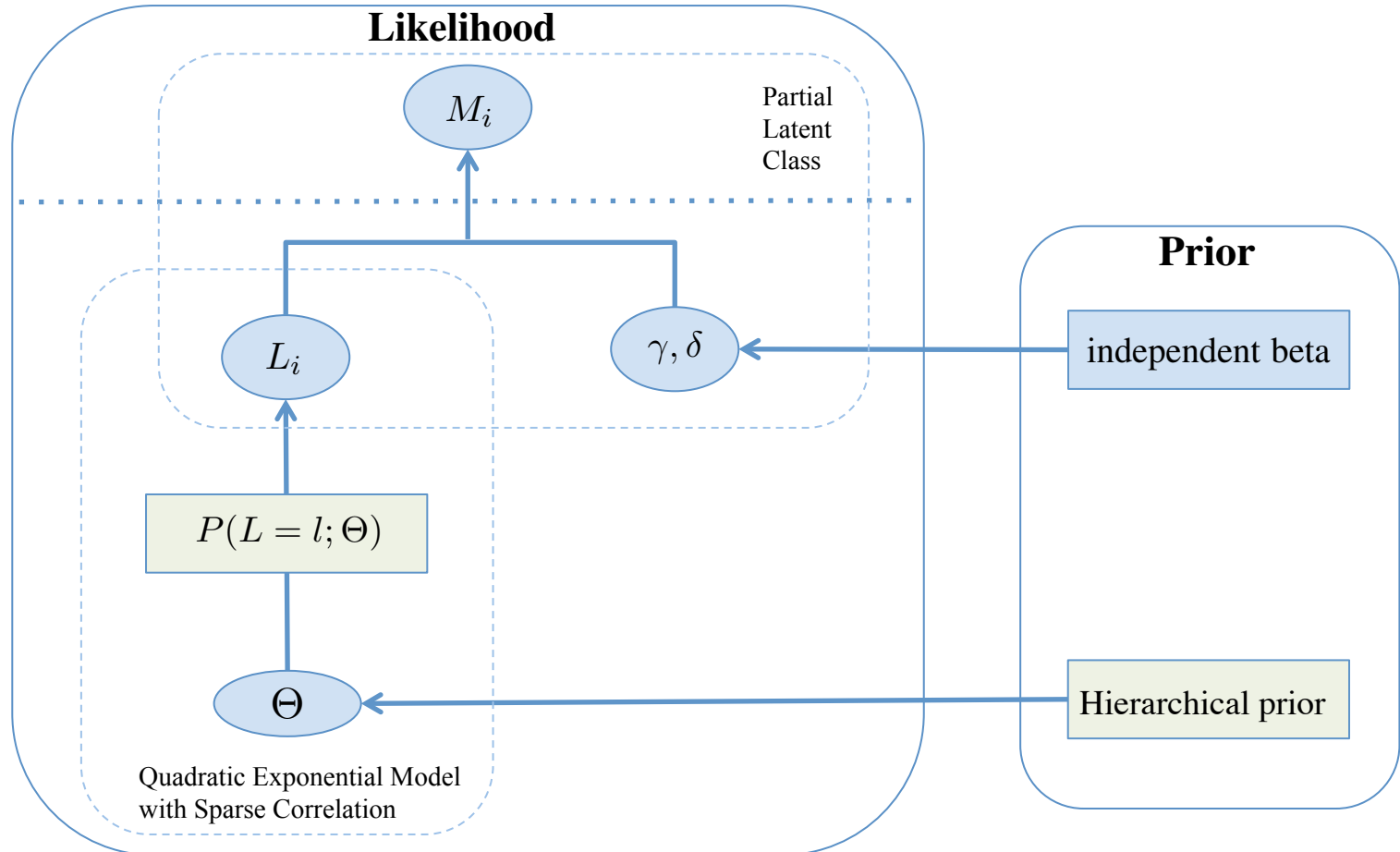
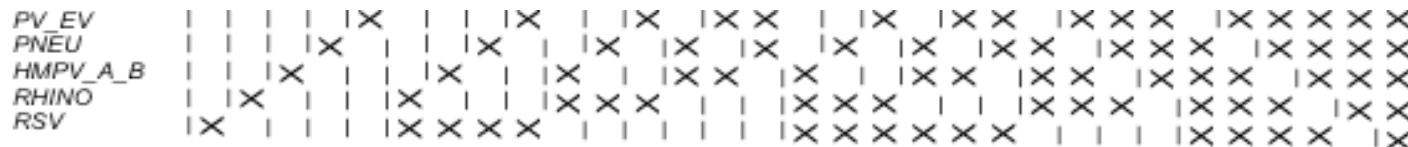


Model Hierarchy



Latent Variable



Regular Quadratic Exponential Model:

$$P(L = l; \Theta) = \exp\{\Theta_1^T l + \Theta_2^T u_2\} / A(\Theta)$$

$$\text{with } A(\Theta) = \sum_{l^* \in \{0,1\}^K} \exp\{\Theta^T l^*\}$$

$$\theta_{ik}^{(1)} = X_i^T \beta_k, \text{ where } X_i \text{ is the vector of covariates.}$$

Sparse Correlation:

$$\Theta_2 = \theta_2 \cdot (I_1, \dots, I_{\binom{K}{2}})$$

Hierarchical Prior:

$$I_j \sim \text{Bernoulli}(p)$$

$$p \sim \text{Beta}(a, b)$$



Simulation Study

5 candidate etiological pathogens.

BS are available for each of them.

500 cases and 1000 controls in each data set.

200 independent data sets simulated.

Two binary covariates: age and severity.

Simulation I-a:

- Allow multiple pathogen infect lung at the same time. $\Pr(2 \text{ or more}) \approx 0.35$
- All pathogens have SS measurements.
- Relatively low-quality data:
SS TPR ≈ 0.1 BS TPR ≈ 0.6 BS FPR ≈ 0.45

Simulation I-b:

- Only pathogen D, E have SS measurements.

Simulation II:

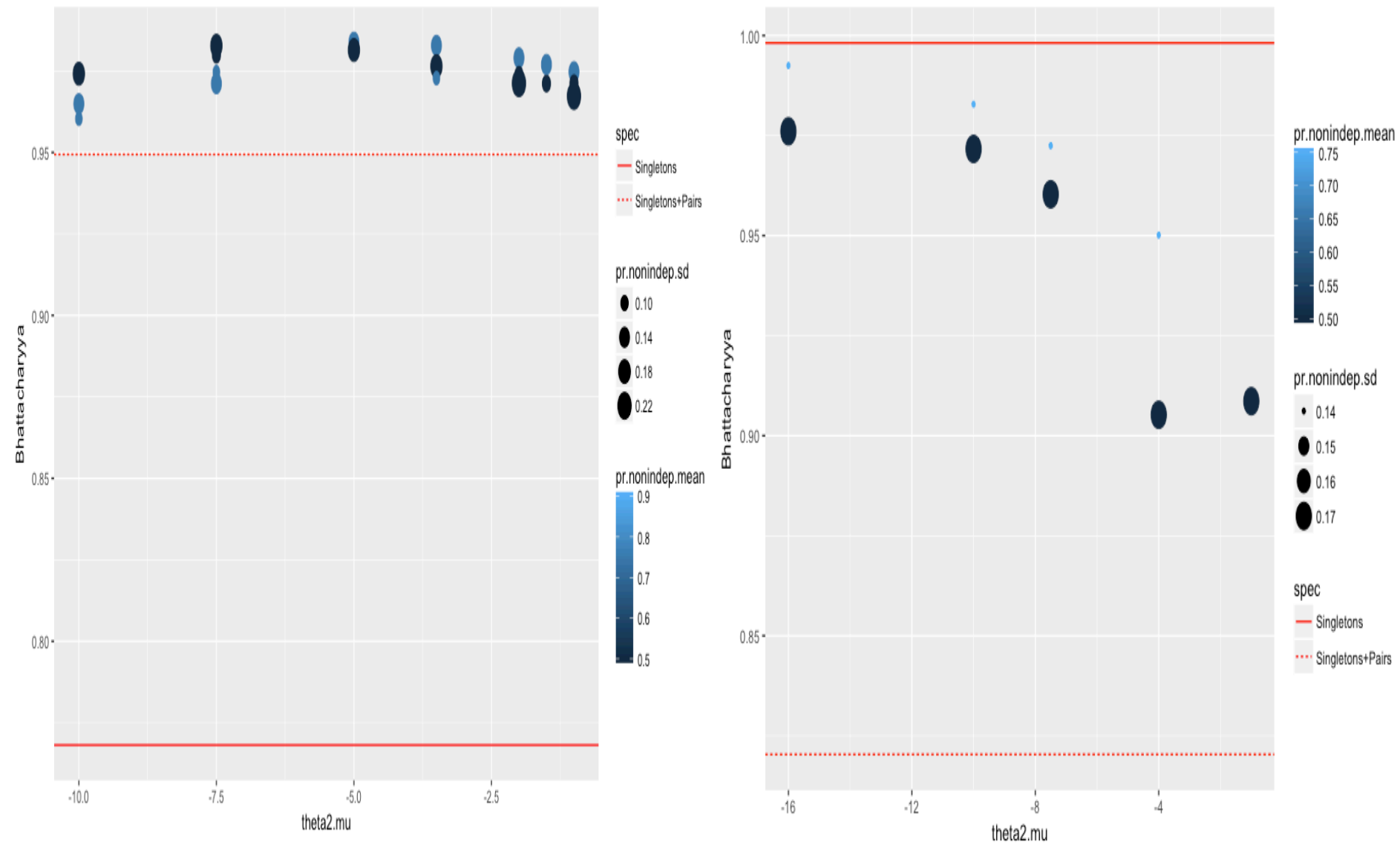
- Relatively high-quality data:
SS TPR ≈ 0.8 BS TPR ≈ 0.9 BS FPR ≈ 0.1

Simulation III:

- Only single-pathogen infection is possible.

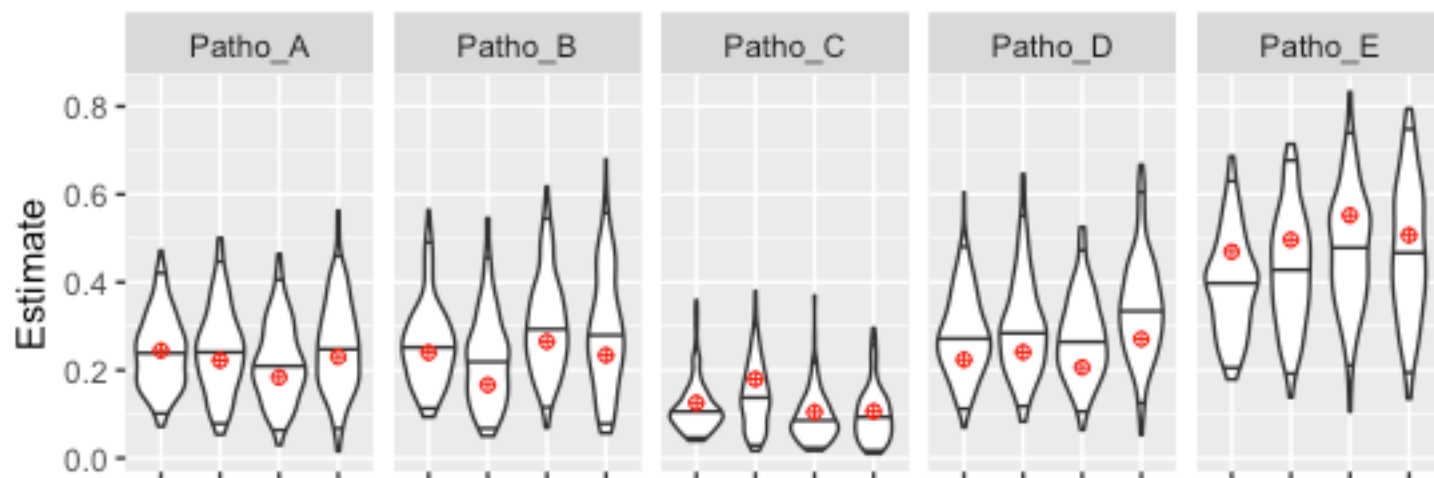


Simulation I-a and III vs. pLCM

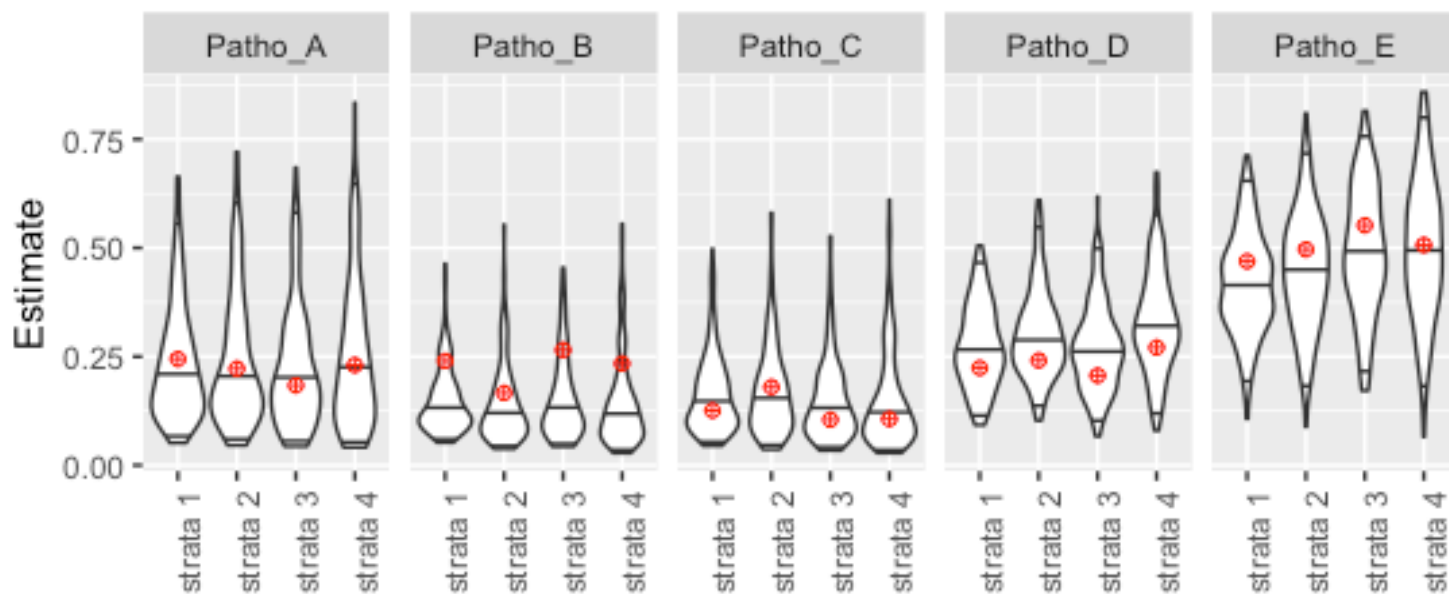


Simulation I-a vs. I-b

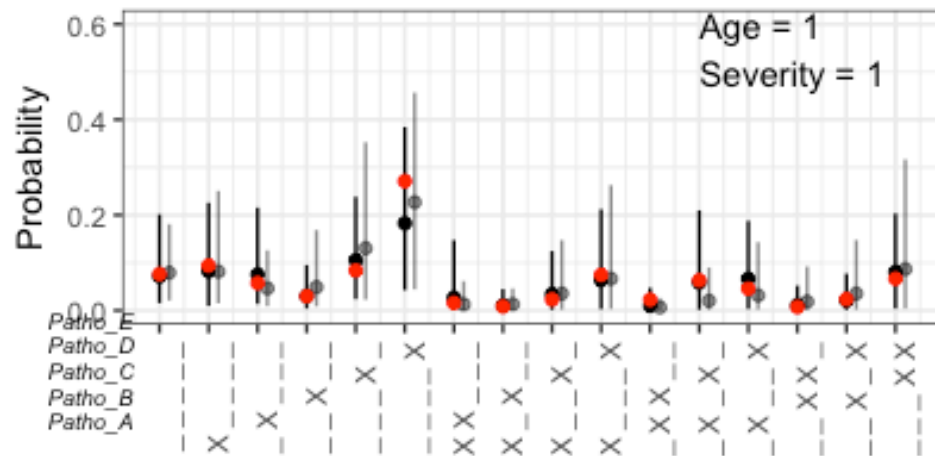
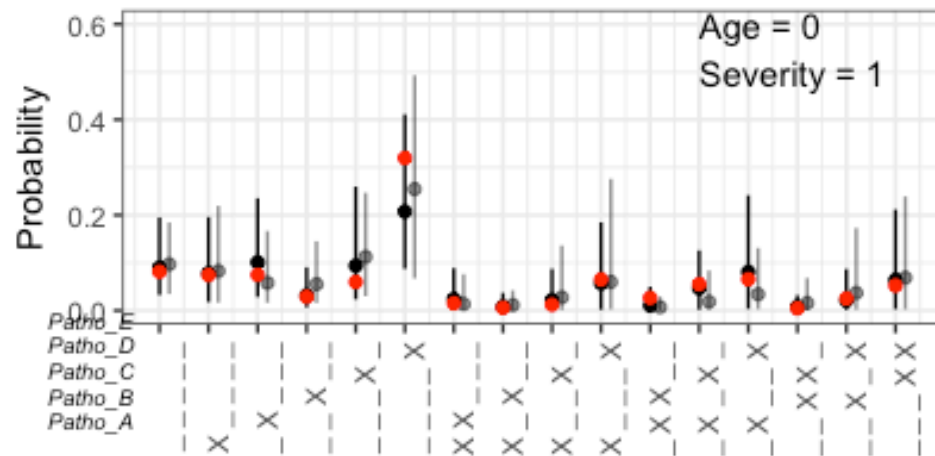
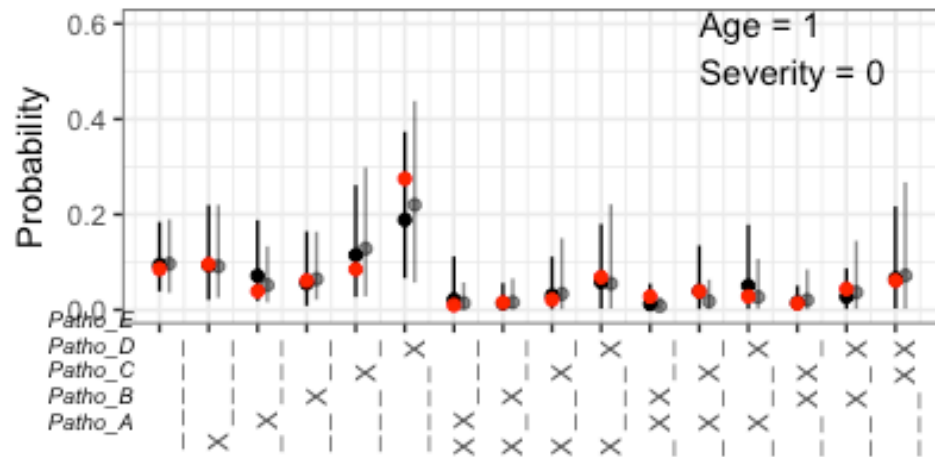
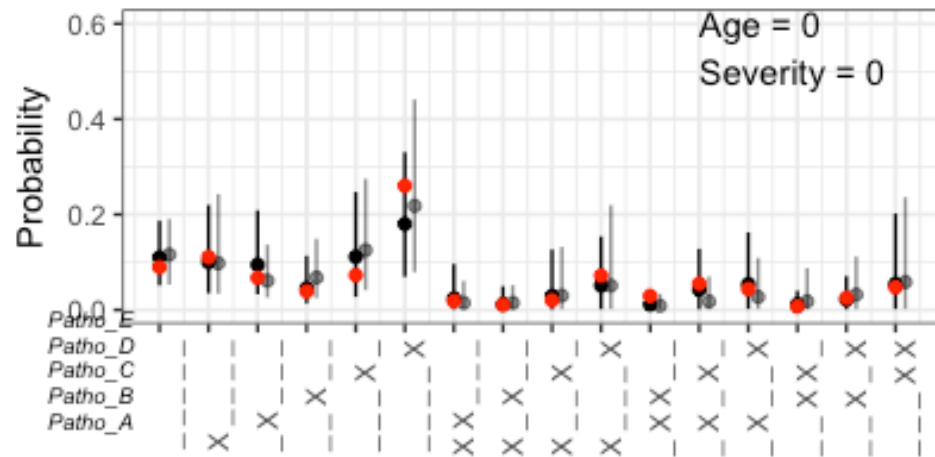
SS available
for all five
pathogens:



SS available
for pathogen
D and E only:

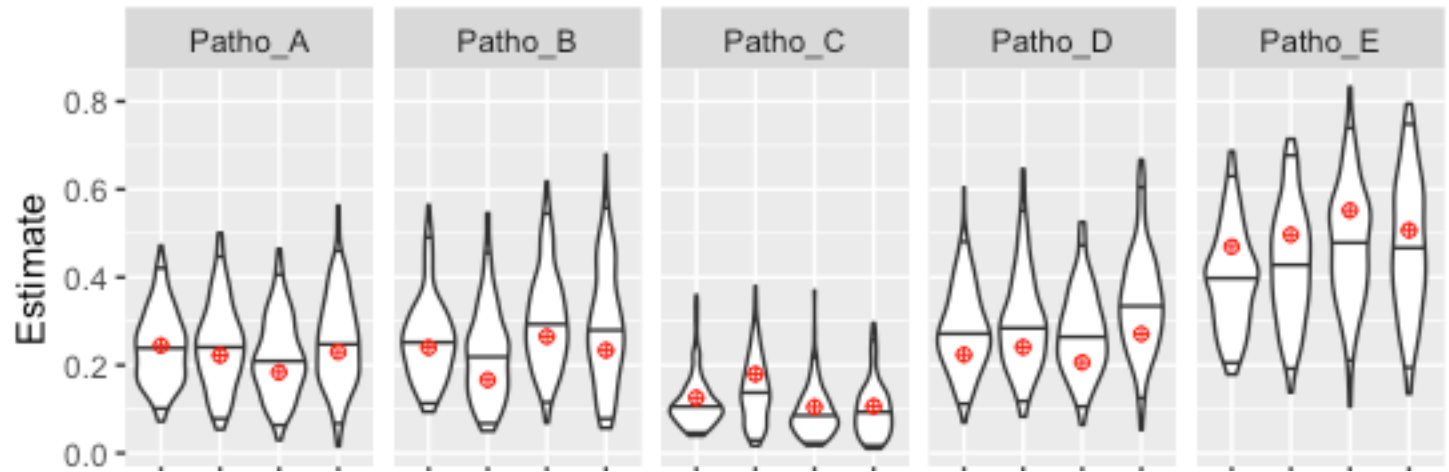


Simulation I-a vs. I-b

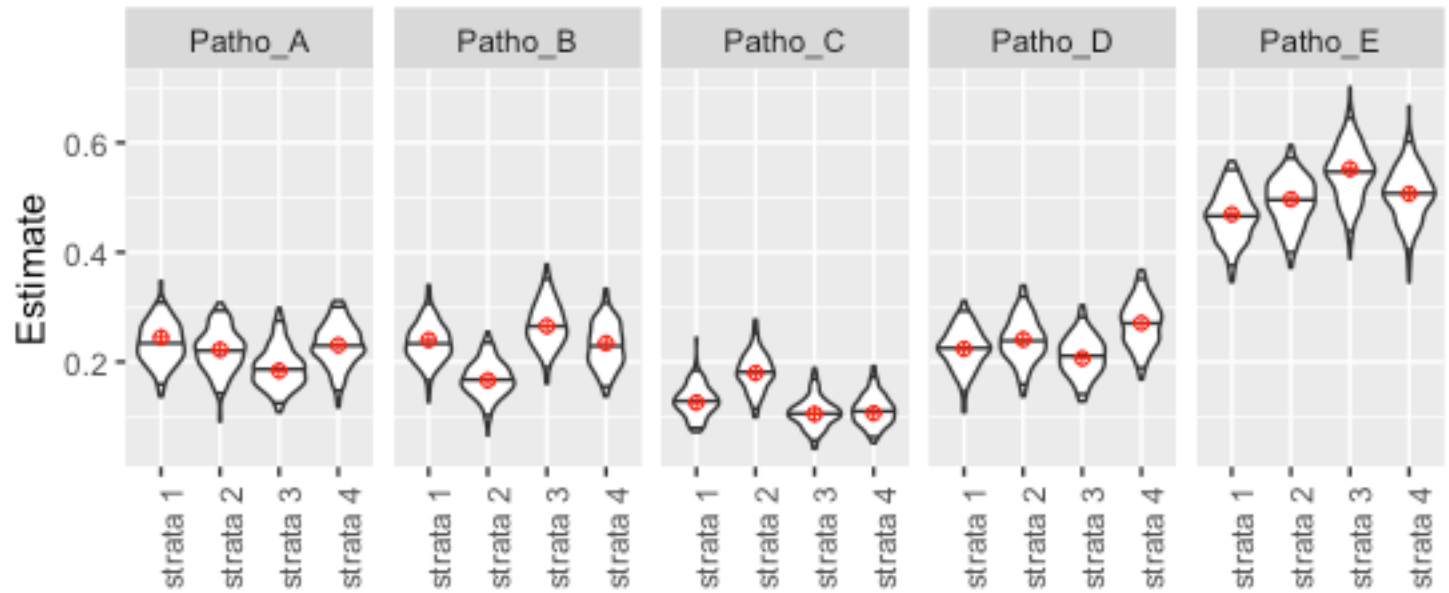


Simulation I-a vs. II

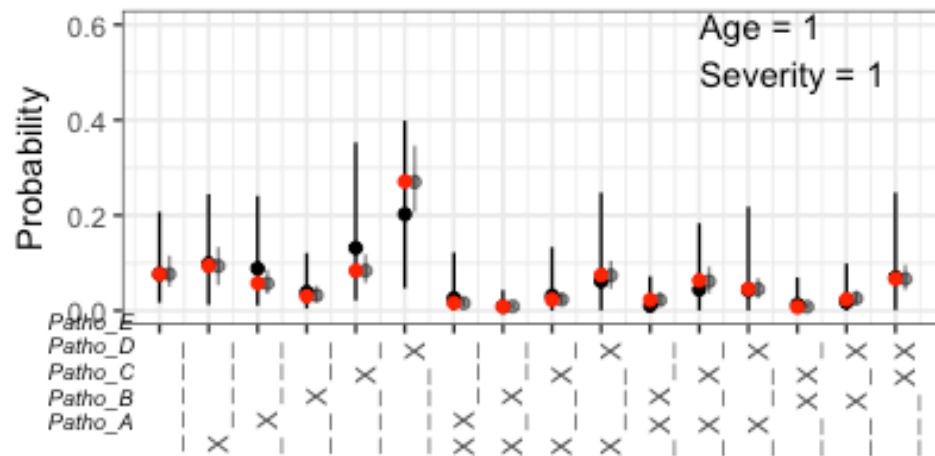
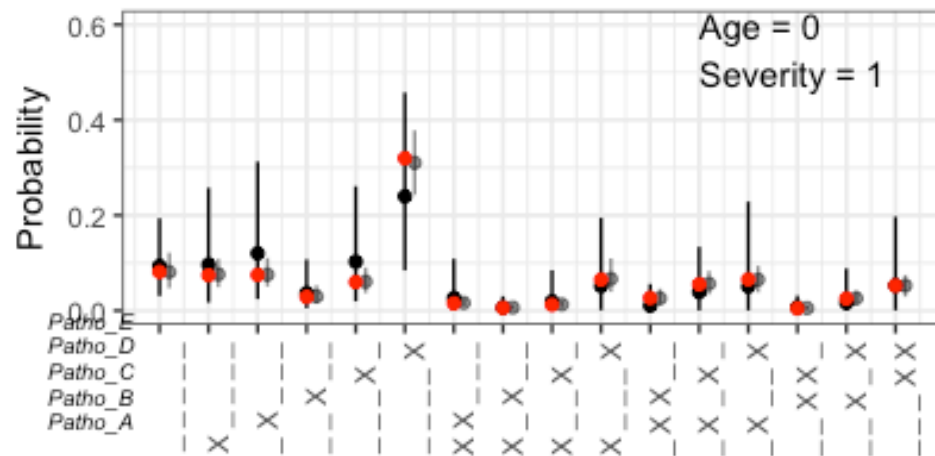
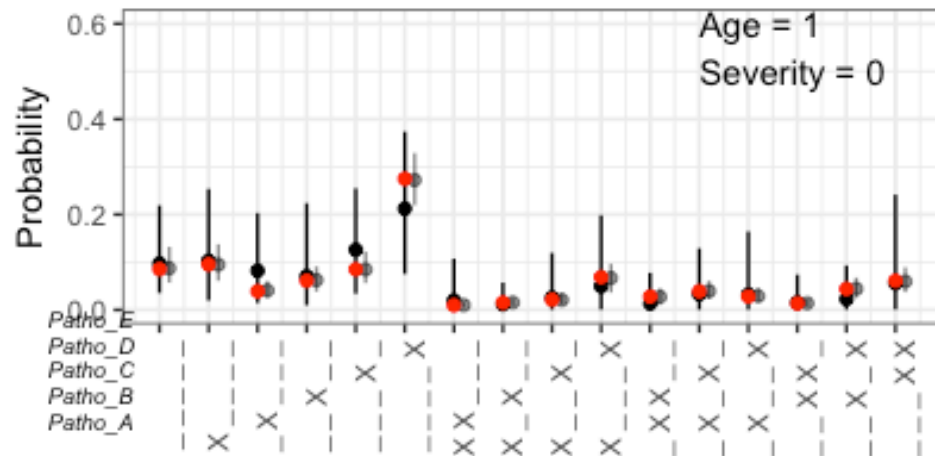
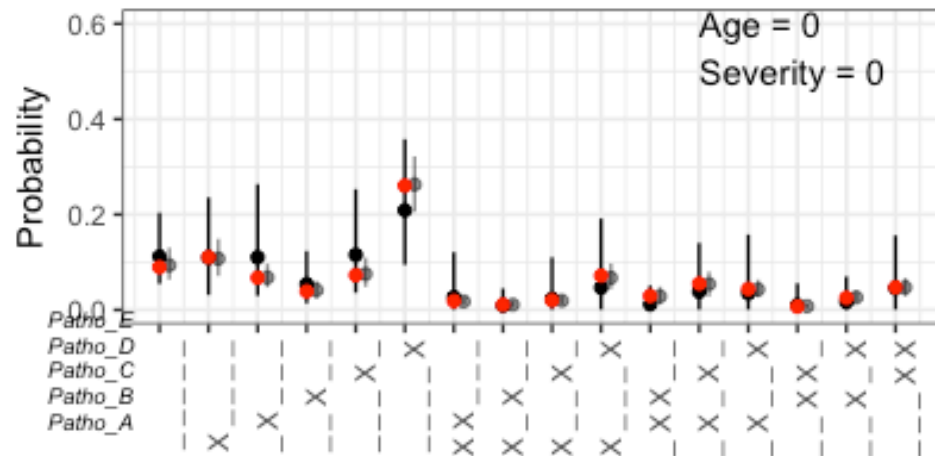
Low-quality
data:



High-quality
data:



Simulation I-a vs. II



Appendix



β_0	0.210	-0.282	-0.835	-0.205	1.068
β_{age}	-0.1	-0.5	0.5	0.2	0.1
β_{sev}	-0.3	0.2	-0.2	-0.1	0.3
$\beta_{\text{a:s}}$	0.4	0.3	-0.4	0.2	-0.2

$$\Theta_2 = (-1.5, -1.5, -1.5, -1.5, 0.0, 0.0, -1.5, -1.5, -1.5, -1.5)$$

Mu	[1]	[2]	[3]	[4]	[5]
00	0.245	0.240	0.126	0.224	0.469
10	0.222	0.166	0.180	0.241	0.497
01	0.184	0.265	0.105	0.206	0.552
11	0.230	0.234	0.106	0.271	0.507

Pr (s)	[0]	[1]	[2]	[3]	[4]	[5]
00	0.090	0.550	0.329	0.031	0.000	0
10	0.085	0.555	0.328	0.031	0.000	0
01	0.081	0.558	0.329	0.032	0.000	0
11	0.076	0.536	0.351	0.036	0.001	0

