Cost effective prediction of bodyfat

An example of project presentation slides

Aki Vehtari
Aalto University

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Introduce yourself

Measuring bodyfat percentage

- Bodyfat percentage is related to many health outcomes

[Nice figures here]

Measuring bodyfat percentage

- Bodyfat percentage is related to many health outcomes
- Relatively accurate way to measure bodyfat is to weight a person in air and immersed in water
  - proportion of body fat can be derived from body density with Siri's (1956) formula
  - water immersion requires a big tub for the water and harness system for lowering a person to water

[Nice figures here]

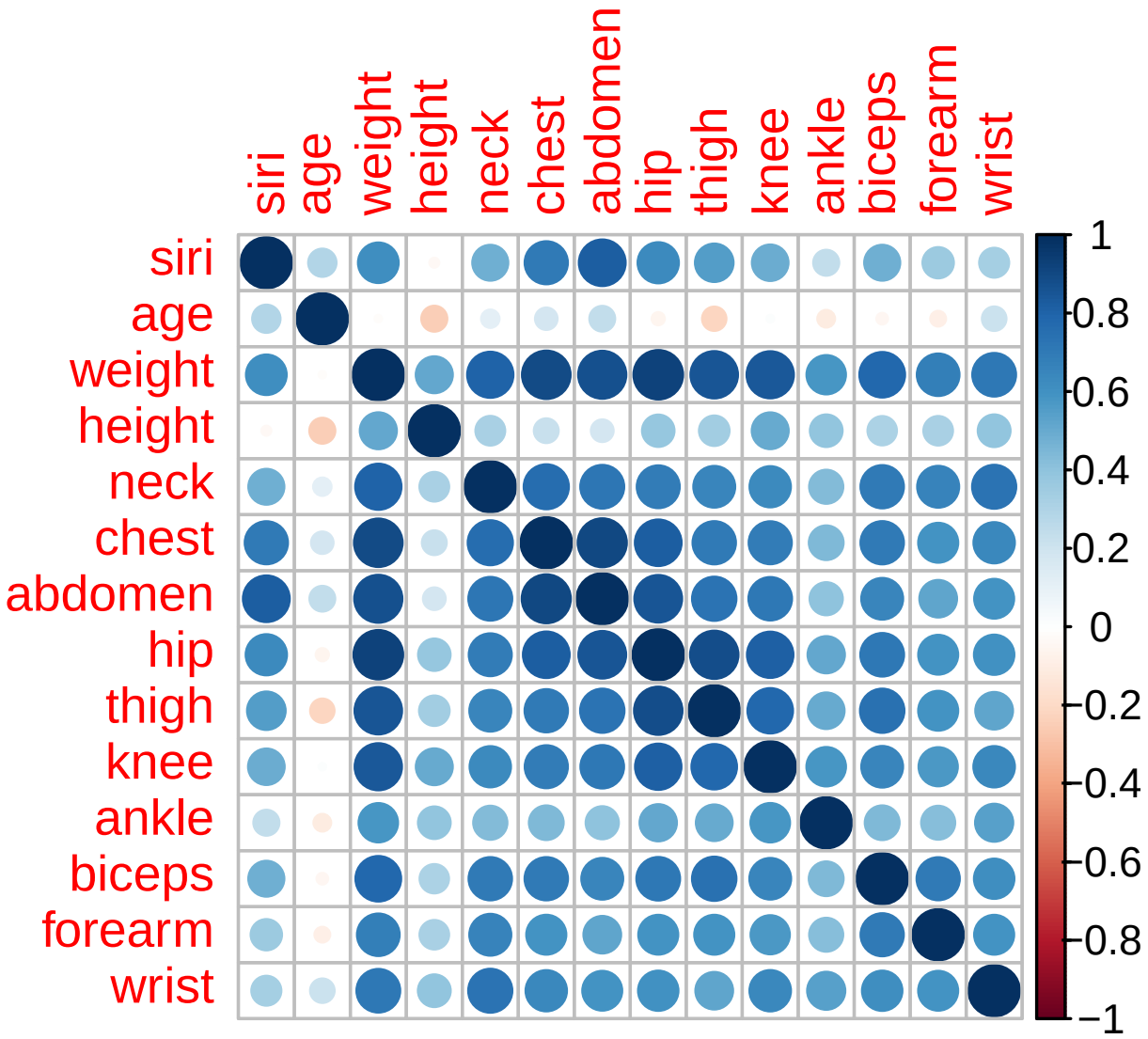
Measuring bodyfat percentage

- Bodyfat percentage is related to many health outcomes
- Relatively accurate way to measure bodyfat is to weight a person in air and immersed in water
  - proportion of body fat can be derived from body density with Siri's (1956) formula
  - water immersion requires a big tub for the water and harness system for lowering a person to water
- Can we estimate the bodyfat percentage with faster and a smaller equipment?
  - with just a scale and measure tape?

[Nice figures here]

Measuring bodyfat percentage

- With just a scale and measure tape?



Bodyfat predictive model

- Gaussian linear regression model with regularized horseshoe prior ($p_0 = 5$) on coefficients

Bodyfat predictive model

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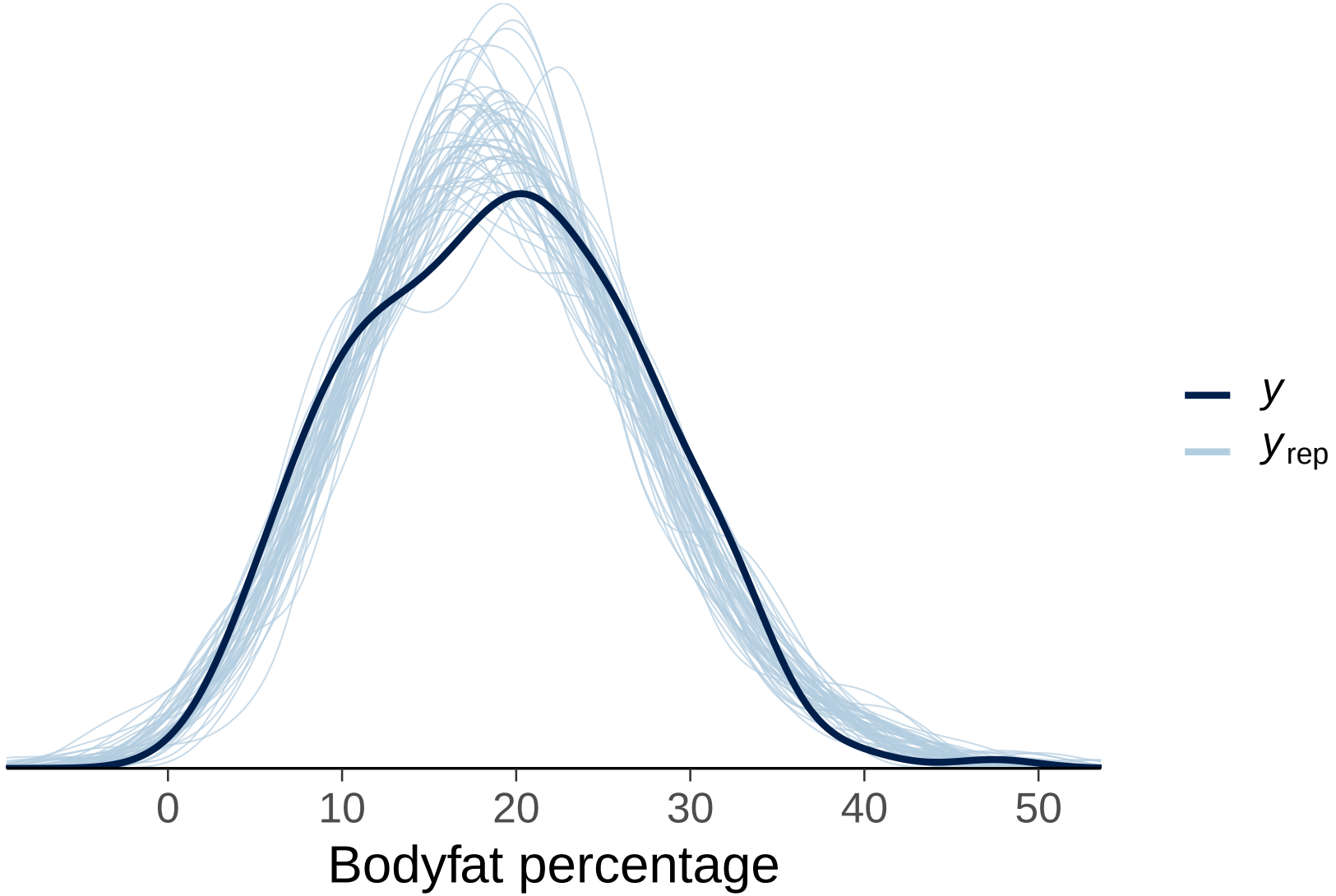
- Model build with `rstanarm` and inference run with Stan
  - all convergence diagnostics were good

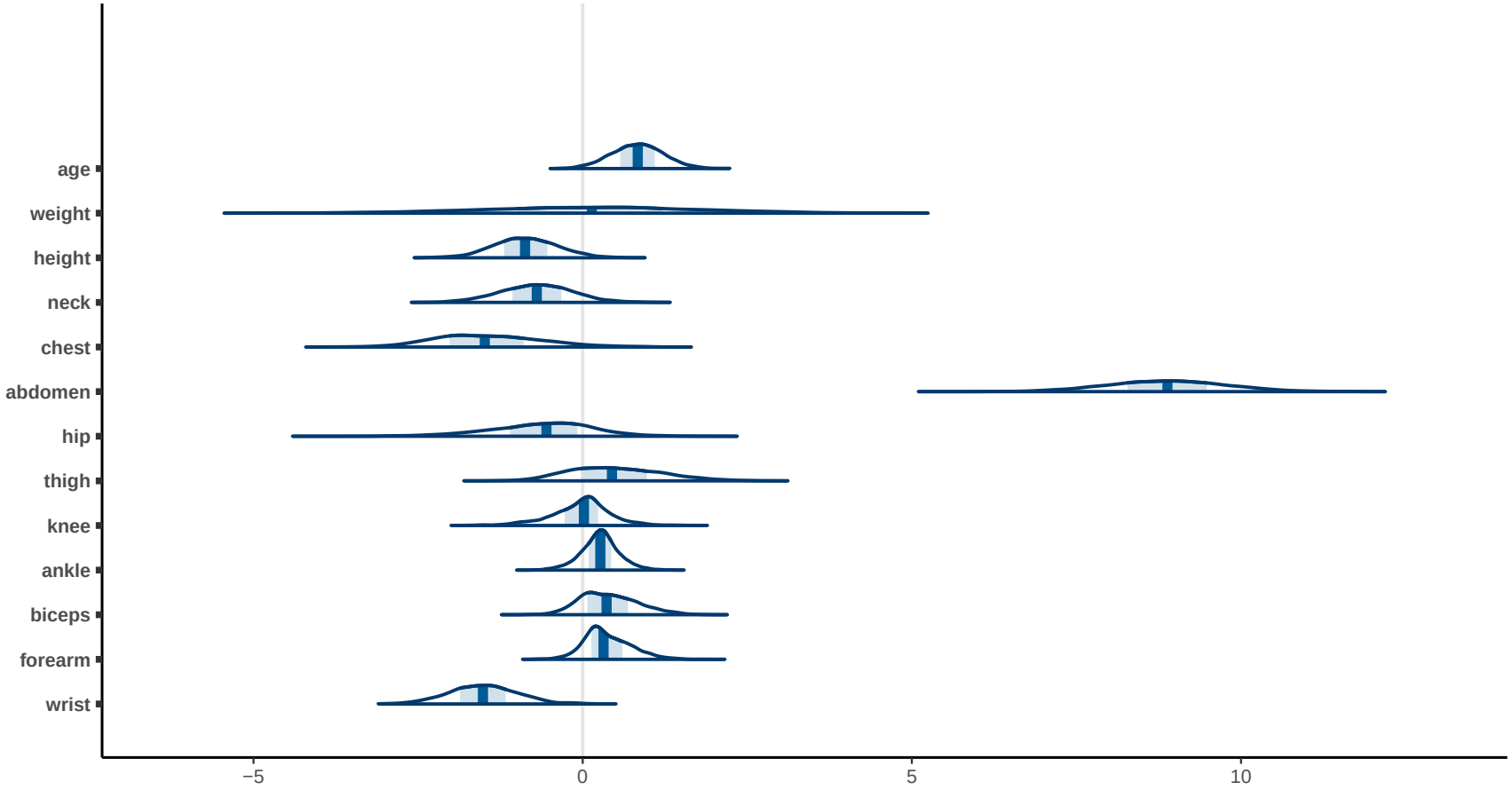
Bodyfat model checking

Posterior predictive checking



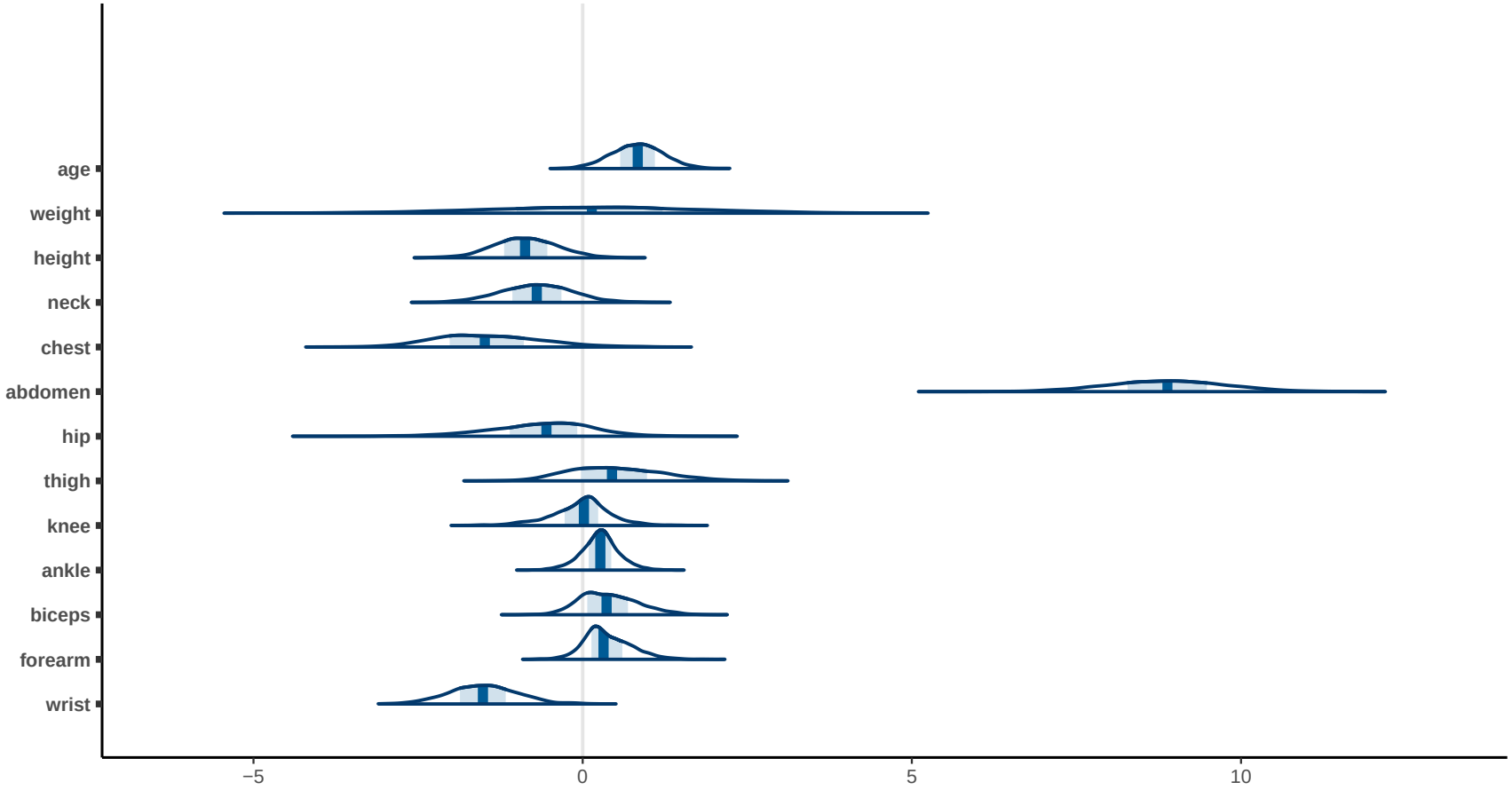
Bodyfat

Marginal posteriors of coefficients



Bodyfat

Check that the font in all figures is big enough!



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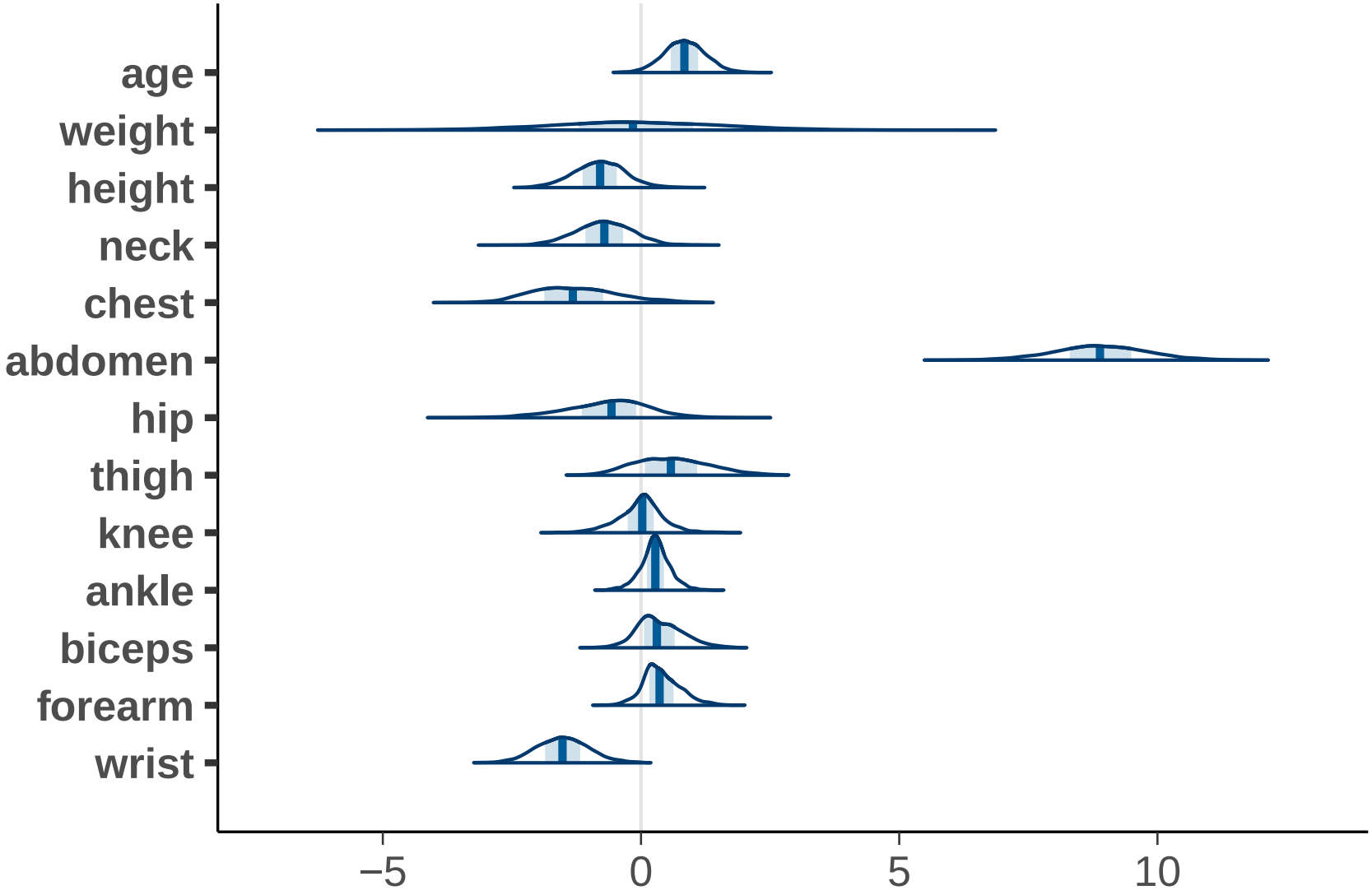
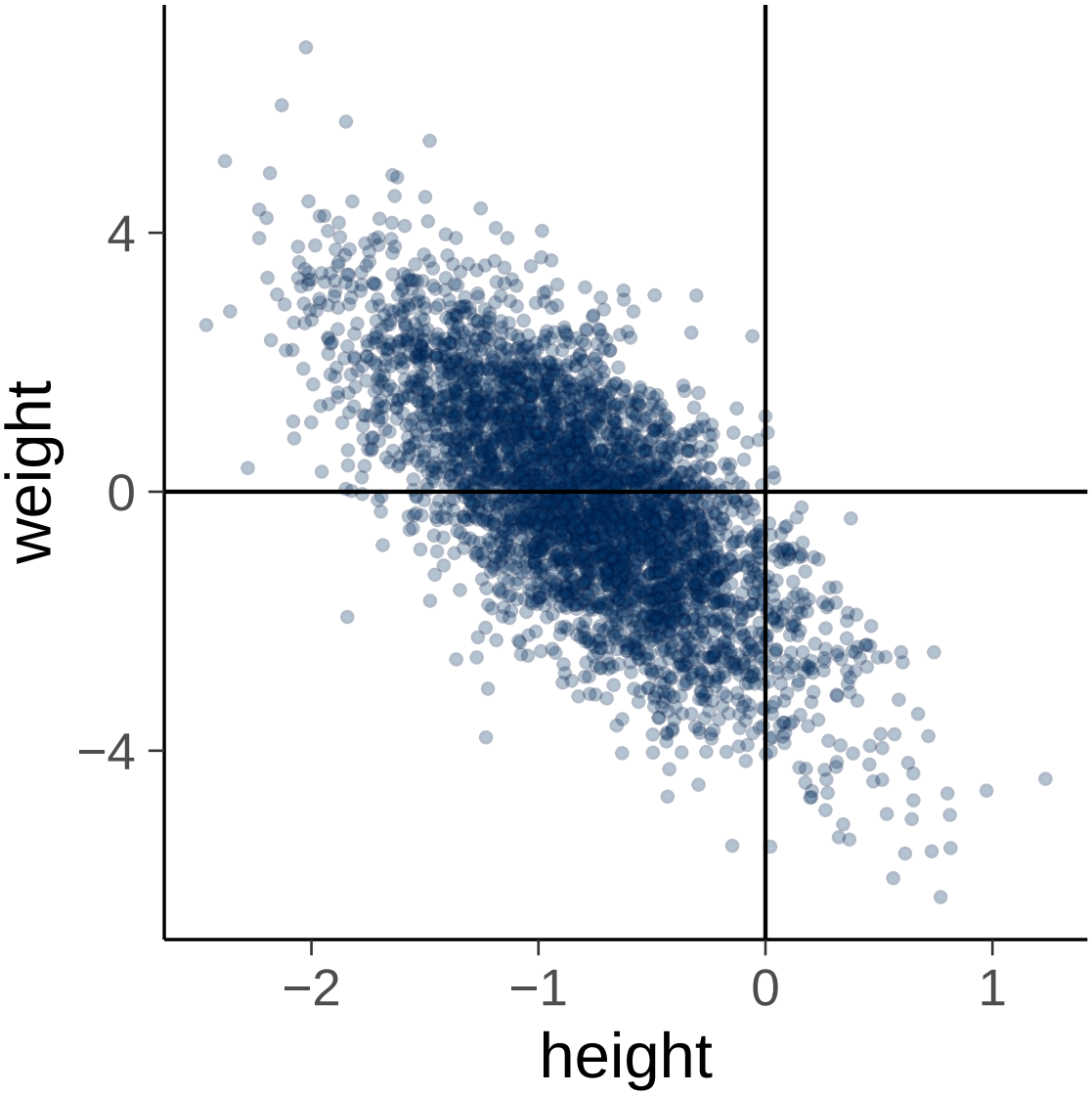


Bodyfat

Bivariate marginal of weight and height



Bodyfat variable selection

- Do we need all the measurements?
- We find the model with a minimal set of variables which have similar predictive performance as the model with all variables

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- We use projection predictive variable selection implemented in `projpred` package

Projective predictive covariate selection

- The full model predictive distribution represents our best knowledge about future $\tilde{y}$

$$p(\tilde{y}|D) = \int p(\tilde{y}|\theta)p(\theta|D)d\theta,$$

  where $\theta = (\beta, \sigma^2)$) and β is in general non-sparse (all $\beta_j \neq 0$)
- What is the best distribution $q_\perp(\theta)$ given a constraint that only selected covariates have nonzero coefficient
- Optimization problem:

$$q_\perp = \arg\min_q \frac{1}{n}\sum_{i=1}^{n} \mathrm{KL}\left(p(\tilde{y}_i \mid D) \,\|\, \int p(\tilde{y}_i \mid \theta)q(\theta)d\theta\right)$$

- Optimal projection from the full posterior to a sparse posterior (with minimal predictive loss)

For 10min presentation, too much information

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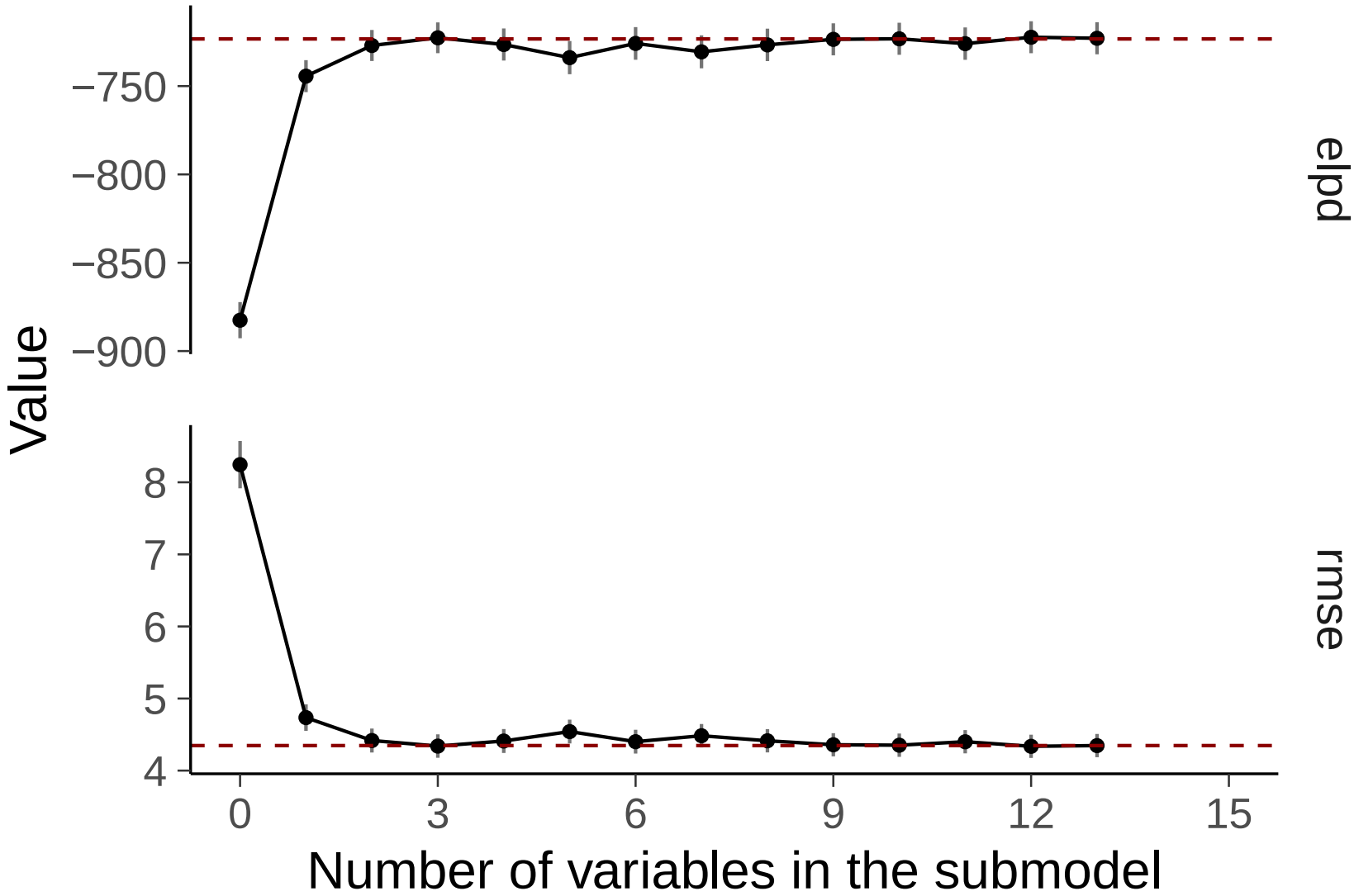
Bodyfat

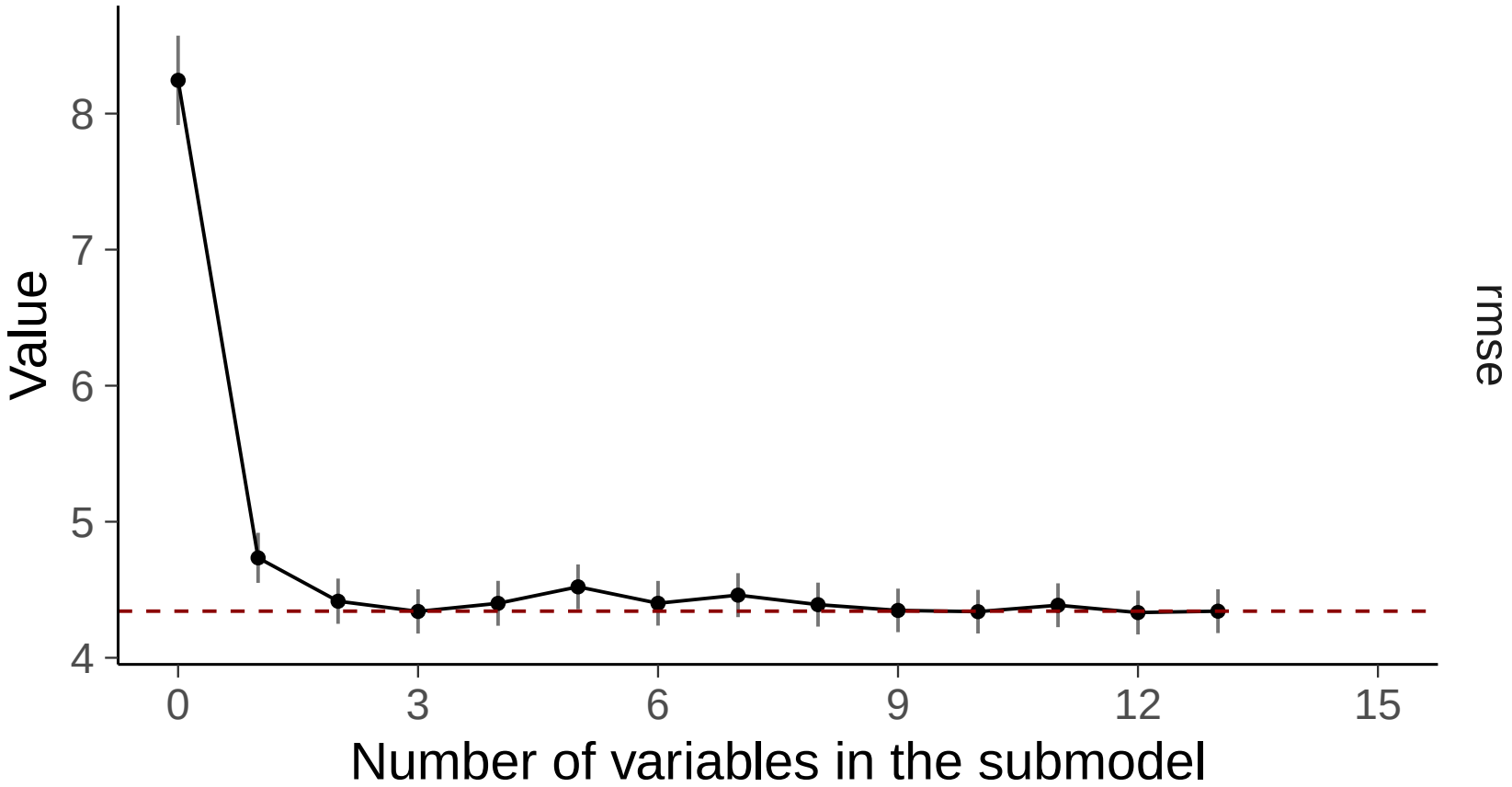
The predictive performance of the full and submodels



Bodyfat

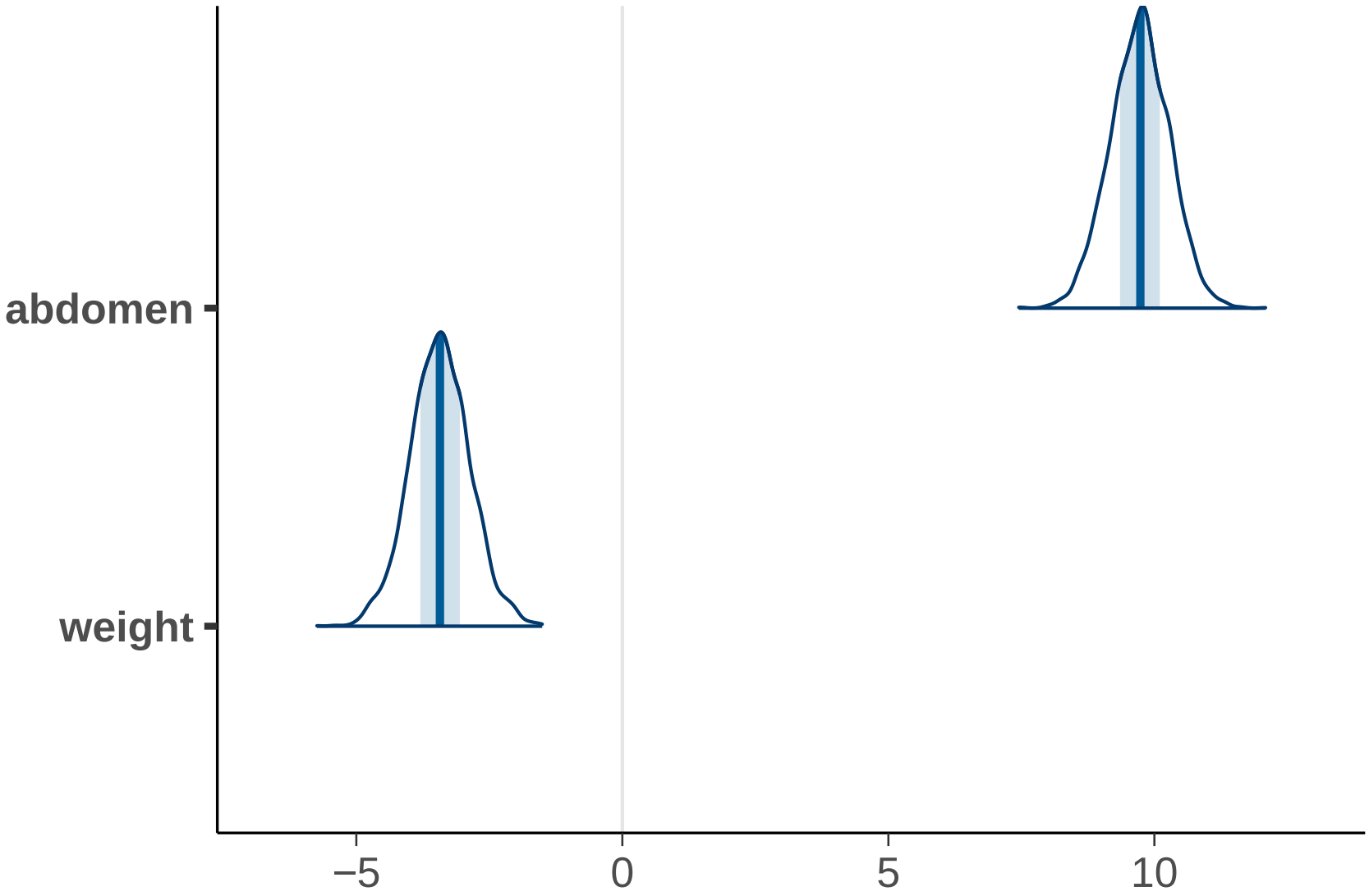
The predictive performance of the full and submodels

One of these plots is probably sufficient



Bodyfat

Marginals of projected posterior



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- More results at avehtari.github.io/modelselection/bodyfat.html

THANKS!

NO “THANKS”!

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- Don’t ever end with a slide having just “THANKS”

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- Don’t ever end with a slide having just “THANKS”
- “THANKS” slide has zero information content

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- Leave the conclusion slide or contact information slide

Conclusion

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Additional information

- You can have additional slides after the conclusion for supporting material to answer questions
  - for example, in this course, include Stan code and additional convergence and model checking results

Gaussian linear model with regularized horseshoe prior

```
p0 <- 5 # prior guess for the number of relevant variables
tau0 <- p0/(p-p0) * 1/sqrt(n)
rhs_prior <- hs(global_scale=tau0)
fitrhs <- stan_glm(formula, data = df, prior=rhs_prior,
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For figures, e.g.,

```
theme_set(bayesplot::theme_default(base_family = "sans",
          base_size=16))
```