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Supplemental Materials for

Comparing approaches for modelling indirect contact transmission of infectious diseases

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Explanation of Model Parameters

Transfer Efficiencies

Lognormal distribution fits reported by Julian et al.[1] for transfer efficiencies for MS2 were used to inform transfer efficiencies for hand-to-fomite contacts in this study. Transfer efficiencies for MS2 have been demonstrated to be similar in either direction (fomite-to-finger or finger-to-fomite) for unwashed hand conditions.[1] Therefore, the same distribution was used for describing transfer in either direction. However, two transfer efficiencies were sampled per iteration, one representing transfer in either direction, allowing for small differences in transfer in either direction.

Transfer efficiencies for hand-to-mouth contacts were informed by viral hand-to-mouth transfer efficiencies measured by Rusin et al.[2], where the standard deviation of the distribution was informed by the standard deviation of transfer efficiencies obtained from the original data set.

Fraction of the Hand Used for Contacts

For hand-to-fomite contacts, it was assumed as little as a fingertip all the way up to a "full front palm with fingers" configuration could be used. To estimate the fraction of total hand surface area used for a fingertip, the minimum fraction of the "front partial fingers" configuration measured by AuYeung et al.[3] was divided by 5 to estimate the fraction of total hand surface area for a single fingertip touch. This value was used to inform the minimum of a uniform distribution, while the maximum was informed by the maximum fraction of total hand surface area for the "full front palm with fingers" configuration.[3]

For hand-to-mouth contacts, it was assumed a single fingertip would be used. The minimum and maximum fractions of total hand surface area for the "front partial fingers" configuration for adults measured by AuYeung et al. were divided by 5 to inform the minimum and maximum for a uniform distribution.[3]

Hand Hygiene Efficacy

The distribution used to represent hand hygiene efficacy was informed by reductions of norovirus measured for 30-second applications of ethanol-based hand sanitizers.[4] The maximum $\log_{10}$ reduction was used to inform the right-truncation point.[4]

Inactivation Rates

Boone & Gerba state that, "four out of five enteric viruses," in their review had "inactivation coefficients between 0.0021 and 0.0059 $\log_{10}$/h."[5]

$$C_t = C_0 e^{-k\Delta t}$$

The first order decay equation was used to calculate k based on a Δt of 1 hour for a $\frac{C_t}{C_0}$ ratio of $10^{0.021}$ or $10^{0.0059}$. The k values calculated were then used to inform a minimum and maximum for a uniform distribution for inactivation of enteric virus on fomites.

For inactivation on hands, data from Ansari et al.[6] was utilized, where they report reductions of "57, 42.6, and 7.1%" in virus on hand after 20, 60, and 260 minutes. This was used to calculate 3 inactivation constants. The minimum and maximum inactivation constants of these three time points were used to inform the minimum and maximum of a uniform distribution for inactivation rates of virus on hands in this study.

For transfer from hands to inactivation as a function of hand hygiene as opposed to natural decay, the rate was calculated based on an expected $\log_{10}$ efficacy per hand wash multiplied by the frequency of hand washes per time. If hand washing was treated as a specific event, then the rate of transfer during this event did not involve the frequency of hand washing but was merely for a single event (Markov models 1 and 3). The moments at which these hand hygiene events occurred for these models were at 5, 10, 15, and 20 minutes to be consistent with the timing of these events in the discrete event models.

Hand-to-Mouth Contact Frequency

For non-eating activities, Wilson et al.[7] reported a mean frequency of hand-to-mouth contacts for adults of 2.9 touches per hour. We used this rate to estimate 1 touch per 20 min.

Transitional Probability Examples*

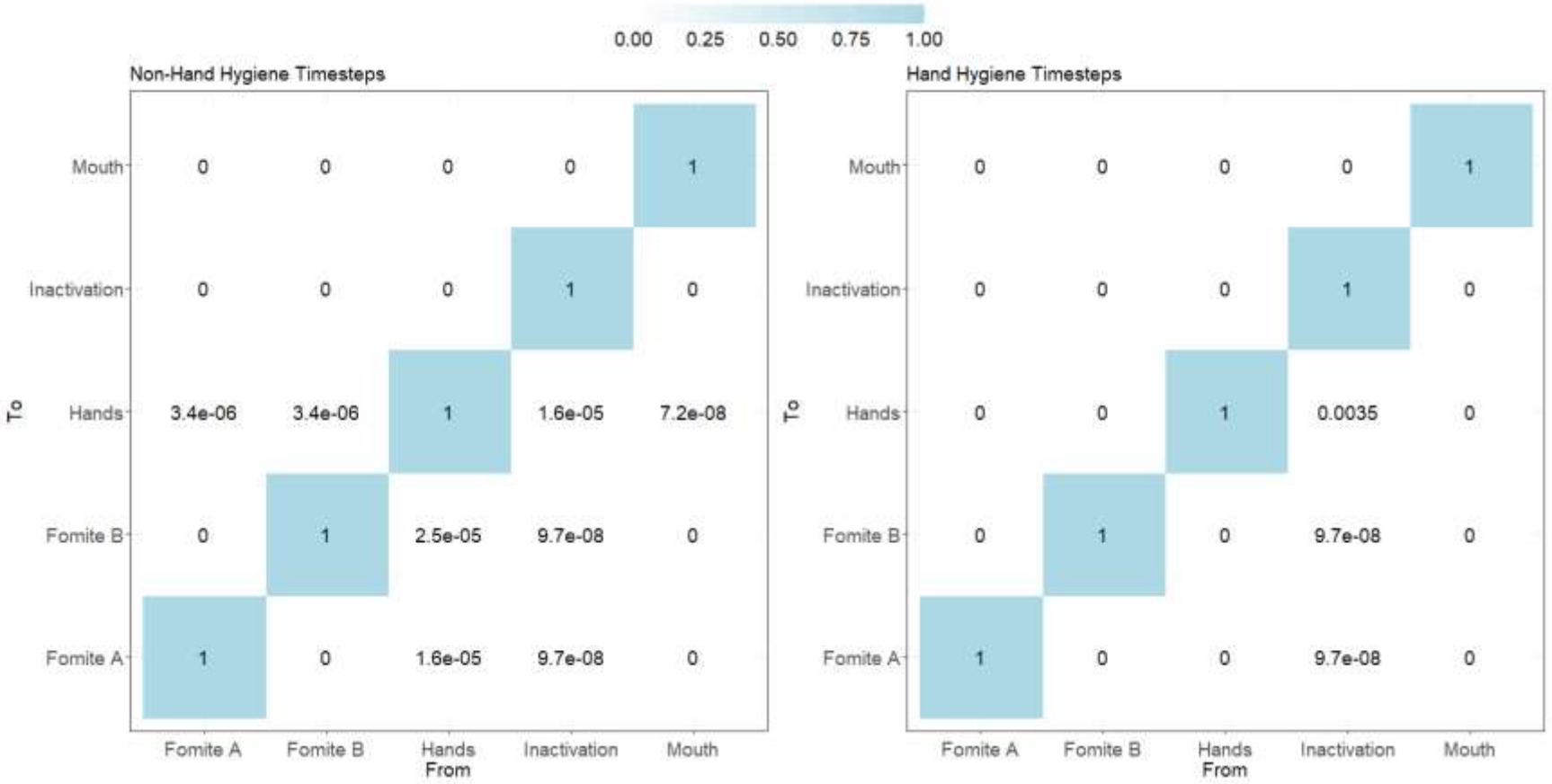

Figure S1. Example of transitional probabilities for a timestep of 0.001 min for Markov Model 1*

*2 significant figures, so large probabilities represented as 1

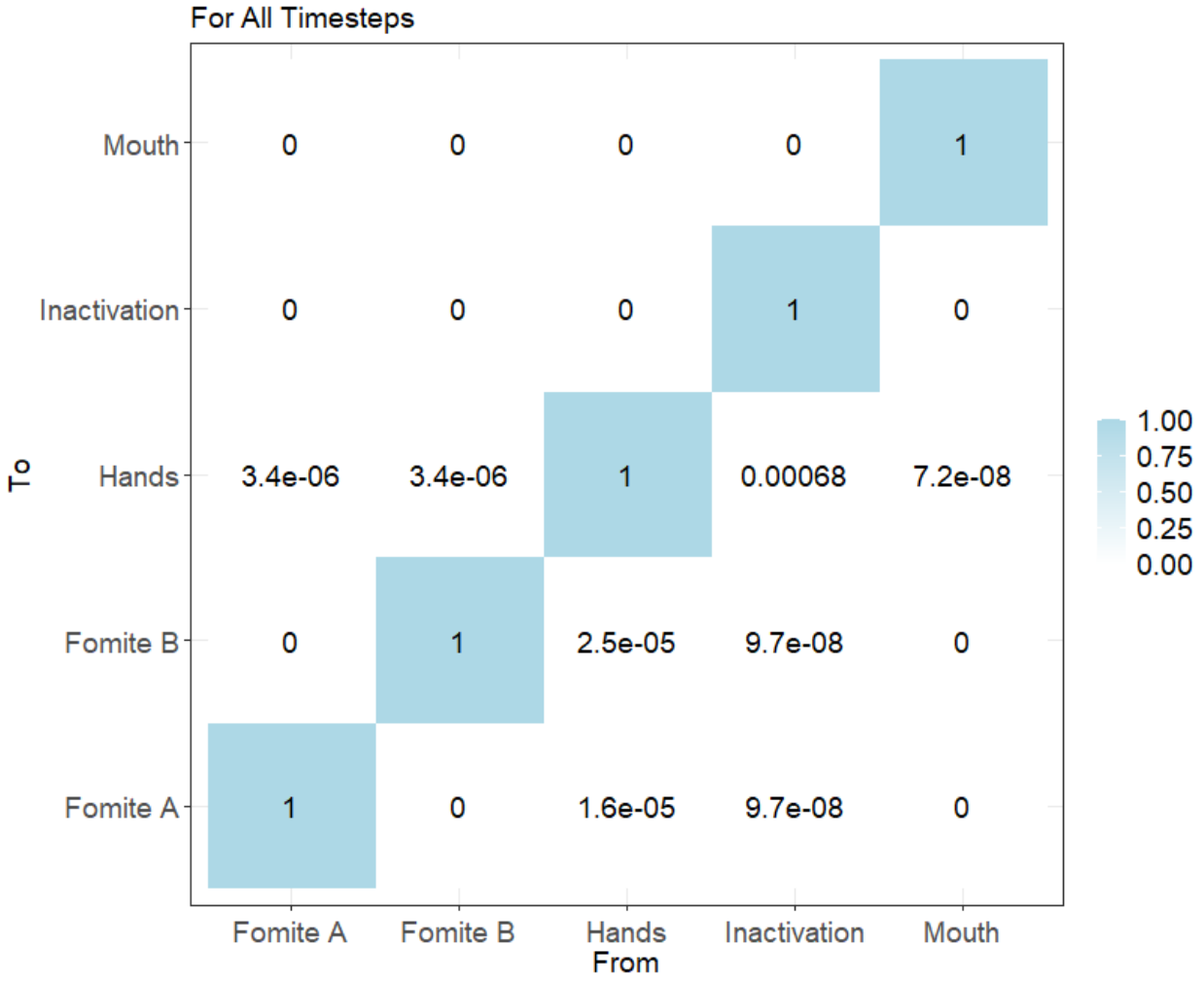

Figure S2. Example of transitional probability matrix for a timestep of 0.001 min for Markov Model 2*

*2 significant figures, so large probabilities represented as 1

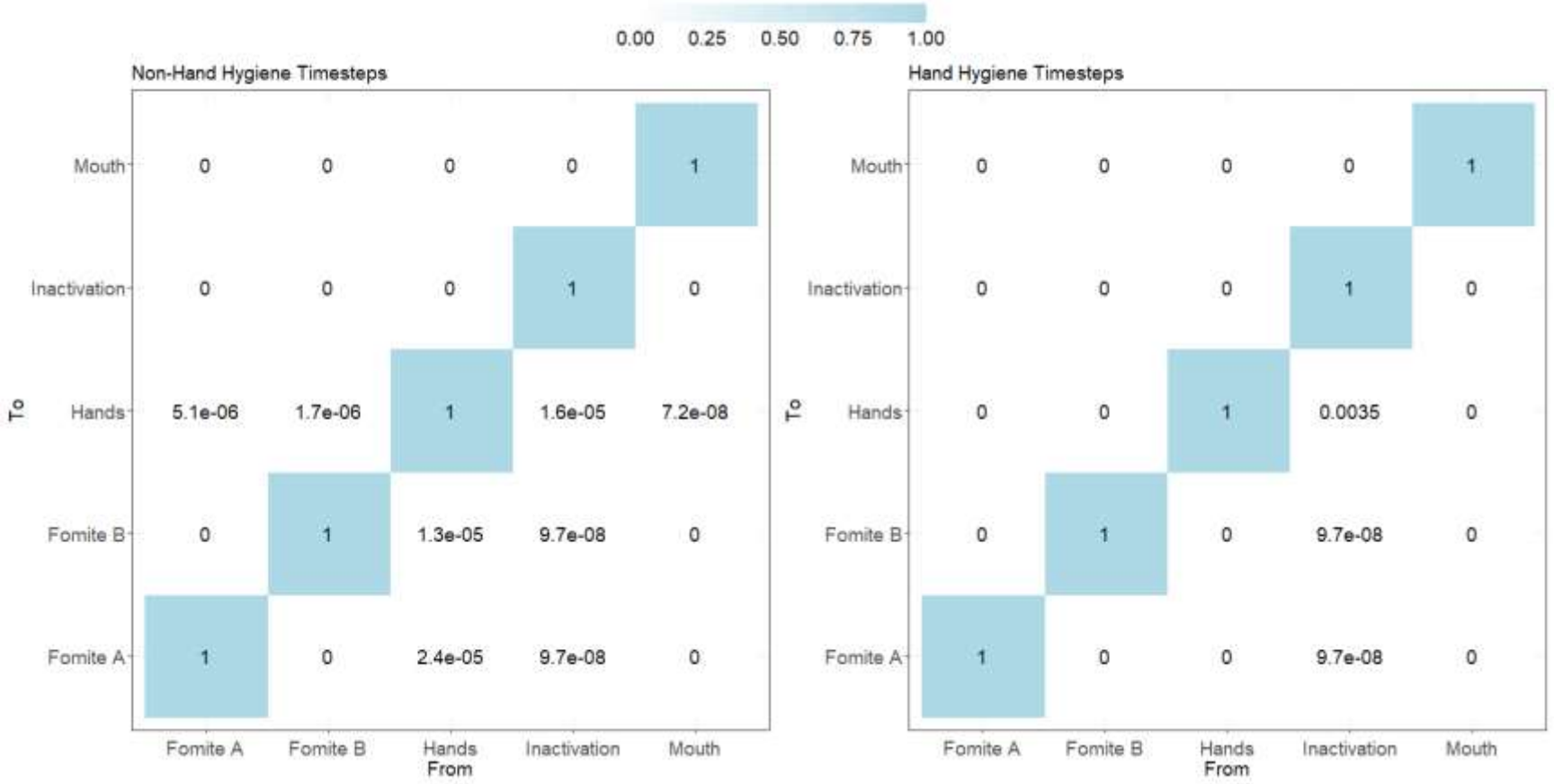

Figure S3. Example of transitional probability matrix for a timestep of 0.001 min for Markov Model 3*

*2 significant figures, so large probabilities represented as 1

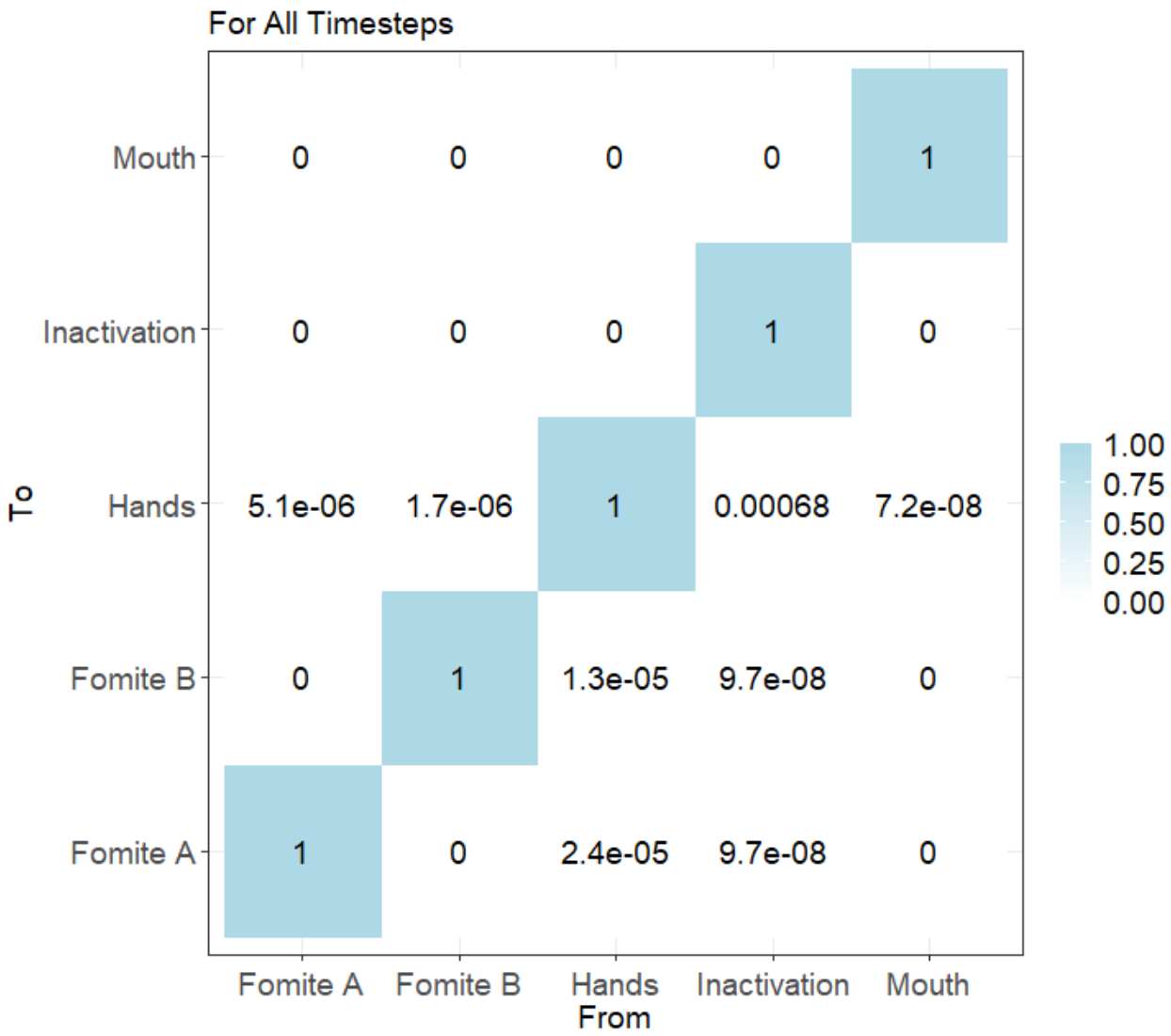

Figure S4. Example of transitional probability matrix for a timestep of 0.001 min for Markov Model 4*

*2 significant figures, so large probabilities represented as 1

Summary Statistics

Table S1. Summary statistics of estimated doses per model framework and scenario*

Model Type			Min, Max	Median (IQR)	Mean (SD)
Markov Chain Model	Symmetrical contact frequency	1	2.0×10^{-6}, 1.7×10^{1}	6.6×10^{-1} (1.4×10^{0})	1.2×10^{0} (1.5×10^{0})
		2	1.0×10^{-6}, 2.1×10^{1}	6.3×10^{-1} (1.3×10^{0})	1.2×10^{0} (1.6×10^{0})
	Asymmetrical contact frequency	3	3.0×10^{-6}, 1.9×10^{1}	9.3×10^{-1} (1.9×10^{0})	1.6×10^{0} (1.8×10^{0})
		4	2.0×10^{-6}, 2.3×10^{1}	8.5×10^{-1} (1.7×10^{0})	1.5×10^{0} (1.9×10^{0})
Discrete Event Model	Symmetrical contact frequency	1	0.0×10^{0}, 5.2×10^{1}	5.5×10^{-1} (2.3×10^{0})	2.0×10^{0} (3.8×10^{0})
		2	0.0×10^{0}, 5.6×10^{1}	3.9×10^{-1} (1.6×10^{0})	1.8×10^{0} (4.1×10^{0})
	Asymmetrical contact frequency	3	0.0×10^{0}, 5.0×10^{1}	6.6×10^{-1} (2.4×10^{0})	2.2×10^{0} (4.1×10^{0})
		4	0.0×10^{0}, 7.1×10^{1}	8.6×10^{-1} (2.8×10^{0})	2.4×10^{0} (4.4×10^{0})

*n=5,000 per model type (20,000 runs for Markov chain model total; 20,000 runs for discrete event model, total)

Sensitivity Analysis Plots

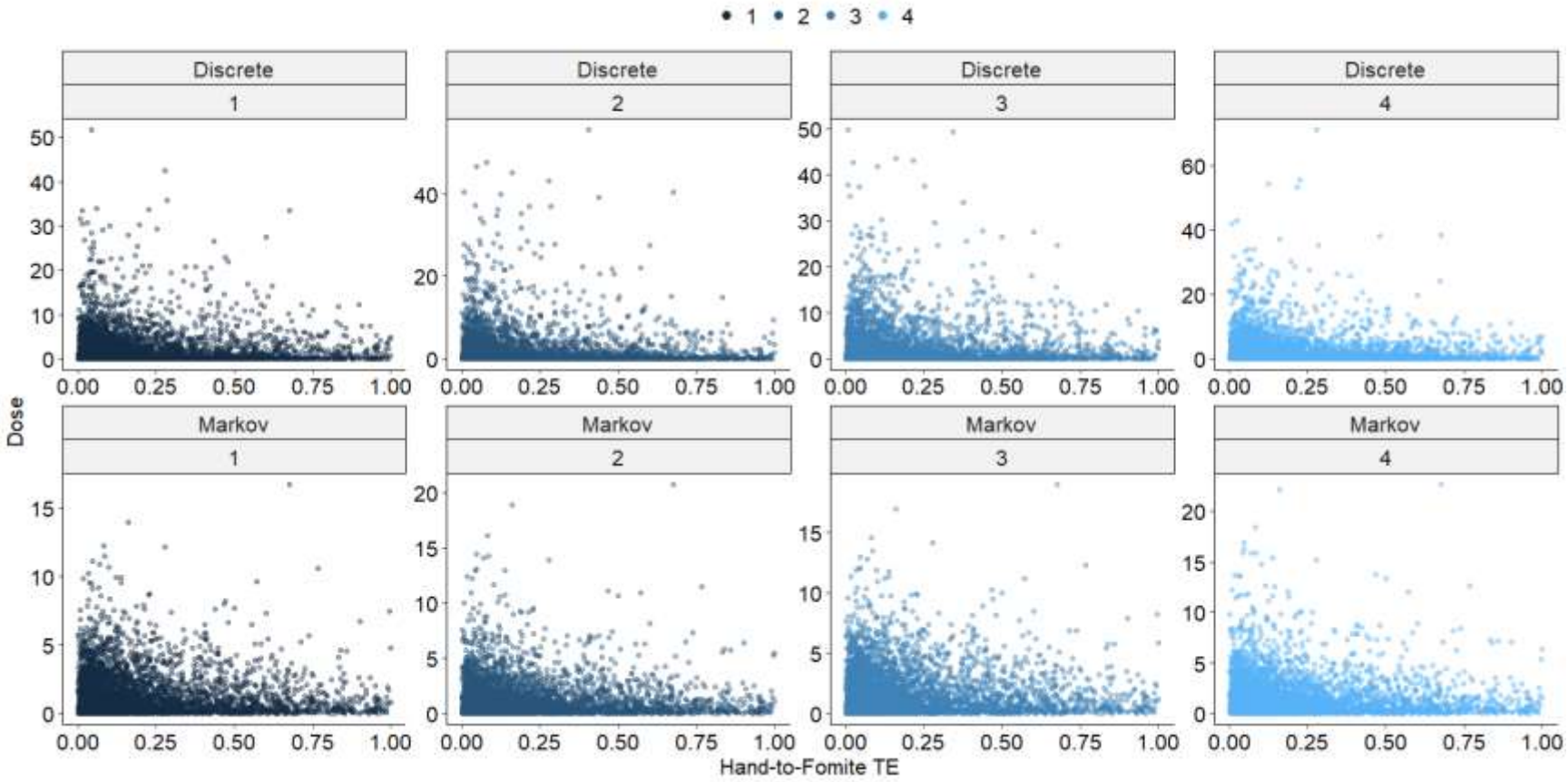

Figure S5. Dose (number of viral particles) vs. hand-to-fomite transfer efficiency for all model frameworks and scenarios

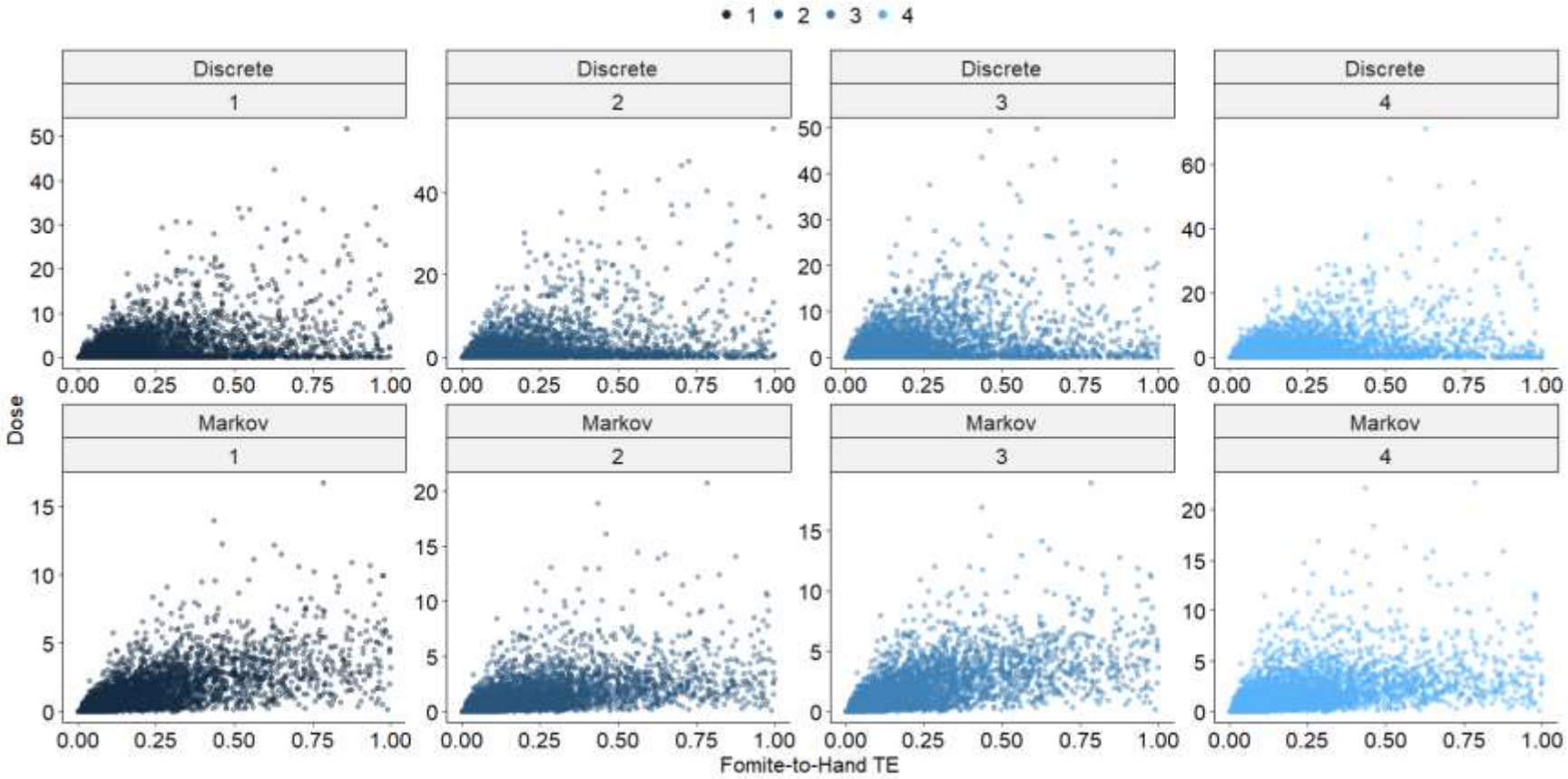

Figure S6. Dose (number of viral particles) vs. fomite-to-hand transfer efficiency for all model frameworks and scenarios

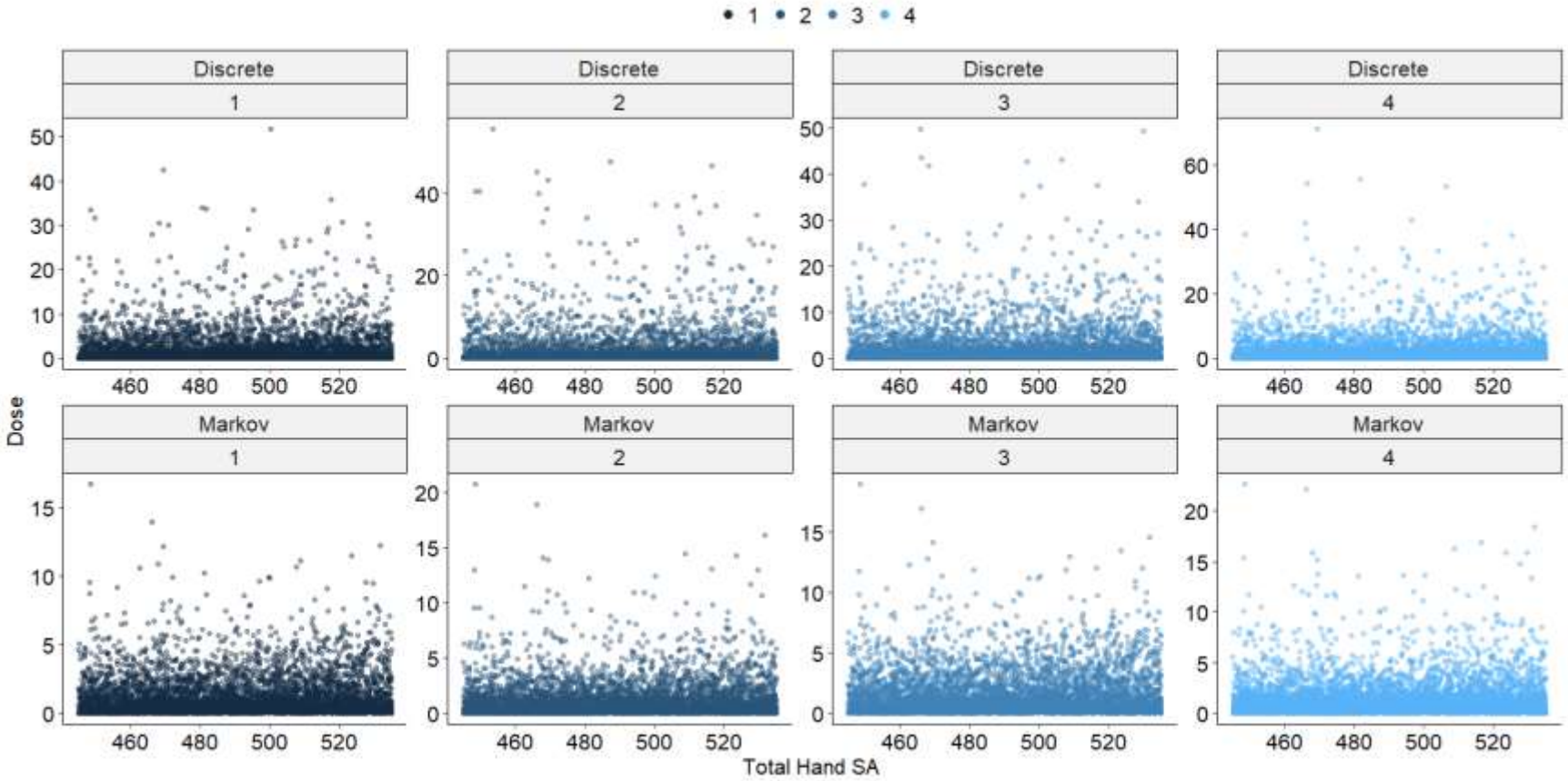

Figure S7. Dose (number of viral particles) vs. single total hand surface area (cm^2) for all model frameworks and scenarios

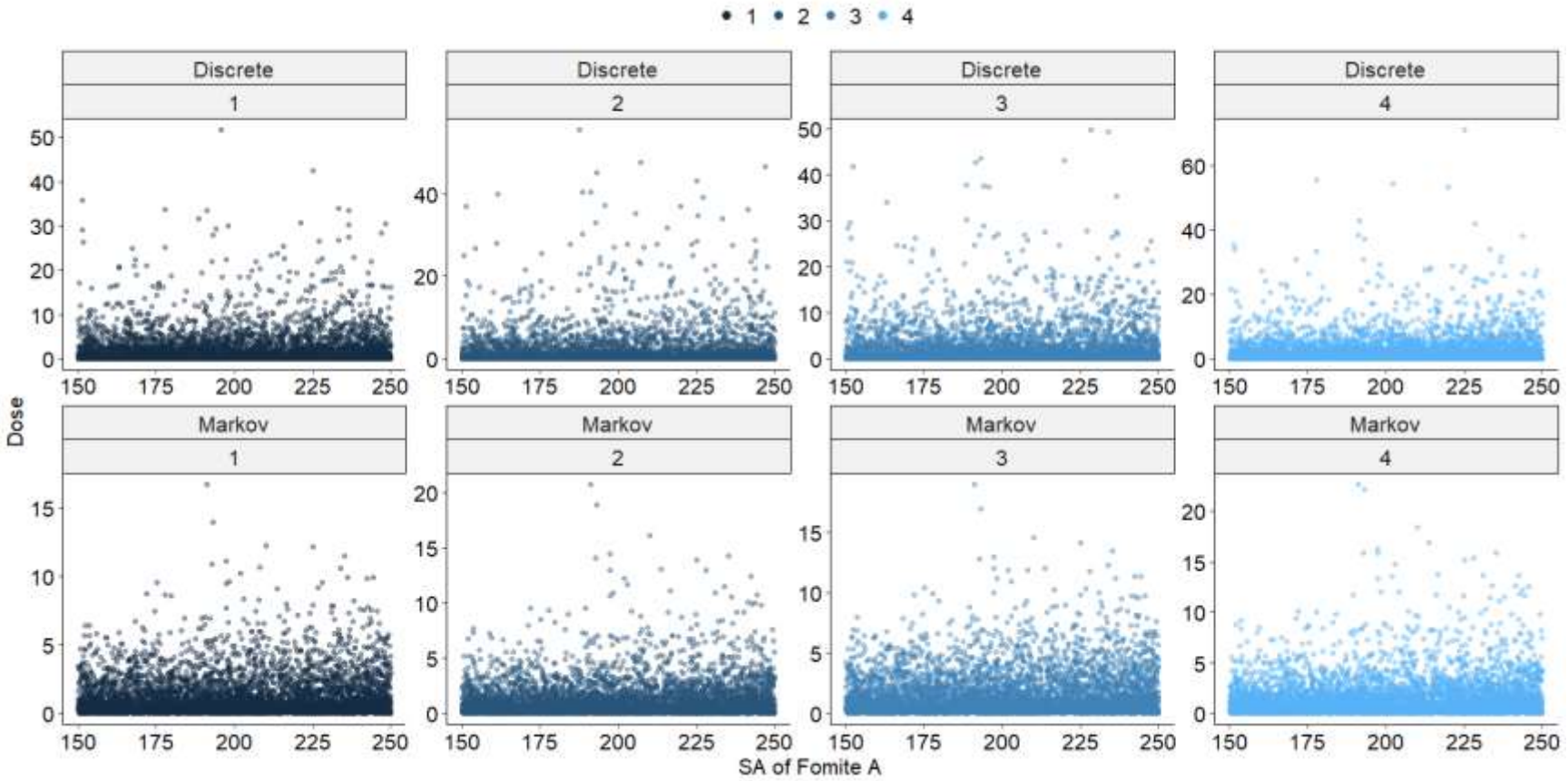

Figure S8. Dose (number of viral particles) vs. surface area for fomite A (cm^2) for all model frameworks and scenarios

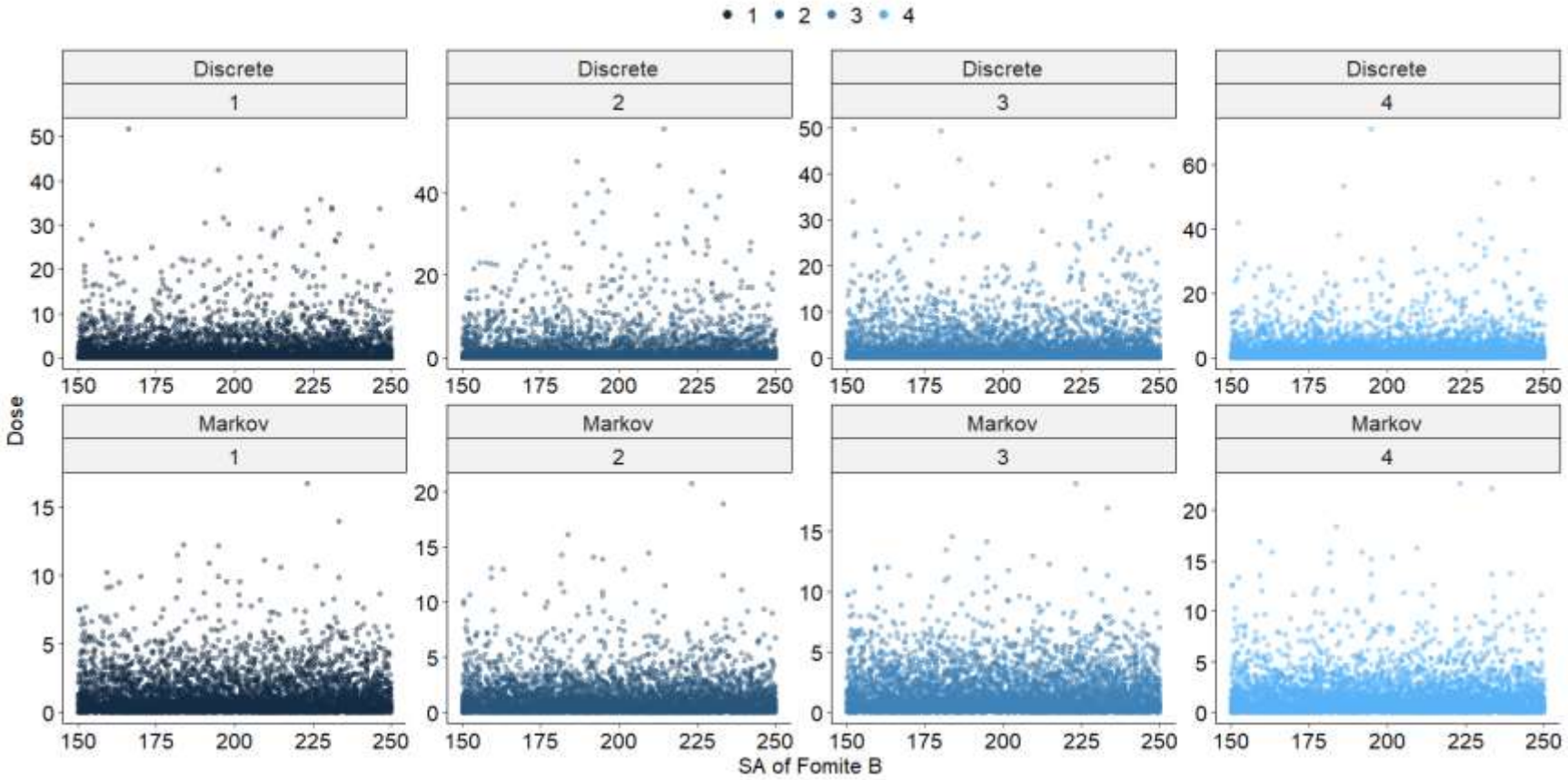

Figure S9. Dose (number of viral particles) vs. surface area for fomite B (cm^2) for all model frameworks and scenarios

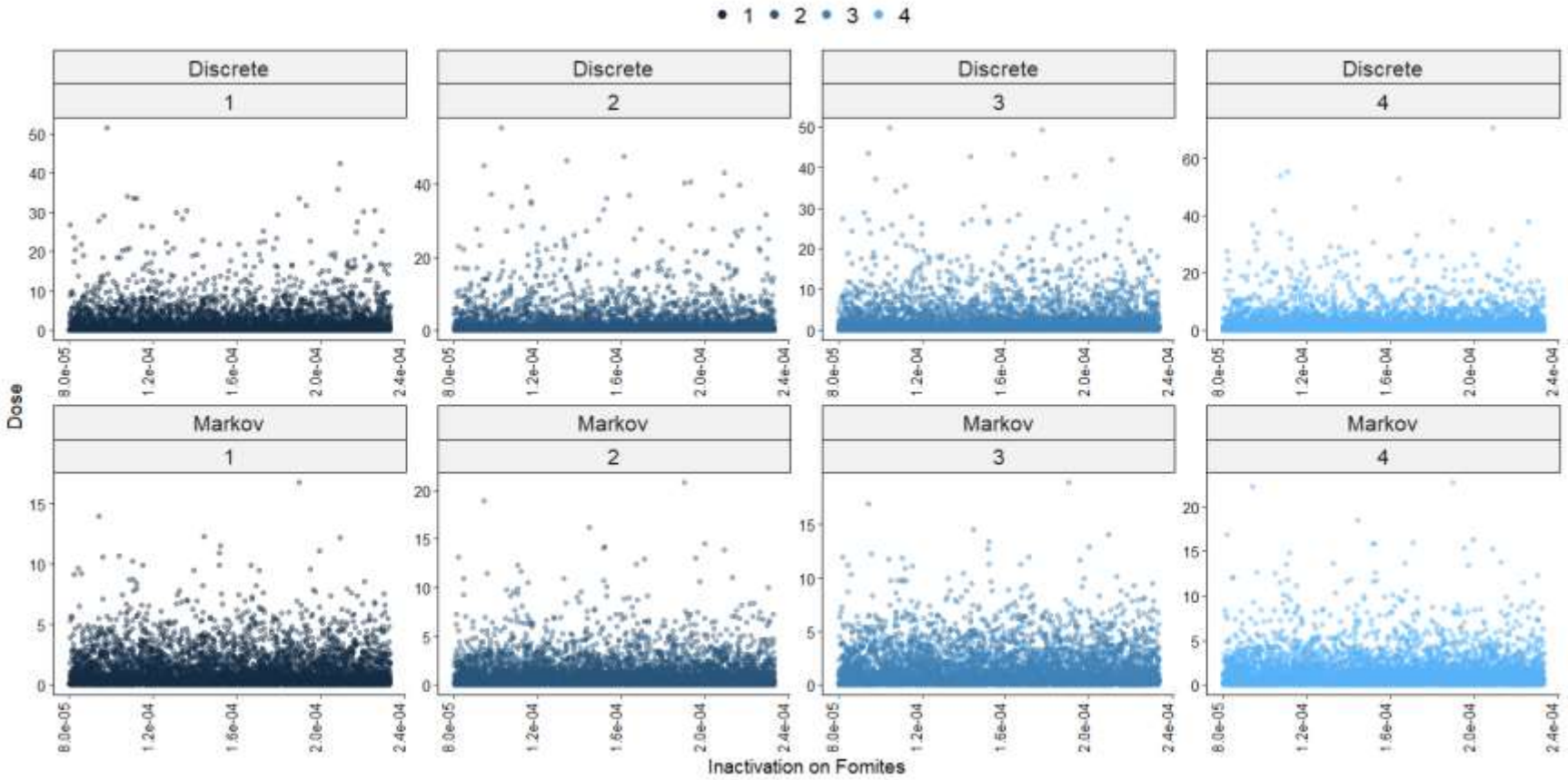

Figure S10. Dose (number of viral particles) vs. inactivation rate on fomites (min^{-1}) for all model frameworks and scenarios

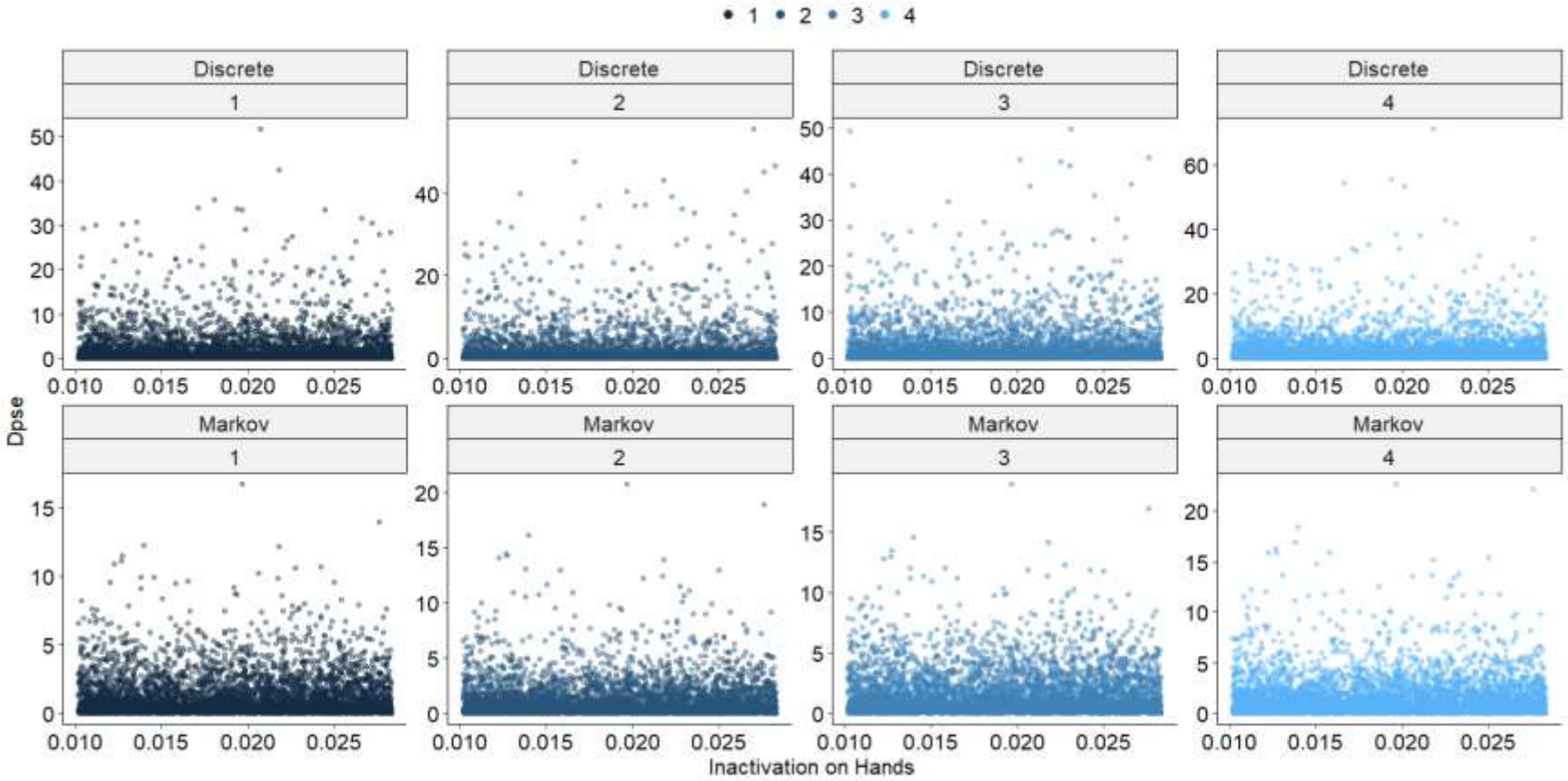

Figure S11. Dose (number of viral particles) vs. inactivation rate on hands (min^{-1}) for all model frameworks and scenarios

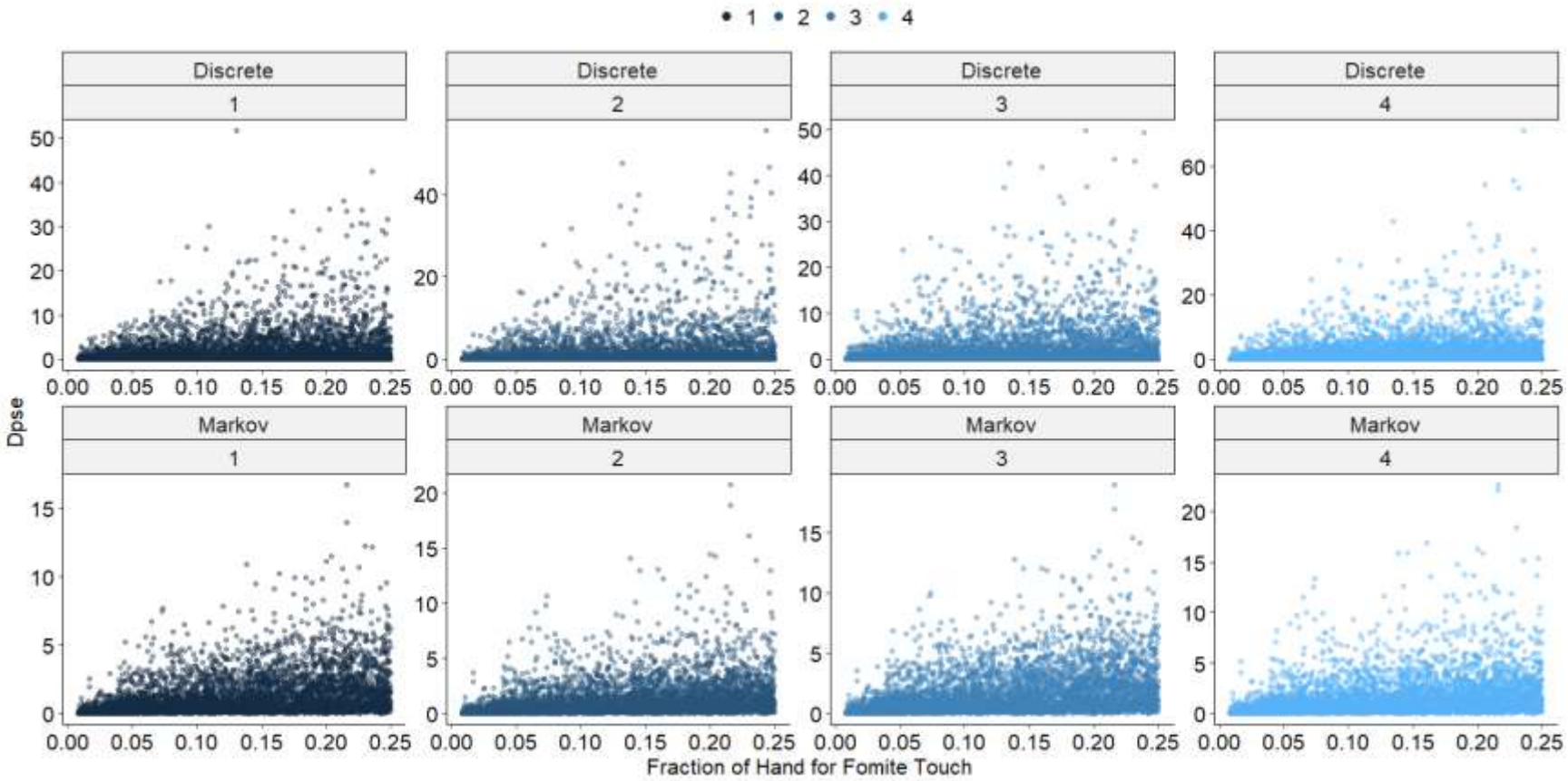

Figure S12. Dose (number of viral particles) vs. fraction of the hand used for a fomite contact for all model frameworks and scenarios

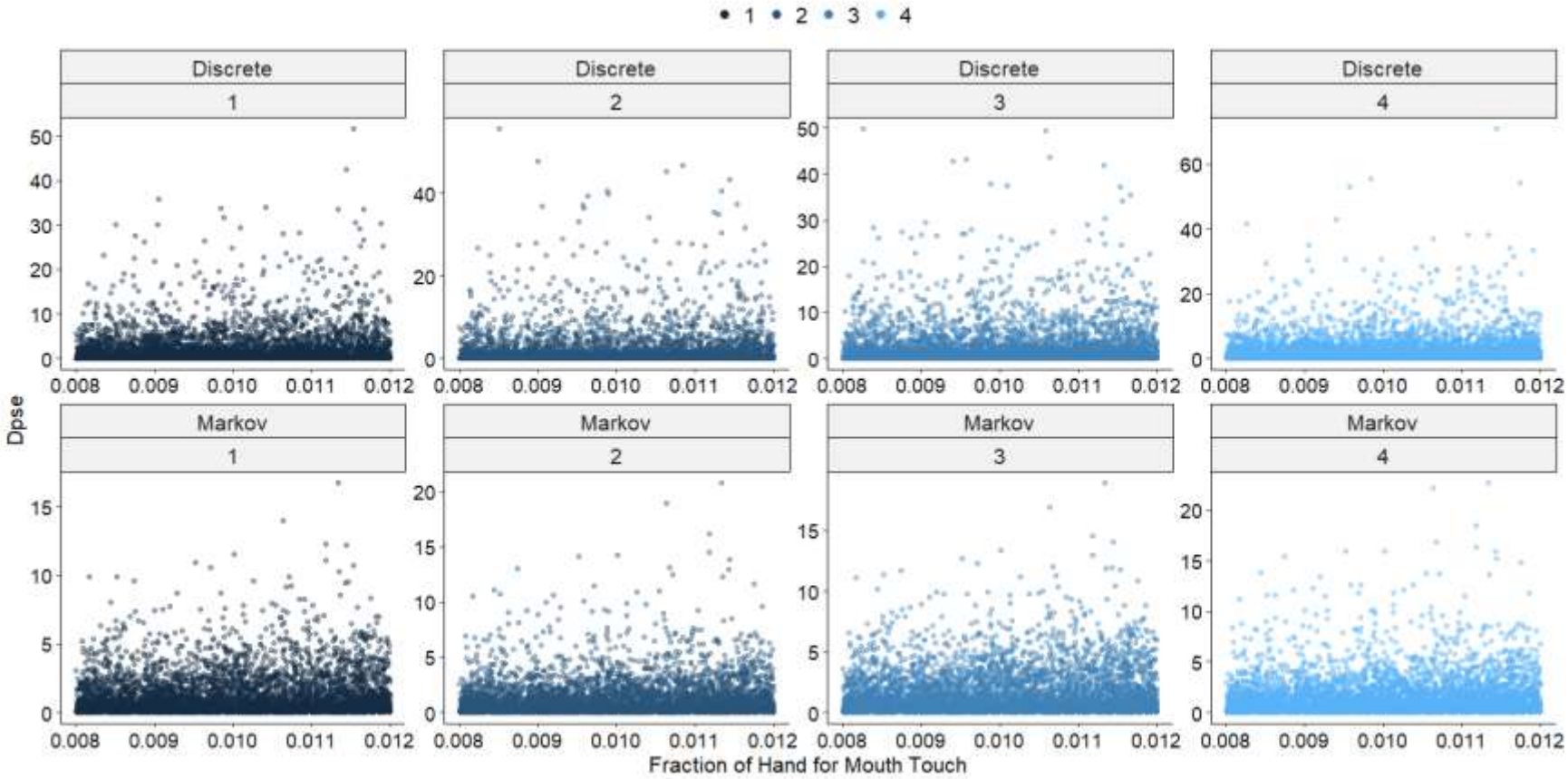

Figure S13. Dose (number of viral particles) vs. fraction of the hand used for a mouth contact for all model frameworks and scenarios

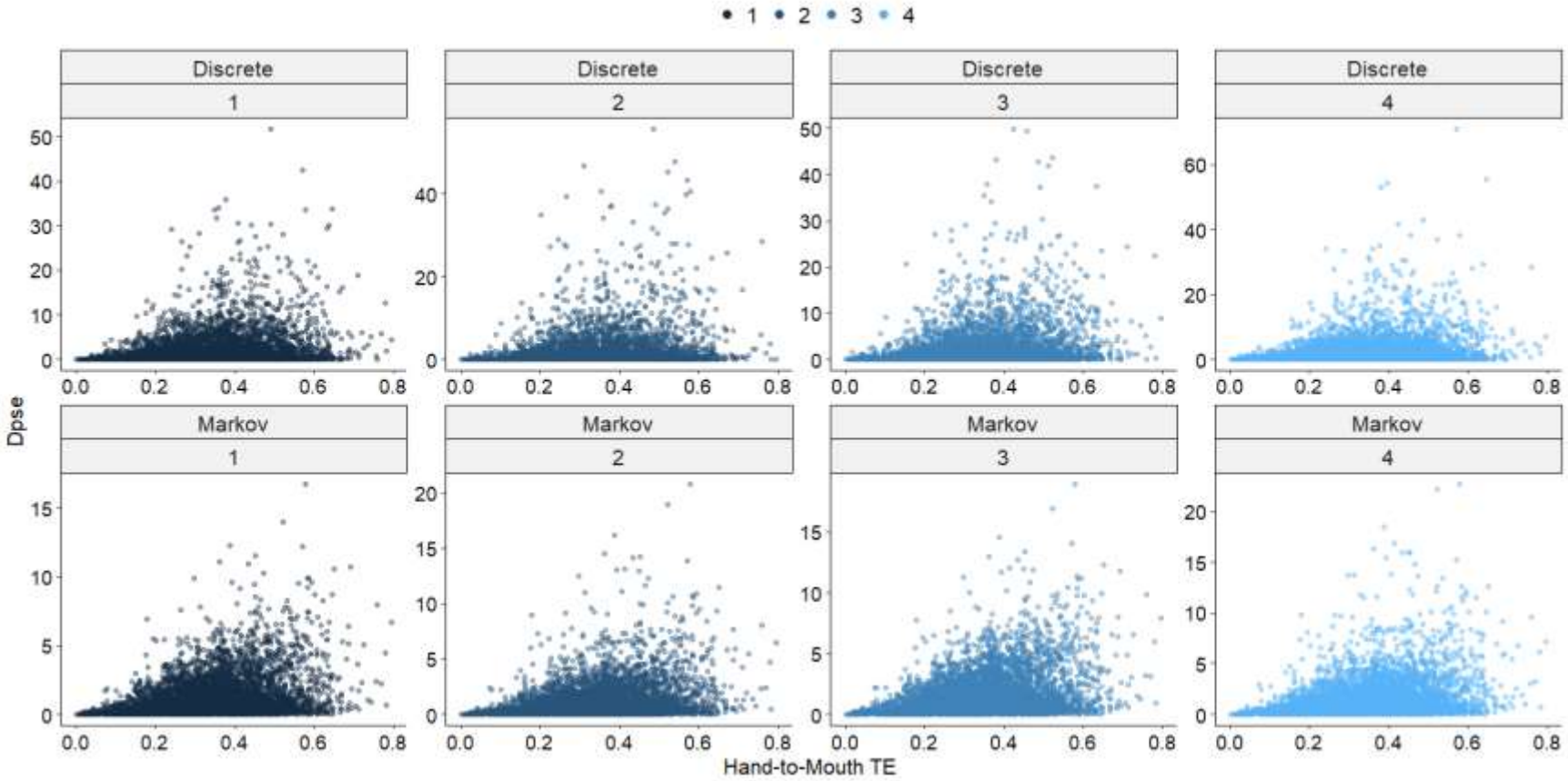

Figure S14. Dose (number of viral particles) vs. hand-to-mouth transfer efficiency for all model frameworks and scenarios

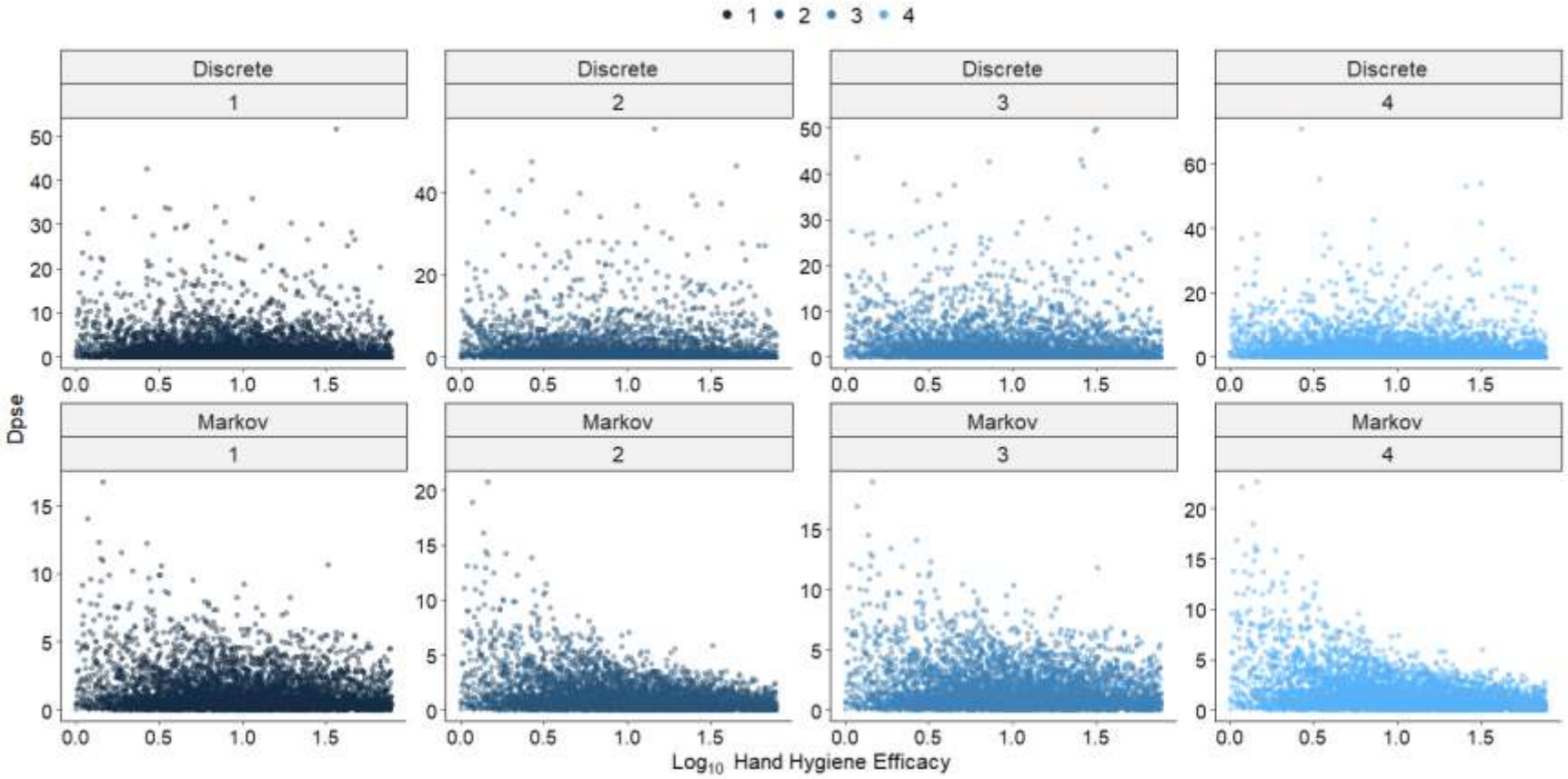

Figure S15. Dose (number of viral particles) vs. hand hygiene efficacy for all model frameworks and scenarios

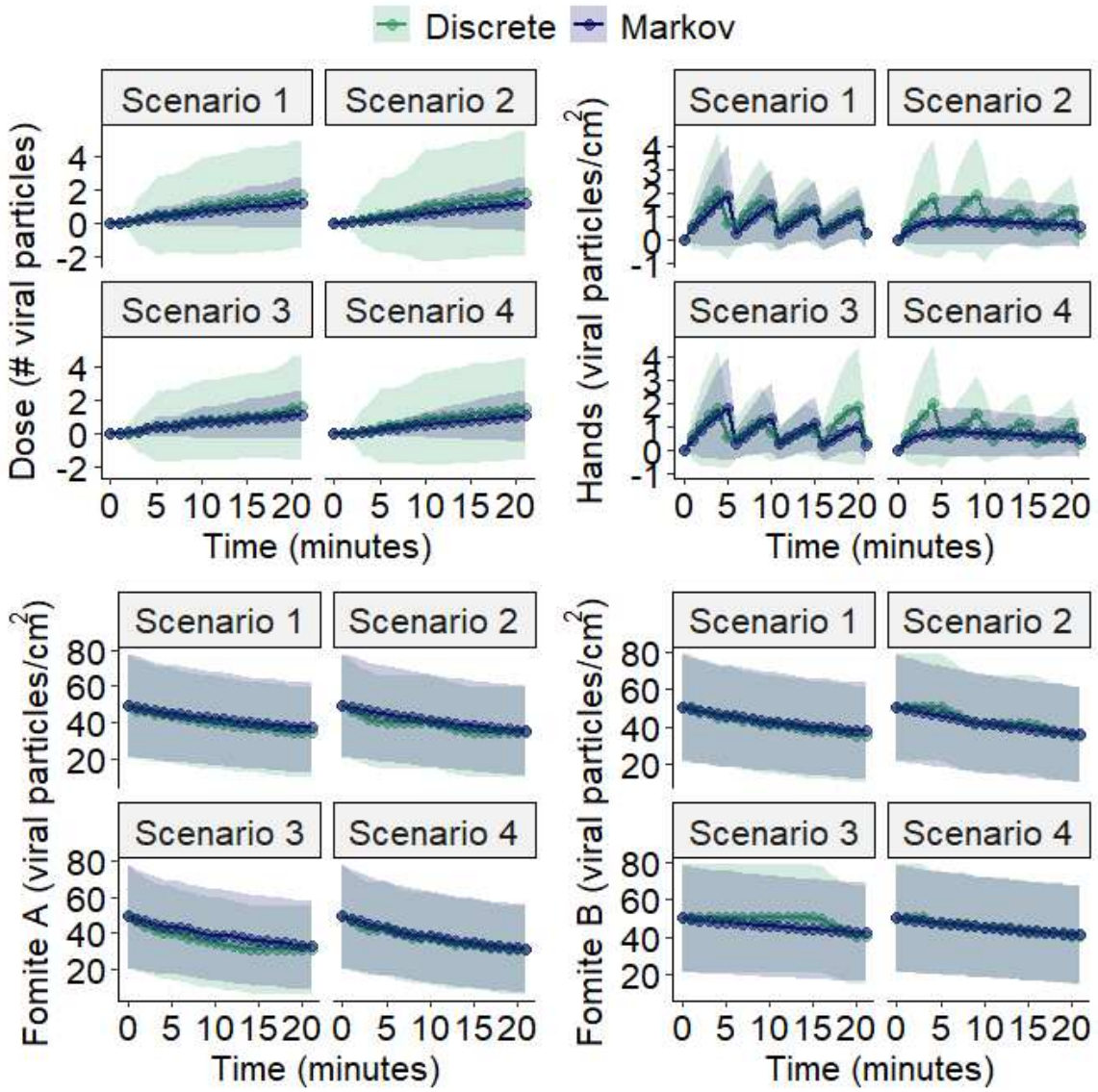

Figure S16. Mean ± SD of dose (number of viral particles) and viral concentrations on hands, fomite A, and fomite B (viral particles/cm2) over time when concentrations on fomites A and B ranged from 0 to 100 viral particles/cm^2

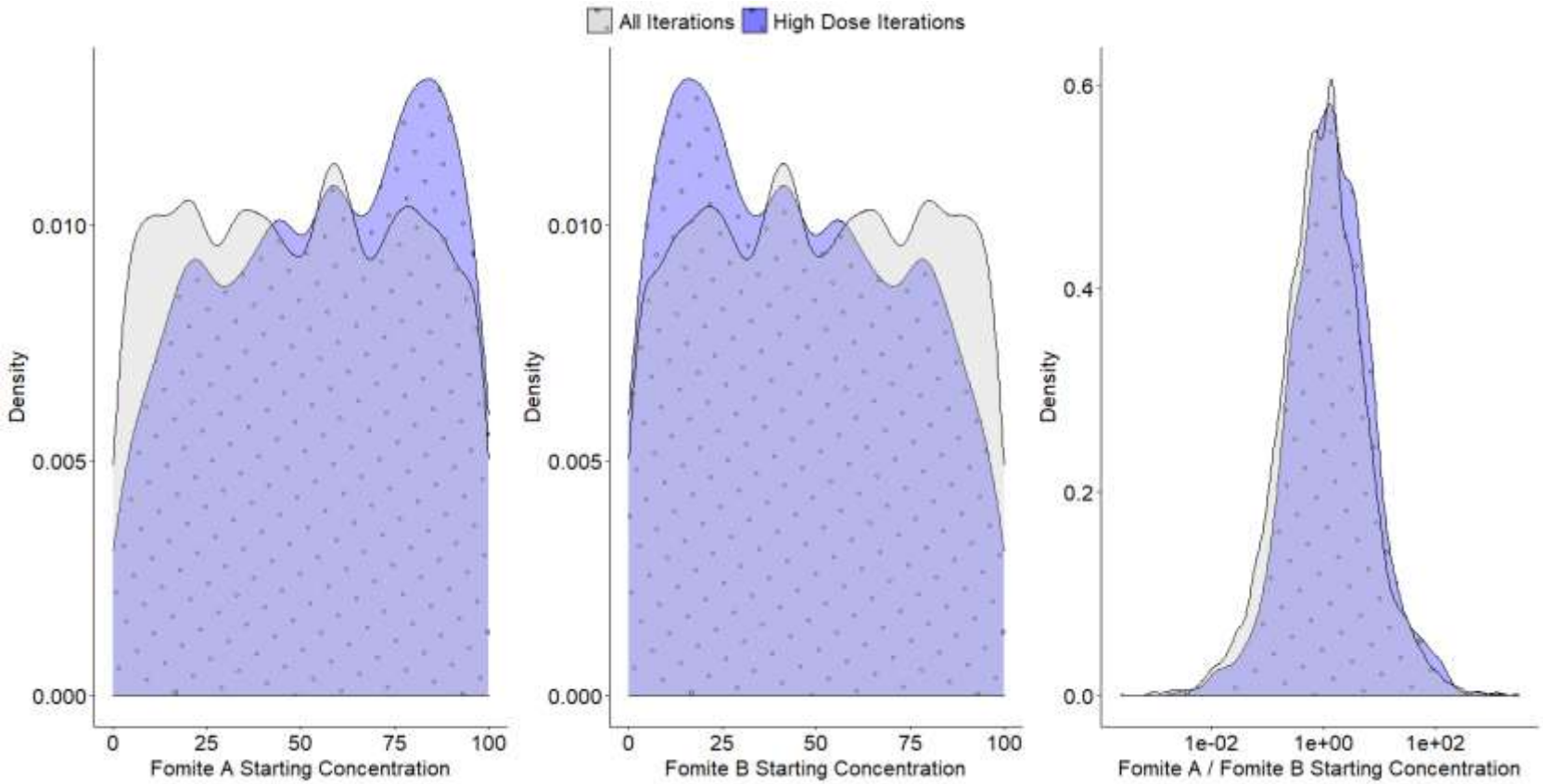

Figure S17. Comparing density plots of starting concentrations on fomites A and B and the ratio of their starting concentrations for all iterations vs. the iterations with the 15% highest estimated doses in sensitivity analysis models

References

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