Simulation Result Analysis

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Coverage Probability

Full Model

The coverage probabilities for estimates of the interaction effect all achieved at least 92%. Probabilities from simulated data with dropouts are one percent lower than the results based on the full data, but these probabilities were improved to around 94% (similar to the results of the full data without adjusting for SEs) after adjusting for standard errors.

Table 1: True Parameter Coverage Rate from Full Model with 1000 Simulations

	Unadjusted Standard Error							Adjusted Standard Error						
	Intercept	BAV	Visit	Age	Male	BSA	BAV:Visit	Intercept	BAV	Visit	Age	Male	BSA	BAV:Visit
Without Drop out														
Independent	0.921	0.939	0.941	0.917	0.921	0.918	**0.943**	0.934	0.948	0.950	0.929	0.939	0.927	**0.952**
Exchangeable	0.919	0.939	0.940	0.923	0.924	0.917	**0.942**	0.937	0.949	0.950	0.928	0.940	0.930	**0.950**
AR1	0.920	0.936	0.940	0.924	0.922	0.917	**0.941**	0.935	0.950	0.951	0.933	0.936	0.931	**0.951**
With Drop outs														
Independent	0.903	0.929	0.933	0.914	0.924	0.916	**0.929**	0.918	0.944	0.948	0.922	0.942	0.928	**0.943**
Exchangeable	0.904	0.931	0.935	0.910	0.925	0.914	**0.929**	0.918	0.944	0.946	0.922	0.939	0.932	**0.939**
AR1	0.899	0.929	0.936	0.914	0.926	0.915	**0.927**	0.916	0.945	0.948	0.923	0.937	0.929	**0.940**

Reduced Model

There is no significant difference in coverage probabilities between results from the full data and results from data with dropouts.

Table 2: True Parameter Coverage Rate from Reduced Model with 1000 Simulations

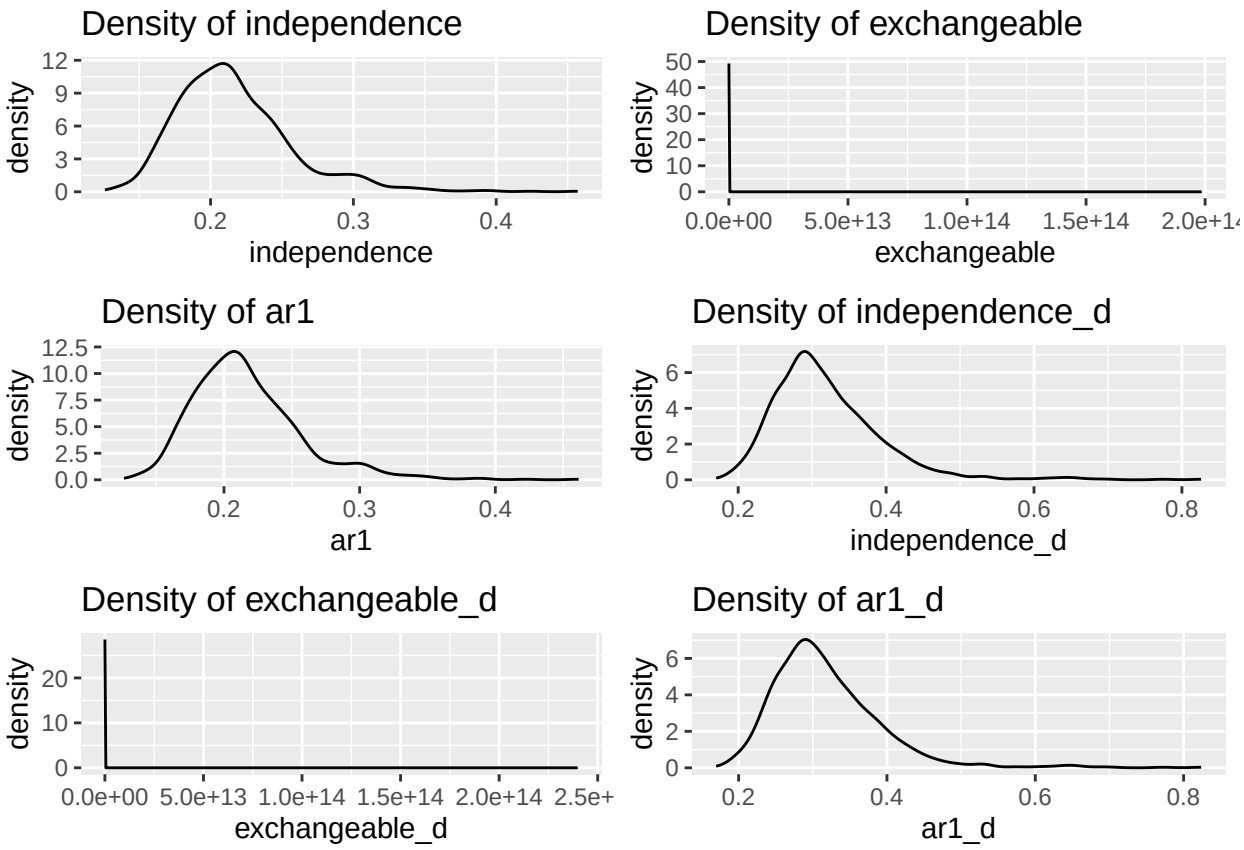
	Unadjusted Standard Error				Adjusted Standard Error			
	Intercept	BAV	Visit	BAV:Visit	Intercept	BAV	Visit	BAV:Visit
Without Drop out								
Independent	0.750	0.879	0.918	**0.943**	0.763	0.891	0.926	**0.951**
Exchangeable	0.750	0.879	0.919	**0.944**	0.763	0.896	0.926	**0.951**
AR1	0.756	0.875	0.917	**0.944**	0.770	0.889	0.922	**0.950**
With Drop outs								
Independent	0.789	0.896	0.930	**0.941**	0.806	0.905	0.937	**0.947**
Exchangeable	0.787	0.897	0.930	**0.938**	0.797	0.908	0.934	**0.946**
AR1	0.790	0.896	0.932	**0.947**	0.804	0.908	0.937	**0.953**

Check Convergence

Visualize the distribution standard errors

Titles with `_d` followed the correlation structure name indicates that dropout data.

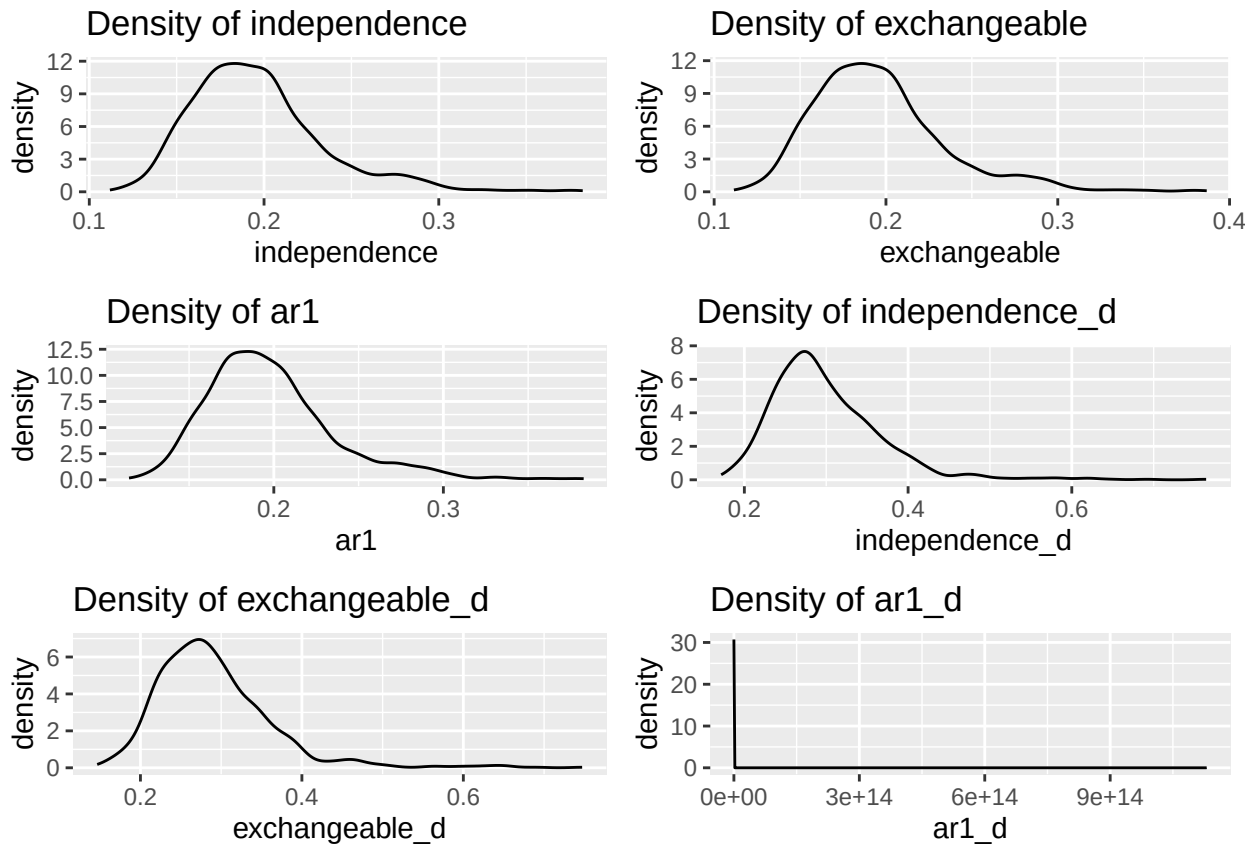
Full Model



The density plot suggests that

1. Non-convergence occurred in exchangeable correlation structure for both full data and with dropouts.
2. Standard errors are distributed from 0 to 0.5.

Reduced Model



The density plot suggests that
1. Non-convergence occurred in AR1 correlation structure for data with dropouts.
2. Standard errors are distributed from 0 to 0.5.

Convergence Selection

```
## $independence
## integer(0)
##
## $exchangeable
## [1] 732
##
## $ar1
## integer(0)
##
## $independence_d
## integer(0)
##
## $exchangeable_d
## [1] 869
##
## $ar1_d
## integer(0)
```

One non-converged simulation was detected in GEE fit with Exchangeable correlation structure from both full data and dropout data.

```
## $independence
## integer(0)
##
## $exchangeable
## integer(0)
##
## $ar1
## integer(0)
##
## $independence_d
## integer(0)
##
## $exchangeable_d
## integer(0)
##
## $ar1_d
## [1] 201
```

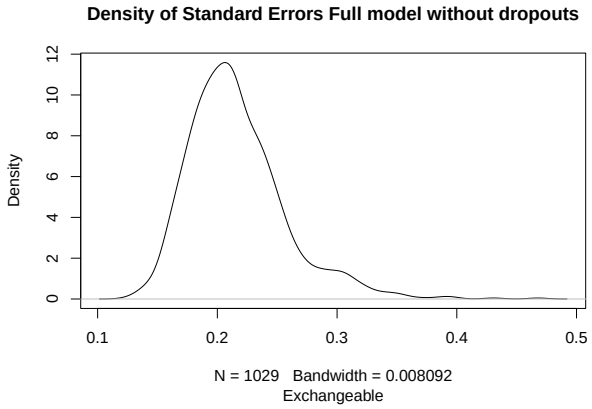
One non-converged simulation was detected in GEE fit with AR1 correlation from data with dropouts.

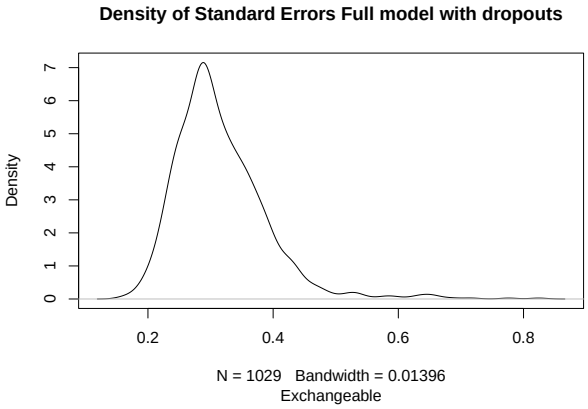
Remove non-converged simulations and check the standard error distributions.

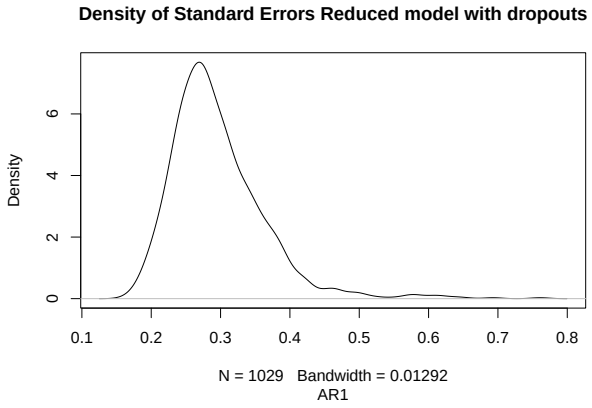
```
corrstr <- c("Independent", "Exchangeable", "AR1")
for (i in 1:6) {
  # Adjusted for Control Covariates
  if(length(bad_full[[i]]) != 0){
    if(i > 3){
      cor_idx <- i-3
      fullmod_resdo[[cor_idx]] <- lapply(fullmod_resdo[[cor_idx]],
                                         function(x) x[-bad_full[[i]], ])
      se <- density(fullmod_resdo[[cor_idx]]$SE[,7])
      plot(se,main="Density of Standard Errors Full model with dropouts",
           sub = corrstr[cor_idx])
      } else{
      fullmod_res[[i]] <- lapply(fullmod_res[[i]], function(x) x[-bad_full[[i]],])
      se <- density(fullmod_res[[i]]$SE[,7])
      plot(se, main="Density of Standard Errors Full model without dropouts",
           sub = corrstr[i])
    }
  }

  # Unadjusted for Control Covariates
  if(length(bad_red[[i]]) != 0){
    if(i > 3){
      cor_idx <- i-3
      redmod_resdo[[cor_idx]] <- lapply(redmod_resdo[[cor_idx]],
                                         function(x) x[-bad_red[[i]], ])
      se <- density(redmod_resdo[[cor_idx]]$SE[,4])
      plot(se,main="Density of Standard Errors Reduced model with dropouts",
           sub = corrstr[cor_idx])
      } else{
```

```
      redmod_res[[i]] <- lapply(redmod_res[[i]], function(x) x[-bad_full[[i]],])
      se <- density(redmod_res[[i]]$SE[,4])
      plot(se,main="Density of Standard Errors Reduced model without dropouts",
           sub = corrstr[i])
    }
  }
}
```







The standard error plots suggests that non-converged simulations are all removed.

Estimation Results

Adjusted for Control Covariates

Without Dropouts

Table 3: Estimation Results for Full Model without dropout from 1000 Simulations

	Intercept	BAV	Visit	Age	Male	BSA	BAV:Visit
True Value	-3.815	-1.938	0.114	-0.036	1.196	1.955	**0.345**
Independent							
Mean Estimate	-3.846	-2.045	0.117	-0.037	1.240	1.967	**0.362**
SD(Estimate)	1.748	0.909	0.129	0.021	0.384	0.688	**0.231**
Mean Std. Error	1.546	0.838	0.125	0.018	0.353	0.616	**0.216**
SD(Std. Error)	0.310	0.174	0.021	0.004	0.051	0.127	**0.041**
Mean Bias	0.008	0.055	0.031	0.031	0.037	0.006	**0.050**
Mean MSE	3.054	0.837	0.017	0.000	0.149	0.473	**0.053**
Exchangeable							
Mean Estimate	-3.850	-2.044	0.118	-0.037	1.242	1.969	**0.362**
SD(Estimate)	1.742	0.909	0.129	0.020	0.383	0.687	**0.231**
Mean Std. Error	1.546	0.839	0.125	0.018	0.353	0.615	**0.216**
SD(Std. Error)	0.307	0.175	0.021	0.004	0.051	0.125	**0.041**
Mean Bias	0.009	0.055	0.033	0.032	0.038	0.007	**0.049**
Mean MSE	3.034	0.838	0.017	0.000	0.149	0.472	**0.053**
AR1							
Mean Estimate	-3.845	-2.046	0.118	-0.037	1.242	1.967	**0.363**
SD(Estimate)	1.753	0.913	0.130	0.020	0.384	0.690	**0.232**
Mean Std. Error	1.547	0.839	0.125	0.018	0.353	0.616	**0.216**
SD(Std. Error)	0.311	0.174	0.021	0.004	0.051	0.127	**0.040**
Mean Bias	0.008	0.056	0.032	0.033	0.038	0.006	**0.051**
Mean MSE	3.072	0.845	0.017	0.000	0.150	0.476	**0.054**

Observations:
1. Exchangeable and independent working correlation had the same estimate for the interaction effect.
2. Estimates for main effects of BAV and Visits are all similar across the three working correlations and similar to true values.
3. The mean bias and mean MSE are similar, around 0.05, regardless of working correlation structure.

With Dropouts

Table 4: Estimation Results for Full Model with Drop outs from 1000 Simulations

	Intercept	BAV	Visit	Age	Male	BSA	BAV:Visit
True Value	-3.815	-1.938	0.114	-0.036	1.196	1.955	**0.345**
Independent							
Mean Estimate	-3.911	-2.069	0.112	-0.038	1.260	2.019	**0.356**
SD(Estimate)	2.285	1.079	0.200	0.027	0.503	0.904	**0.348**
Mean Std. Error	1.946	0.971	0.186	0.023	0.450	0.784	**0.319**
SD(Std. Error)	0.429	0.230	0.041	0.005	0.080	0.179	**0.074**
Mean Bias	0.025	0.068	-0.018	0.063	0.054	0.033	**0.031**
Mean MSE	5.227	1.181	0.040	0.001	0.256	0.821	**0.121**
Exchangeable							
Mean Estimate	-3.917	-2.071	0.112	-0.038	1.259	2.021	**0.356**
SD(Estimate)	2.276	1.074	0.198	0.027	0.502	0.903	**0.346**
Mean Std. Error	1.946	0.967	0.184	0.023	0.449	0.783	**0.316**
SD(Std. Error)	0.427	0.230	0.041	0.005	0.079	0.178	**0.075**
Mean Bias	0.027	0.069	-0.020	0.061	0.053	0.034	**0.033**
Mean MSE	5.184	1.171	0.039	0.001	0.256	0.820	**0.119**
AR1							
Mean Estimate	-3.913	-2.071	0.112	-0.038	1.259	2.021	**0.356**
SD(Estimate)	2.290	1.081	0.199	0.027	0.502	0.904	**0.348**
Mean Std. Error	1.948	0.969	0.186	0.023	0.450	0.784	**0.318**
SD(Std. Error)	0.430	0.229	0.040	0.005	0.080	0.179	**0.074**
Mean Bias	0.026	0.068	-0.013	0.064	0.053	0.034	**0.033**
Mean MSE	5.247	1.186	0.040	0.001	0.255	0.820	**0.121**

Observations:

1. Exchangeable working correlation provided the closest estimates for all coefficients.
2. Estimates are similar between independent and AR1 working correlations for all coefficients.
3. Mean biases and mean MSEs are similar, at around 0.03 and 0.120, respectively.

Without Adjusting for Control Covariates

Without Dropouts

Table 5: Estimate Results for Reduced Model without dropouts from 1000 Simulations

	Intercept	BAV	Visit	BAV:Visit
True Value	-2.050	-1.183	0.058	**0.220**
Independent				
Mean Estimate	-1.596	-1.872	0.103	**0.336**
SD(Estimate)	0.439	0.834	0.113	**0.209**
Mean Std. Error	0.417	0.797	0.110	**0.196**
SD(Std. Error)	0.065	0.163	0.019	**0.038**
Mean Bias	-0.222	0.582	0.773	**0.038**
Mean MSE	0.399	1.170	0.015	**0.044**
Exchangeable				
Mean Estimate	-1.596	-1.870	0.103	**0.336**
SD(Estimate)	0.439	0.833	0.113	**0.209**
Mean Std. Error	0.417	0.798	0.110	**0.196**
SD(Std. Error)	0.065	0.166	0.019	**0.039**
Mean Bias	-0.222	0.581	0.773	**0.037**
Mean MSE	0.399	1.166	0.015	**0.044**
AR1				
Mean Estimate	-1.599	-1.873	0.103	**0.336**
SD(Estimate)	0.443	0.841	0.114	**0.211**
Mean Std. Error	0.421	0.802	0.111	**0.198**
SD(Std. Error)	0.064	0.165	0.019	**0.038**
Mean Bias	-0.220	0.583	0.780	**0.037**
Mean MSE	0.399	1.182	0.015	**0.044**

Observations:
The three working correlations provided the exact same estimate for the interaction effect and the main effect of Visit, but the independent working correlation had slightly larger mean bias, at -0.025.

With Dropouts

Table 6: Estimate Results for Reduced Model with dropout from 1000 Simulations

	Intercept	BAV	Visit	BAV:Visit
True Value	-2.050	-1.183	0.058	**0.220**
Independent				
Mean Estimate	-1.588	-1.891	0.093	**0.337**
SD(Estimate)	0.500	0.981	0.182	**0.326**
Mean Std. Error	0.479	0.920	0.172	**0.299**
SD(Std. Error)	0.081	0.215	0.036	**0.068**
Mean Bias	-0.225	0.599	0.601	**0.039**
Mean MSE	0.464	1.463	0.034	**0.106**
Exchangeable				
Mean Estimate	-1.591	-1.887	0.096	**0.335**
SD(Estimate)	0.493	0.969	0.176	**0.315**
Mean Std. Error	0.472	0.911	0.165	**0.290**
SD(Std. Error)	0.082	0.220	0.037	**0.073**
Mean Bias	-0.224	0.595	0.647	**0.033**
Mean MSE	0.454	1.434	0.032	**0.099**
AR1				
Mean Estimate	-1.592	-1.890	0.095	**0.336**
SD(Estimate)	0.499	0.975	0.180	**0.319**
Mean Std. Error	0.478	0.918	0.169	**0.296**
SD(Std. Error)	0.079	0.219	0.035	**0.069**
Mean Bias	-0.223	0.597	0.644	**0.038**
Mean MSE	0.459	1.448	0.034	**0.102**

Observations:
Three working correlations provided similar estimates.