width
  - Body depth, muscularity, rump width

Non-explained variance

- Holstein
  - HG (20%), ST (57%), DC (28%)
- Brown Swiss
  - RW (43%), MU (12%)
- Simmental
  - MU (38%), ST (70%)
  - HG (53%), MU (86%)

Conclusions

- For lactating Holstein and Brown Swiss heifers:
  - 3 optimal traits could be identified
- For lactating Simmental heifers:
  - Choice of optimal traits is not as straightforward

- Principal component analyses useful to select traits for constructing total merit indices for Swiss dairy cows

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