The Impact of Prior Choice for Between-Study Heterogeneity in Network Meta-Analysis on Model Conclusions

MSR79

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Background and Objectives

- Network meta-analysis (NMA) enables comparison of multiple treatments by combining direct and indirect evidence.
- Between-study heterogeneity often arises due to differences in study design, biases, or random variation.
- Random-effects models are commonly used to account for this heterogeneity by allowing treatment effects to vary across studies, rather than assuming a single common effect.
- The Bayesian framework allows for the use of informative priors on between-study heterogeneity to improve model stability and precision, however, guidance on how to specify priors is somewhat limited.
- In practice, the choice of prior can have an impact on the conclusions drawn, especially when the data are limited.
- Poorly estimated heterogeneity can lead to artificially wide confidence intervals for treatment effects which can mislead treatment ranking or decision making in practice.
- The objective of this work is to explore the influence of informative and vague priors on between-study heterogeneity in both sparse and dense simulated NMA scenarios.

Methods

- Bayesian random-effects NMAs were conducted using simulated datasets under combinations of sparse and dense network structures.
- Simulations incorporated knowing baseline log-odds and treatment effects for the comparison of 3 treatments (B, C, D) to a reference treatment (A), with the between-study heterogeneity fixed as $\tau = 0.6$. 1000 simulations were conducted for each scenario.
- Sparse networks included one trial per comparison with 75 subjects per treatment arm, while dense networks included five trials per comparison with 100 subjects per arm.
- A vague prior for τ was specified as Uniform(0, 5), and an informative prior as LogNormal(0.2, 0.5).
- The influence of prior specification on posterior estimates of heterogeneity, treatment effect accuracy, and credible interval width was assessed across network sparsity levels.

Results

Posterior Densities of Between-Study Heterogeneity

- In sparse networks, informative priors for between-study heterogeneity produced more stable posterior estimates, though these were notably centered around the prior mean, indicating a degree of prior dominance.
- In contrast, vague priors led to more dispersed posterior distributions, reflecting greater uncertainty.
- In dense networks, both prior types produced similar posterior densities that approached the fixed parameter of $\tau = 0.6$, suggesting the data quantity reduced any sensitivity to prior specification.

Width of the Credible Intervals

- In sparse networks, vague priors led to highly uncertain heterogeneity estimates and wide credible intervals. In contrast, informative priors resulted in narrower credible intervals in sparse networks, reflecting the influence on the estimation of heterogeneity.
- Dense networks provided enough information to result in narrow credible intervals, regardless of prior choice.

Figure 1: Posterior Densities for Between-Study Heterogeneity by Prior Specification and Network Density

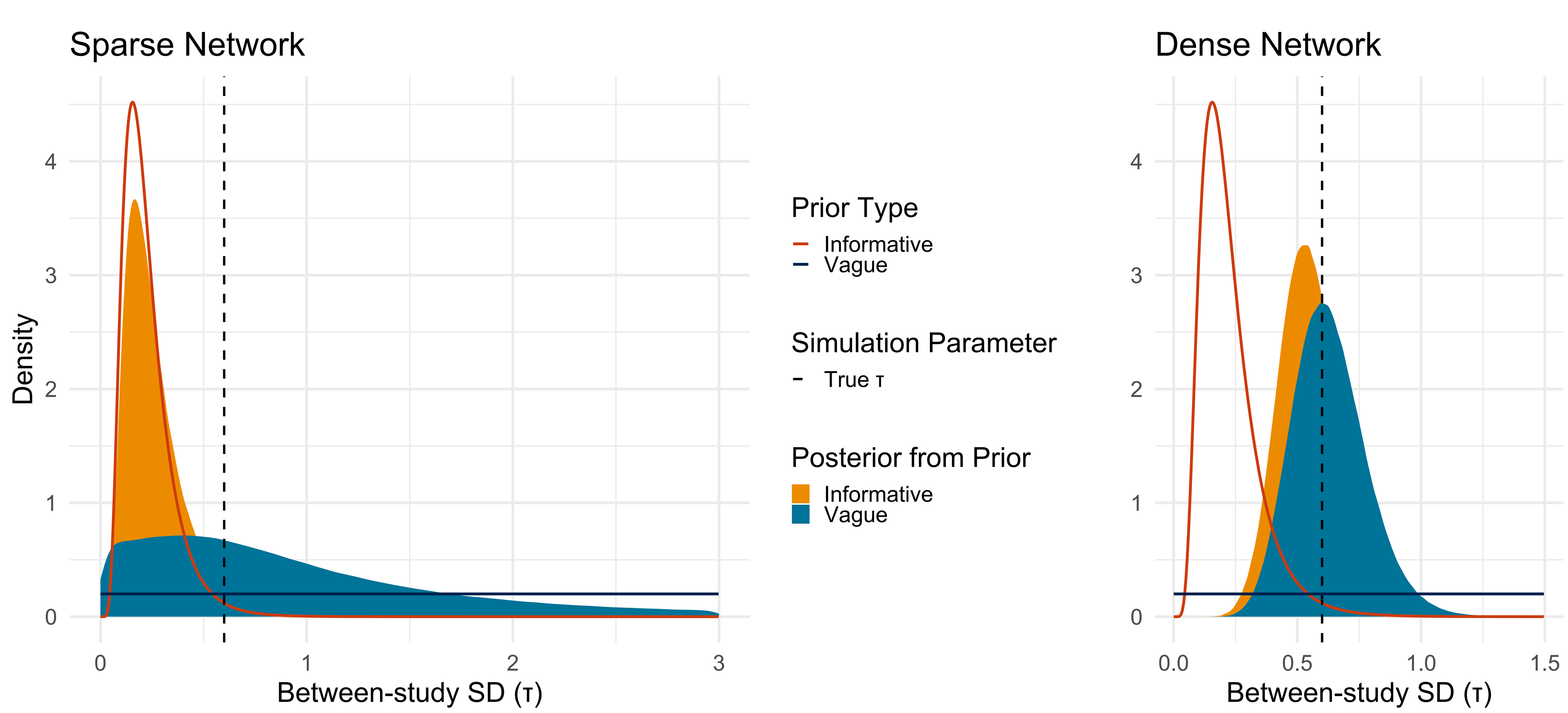
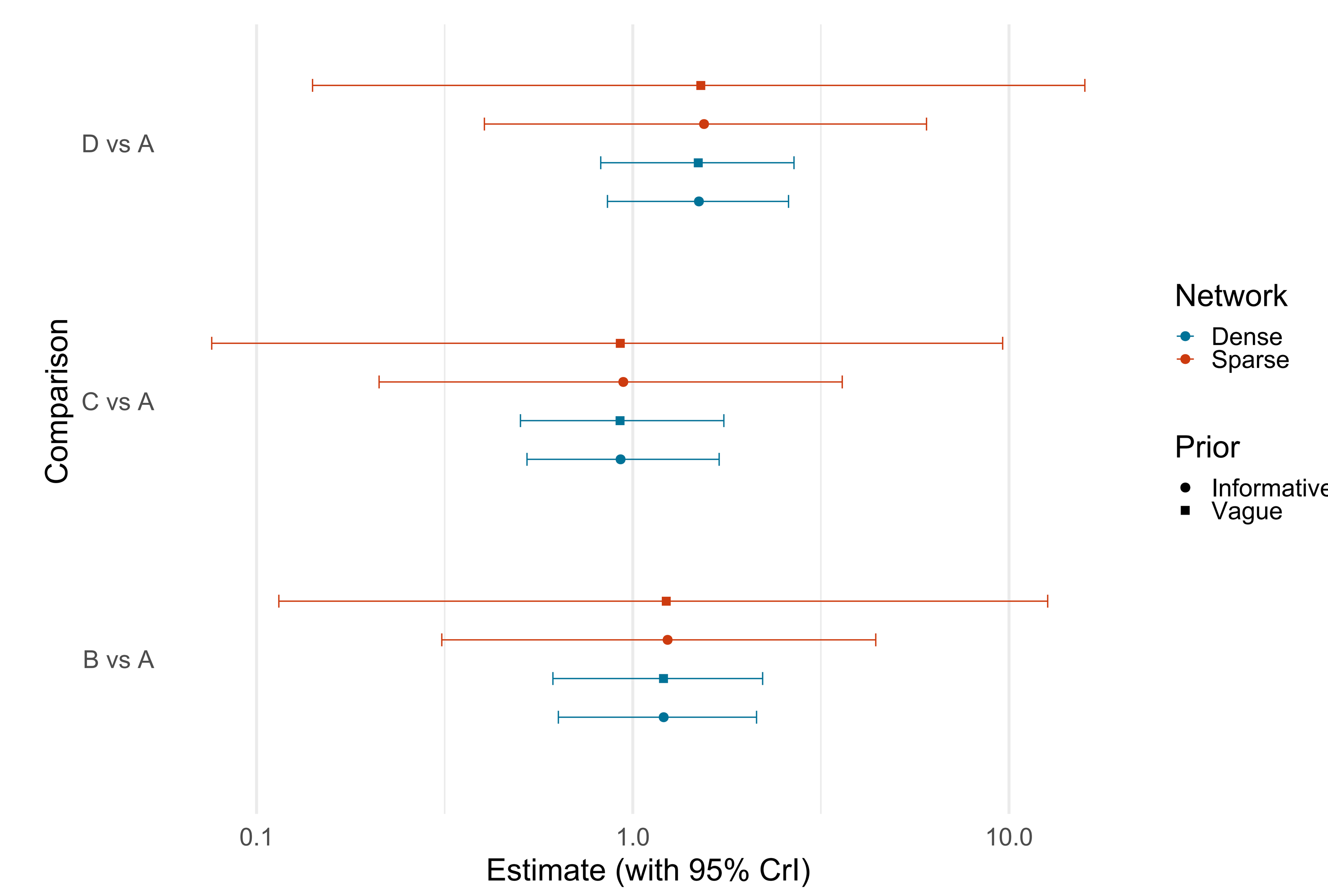


Figure 2: Effect Estimates with Associated Credible Intervals



Discussion

In network meta-analyses with limited data, prior distributions can dominate the analysis, potentially leading to biased estimates that reflect the prior more than the data. This sensitivity raises concerns in sparse networks. Despite this, informative priors can also provide a practical means of stabilizing heterogeneity estimates by incorporating external knowledge, particularly when only a few studies are available. While it is difficult to define a strict threshold for when data become “too sparse,” informative priors are unlikely to adversely affect results in well-populated networks. These findings highlight the importance of thoughtful prior selection and justification in all NMAs, regardless of network size.

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