Subset calibration report: marginal relative risk

2024-09-27

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(Base case) MAR: 12% outcome proportion, 40% missingness proportion

Table 1: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and simple MAR** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.003	0.002	0.061	0.058	0.062	0.058	0.062	0.938	0.950	1.000	100
Complete-case	-0.143	-0.141	0.107	0.105	0.105	0.177	0.176	0.731	0.741	0.440	100
Confounded model	0.192	0.193	0.059	0.057	0.06	0.2	0.203	0.090	0.098	1.000	100
IPW	0.001	0.004	0.106	0.107	0.106	0.107	0.106	0.953	0.952	0.886	100
Raking (vanilla)	0.003	0.002	0.069	0.065	0.069	0.065	0.069	0.934	0.950	0.998	100
MICE	0.003	0.001	0.066	0.063	0.066	0.063	0.066	0.941	0.948	1.000	100
MI-XGB	-0.003	-0.004	0.068	0.064	0.068	0.064	0.068	0.934	0.947	0.999	100
MI-RF	0.008	0.007	0.069	0.062	0.069	0.063	0.069	0.923	0.944	0.999	100
IPCW-TMLE-M	-0.015	-0.015	0.122	0.121	0.123	0.122	0.124	0.944	0.947	0.750	100
IPCW-TMLE-MTO	-0.023	-0.020	0.116	0.112	0.118	0.114	0.12	0.933	0.943	0.784	100

Table 2: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and simple MAR** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.002	0.001	0.061	0.058	0.062	0.058	0.062	0.949	0.939	1.000	100
Complete-case	-0.144	-0.142	0.107	0.105	0.105	0.178	0.177	0.737	0.727	0.440	100
Confounded model	0.191	0.192	0.059	0.057	0.06	0.199	0.202	0.099	0.091	1.000	100
IPW	0	0.002	0.106	0.107	0.106	0.107	0.106	0.952	0.952	0.886	100
Raking (vanilla)	0.001	0.001	0.069	0.065	0.069	0.065	0.069	0.950	0.935	0.998	100
MICE	0.002	0.000	0.066	0.063	0.066	0.063	0.066	0.948	0.940	1.000	100
MI-XGB	-0.004	-0.005	0.068	0.064	0.068	0.064	0.068	0.946	0.934	0.999	100
MI-RF	0.007	0.006	0.069	0.062	0.069	0.063	0.069	0.945	0.922	0.999	100
IPCW-TMLE-M	-0.016	-0.016	0.122	0.121	0.123	0.122	0.124	0.946	0.944	0.750	100
IPCW-TMLE-MTO	-0.024	-0.021	0.116	0.112	0.118	0.114	0.12	0.942	0.933	0.784	100

Table 3: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.269. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal cover-age	Oracle cover-age	Power	Prop. com-pleted
Benchmark model	0.002	0.002	0.053	0.053	0.053	0.053	0.053	0.956	0.952	0.999	100
Complete-case*	-0.115	-0.116	0.109	0.108	0.109	0.158	0.159	0.818	0.822	0.298	100
Confounded model*	-0.188	-0.187	0.061	0.061	0.062	0.198	0.197	0.124	0.128	0.266	100
IPW*	0.04	0.040	0.109	0.109	0.112	0.116	0.118	0.930	0.935	0.805	100
Raking (vanilla)*	0.047	0.048	0.067	0.068	0.067	0.082	0.082	0.892	0.892	0.996	100
MICE*	0.102	0.103	0.067	0.067	0.067	0.122	0.123	0.669	0.665	1.000	100
MI-XGB*	0.079	0.078	0.065	0.065	0.066	0.102	0.102	0.770	0.774	1.000	100
MI-RF*	0.053	0.053	0.068	0.065	0.068	0.083	0.087	0.864	0.882	0.998	100
IPCW-TMLE-M	-0.046	-0.053	0.151	0.141	0.153	0.148	0.162	0.916	0.945	0.356	100
IPCW-TMLE-MTO	-0.049	-0.047	0.121	0.113	0.123	0.124	0.132	0.910	0.936	0.503	100
IPCW-a-TMLE-M	-0.048	-0.055	0.151	0.14	0.154	0.148	0.164	0.913	0.944	0.350	100
IPCW-a-TMLE-MTO	-0.061	-0.061	0.116	0.106	0.116	0.122	0.131	0.885	0.920	0.517	100

Table 4: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.314. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle cover-age	Nominal cover-age	Power	Prop. com-pleted
Benchmark model	0.003	0.003	0.06	0.06	0.059	0.06	0.059	0.951	0.950	1.000	100
Complete-case	-0.161	-0.161	0.109	0.108	0.109	0.194	0.195	0.693	0.687	0.298	100
Confounded model	-0.233	-0.232	0.061	0.061	0.062	0.241	0.24	0.028	0.028	0.266	100
IPW	-0.005	-0.005	0.109	0.109	0.112	0.109	0.112	0.954	0.954	0.805	100
Raking (vanilla)	0.002	0.002	0.067	0.068	0.067	0.068	0.067	0.950	0.950	0.996	100
MICE	0.057	0.058	0.067	0.067	0.067	0.088	0.088	0.871	0.866	1.000	100
MI-XGB	0.034	0.033	0.065	0.065	0.066	0.074	0.074	0.916	0.915	1.000	100
MI-RF	0.007	0.008	0.068	0.065	0.068	0.065	0.069	0.948	0.934	0.998	100
IPCW-TMLE-M*	-0.091	-0.098	0.151	0.141	0.153	0.168	0.182	0.916	0.865	0.356	100
IPCW-TMLE-MTO*	-0.095	-0.093	0.121	0.113	0.123	0.148	0.154	0.881	0.835	0.503	100
IPCW-a-TMLE-M*	-0.093	-0.101	0.151	0.14	0.154	0.168	0.184	0.914	0.858	0.350	100
IPCW-a-TMLE-MTO*	-0.106	-0.106	0.116	0.106	0.116	0.15	0.158	0.850	0.790	0.517	100

Table 5: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and complex MAR** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.001	0.06	0.058	0.06	0.058	0.06	0.942	0.948	1.000	100
Complete-case	0.171	0.171	0.075	0.074	0.077	0.186	0.188	0.360	0.372	1.000	100
Confounded model	0.19	0.190	0.059	0.057	0.059	0.199	0.199	0.092	0.101	1.000	100
IPW	0.108	0.107	0.078	0.078	0.079	0.133	0.134	0.730	0.722	1.000	100
Raking (vanilla)	0.003	0.002	0.064	0.061	0.063	0.061	0.063	0.938	0.951	1.000	100
MICE	0.001	0.001	0.062	0.061	0.062	0.061	0.062	0.946	0.950	1.000	100
MI-RF	-0.005	-0.005	0.063	0.061	0.064	0.061	0.065	0.942	0.950	1.000	100
IPCW-TMLE-M	0.042	0.041	0.085	0.094	0.087	0.103	0.096	0.956	0.920	0.992	100
IPCW-TMLE-MTO	0.047	0.046	0.082	0.087	0.084	0.099	0.096	0.933	0.911	0.995	100
IPCW-a-TMLE-M	0.042	0.040	0.087	0.095	0.087	0.103	0.096	0.954	0.921	0.987	100
IPCW-a-TMLE-MTO	0.048	0.046	0.084	0.088	0.085	0.1	0.097	0.924	0.907	0.996	100

Table 6: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and complex MAR** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0	0.000	0.06	0.058	0.06	0.058	0.06	0.947	0.943	1.000	100
Complete-case	0.17	0.170	0.075	0.074	0.077	0.186	0.187	0.377	0.365	1.000	100
Confounded model	0.189	0.189	0.059	0.057	0.059	0.198	0.198	0.103	0.094	1.000	100
IPW	0.107	0.106	0.078	0.078	0.079	0.132	0.133	0.727	0.732	1.000	100
Raking (vanilla)	0.002	0.001	0.064	0.061	0.063	0.061	0.063	0.951	0.939	1.000	100
MICE	0	0.000	0.062	0.061	0.062	0.061	0.062	0.948	0.947	1.000	100
MI-RF	-0.006	-0.006	0.063	0.061	0.064	0.061	0.065	0.950	0.942	1.000	100
IPCW-TMLE-M	0.041	0.040	0.085	0.094	0.087	0.102	0.096	0.922	0.958	0.992	100
IPCW-TMLE-MTO	0.046	0.045	0.082	0.087	0.084	0.099	0.095	0.913	0.935	0.995	100
IPCW-a-TMLE-M	0.041	0.039	0.087	0.095	0.087	0.103	0.096	0.924	0.955	0.987	100
IPCW-a-TMLE-MTO	0.047	0.045	0.084	0.088	0.085	0.099	0.096	0.910	0.925	0.996	100

Table 7: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and complex MAR** scenario. The value of the estimand is 0.269. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.002	0.053	0.053	0.053	0.053	0.053	0.957	0.953	0.999	100
Complete-case*	0.178	0.178	0.073	0.073	0.075	0.193	0.193	0.317	0.313	1.000	100
Confounded model*	-0.19	-0.189	0.06	0.061	0.059	0.199	0.198	0.118	0.114	0.250	100
IPW*	0.111	0.111	0.078	0.078	0.079	0.135	0.136	0.696	0.701	0.998	100
Raking (vanilla)*	0.051	0.051	0.063	0.061	0.067	0.079	0.084	0.862	0.876	0.999	100
MICE*	0.086	0.087	0.062	0.062	0.066	0.106	0.109	0.714	0.713	1.000	100
MI-RF*	0.048	0.048	0.063	0.063	0.066	0.079	0.082	0.884	0.885	0.999	100
IPCW-TMLE-M	0.022	0.020	0.097	0.101	0.099	0.104	0.101	0.954	0.945	0.836	100
IPCW-TMLE-MTO	0.011	0.009	0.083	0.082	0.083	0.083	0.083	0.948	0.947	0.924	100
IPCW-a-TMLE-M	0.029	0.028	0.1	0.101	0.099	0.106	0.103	0.947	0.939	0.854	100
IPCW-a-TMLE-MTO	0.015	0.012	0.083	0.081	0.082	0.083	0.083	0.938	0.944	0.930	100

Table 8: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and complex MAR** scenario. The value of the estimand is 0.314. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.001	0.002	0.058	0.06	0.059	0.06	0.059	0.953	0.960	1.000	100
Complete-case	0.133	0.132	0.073	0.073	0.075	0.152	0.152	0.553	0.557	1.000	100
Confounded model	-0.235	-0.234	0.06	0.061	0.059	0.242	0.241	0.024	0.025	0.250	100
IPW	0.066	0.066	0.078	0.078	0.079	0.102	0.103	0.864	0.859	0.998	100
Raking (vanilla)	0.006	0.006	0.063	0.061	0.067	0.061	0.067	0.953	0.946	0.999	100
MICE	0.041	0.042	0.062	0.062	0.066	0.074	0.078	0.902	0.903	1.000	100
MI-RF	0.003	0.003	0.063	0.063	0.066	0.063	0.066	0.950	0.952	0.999	100
IPCW-TMLE-M*	-0.023	-0.025	0.097	0.101	0.099	0.104	0.102	0.946	0.952	0.836	100
IPCW-TMLE-MTO*	-0.034	-0.036	0.083	0.082	0.083	0.089	0.09	0.926	0.926	0.924	100
IPCW-a-TMLE-M*	-0.016	-0.017	0.1	0.101	0.099	0.103	0.1	0.950	0.950	0.854	100
IPCW-a-TMLE-MTO*	-0.03	-0.033	0.083	0.081	0.082	0.087	0.088	0.936	0.924	0.930	100

MAR: 12% outcome proportion, 80% missingness proportion

Table 9: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and simple MAR** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.005	0.005	0.057	0.058	0.057	0.059	0.058	0.951	0.946	1.000	100
Complete-case	-0.063	-0.057	0.21	0.211	0.21	0.22	0.218	0.947	0.940	0.262	100
Confounded model	0.195	0.194	0.056	0.057	0.055	0.203	0.202	0.066	0.062	1.000	100
IPW	-0.002	0.000	0.222	0.22	0.221	0.22	0.221	0.944	0.948	0.330	100
Raking (vanilla)	0.004	0.006	0.092	0.089	0.089	0.089	0.089	0.938	0.946	0.945	100
MICE	0.005	0.006	0.08	0.08	0.076	0.08	0.076	0.948	0.949	0.982	100
MI-RF	0.061	0.062	0.082	0.068	0.078	0.091	0.1	0.800	0.890	0.998	100
IPCW-TMLE-M	-0.036	-0.039	0.248	0.239	0.244	0.241	0.247	0.940	0.950	0.246	100
IPCW-TMLE-MTO	-0.044	-0.047	0.233	0.214	0.237	0.219	0.241	0.922	0.942	0.292	100

Table 10: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and simple MAR** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.004	0.004	0.057	0.058	0.057	0.058	0.058	0.947	0.950	1.000	100
Complete-case	-0.064	-0.058	0.21	0.211	0.21	0.22	0.218	0.940	0.946	0.262	100
Confounded model	0.194	0.193	0.056	0.057	0.055	0.202	0.201	0.065	0.070	1.000	100
IPW	-0.003	-0.001	0.222	0.22	0.221	0.22	0.221	0.948	0.945	0.330	100
Raking (vanilla)	0.003	0.004	0.092	0.089	0.089	0.089	0.089	0.946	0.938	0.945	100
MICE	0.004	0.005	0.08	0.08	0.076	0.08	0.076	0.948	0.948	0.982	100
MI-RF	0.059	0.061	0.082	0.068	0.078	0.09	0.099	0.891	0.801	0.998	100
IPCW-TMLE-M	-0.037	-0.040	0.248	0.239	0.244	0.242	0.247	0.950	0.940	0.246	100
IPCW-TMLE-MTO	-0.045	-0.048	0.233	0.214	0.237	0.219	0.241	0.942	0.921	0.292	100

Table 11: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.269. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0	0.001	0.055	0.053	0.052	0.053	0.052	0.938	0.945	0.998	100
Complete-case*	-0.08	-0.075	0.22	0.216	0.217	0.231	0.229	0.936	0.930	0.156	100
Confounded model*	-0.191	-0.190	0.061	0.061	0.061	0.2	0.2	0.117	0.120	0.256	100
IPW*	0.02	0.025	0.244	0.219	0.229	0.22	0.231	0.931	0.959	0.294	100
Raking (vanilla)*	0.041	0.043	0.098	0.096	0.1	0.104	0.108	0.918	0.936	0.885	100
MICE*	0.116	0.119	0.095	0.09	0.096	0.147	0.153	0.736	0.766	0.985	100
MI-RF*	0.052	0.052	0.091	0.071	0.091	0.088	0.105	0.809	0.909	0.974	100
IPCW-TMLE-M	-0.095	-0.094	0.306	0.266	0.305	0.283	0.32	0.896	0.943	0.135	100
IPCW-TMLE-MTO	-0.101	-0.098	0.243	0.215	0.249	0.238	0.267	0.890	0.932	0.172	100

Table 12: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.314. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.001	0.000	0.061	0.06	0.061	0.06	0.061	0.950	0.948	0.999	100
Complete-case	-0.125	-0.120	0.22	0.216	0.217	0.25	0.248	0.908	0.915	0.156	100
Confounded model	-0.236	-0.235	0.061	0.061	0.061	0.244	0.243	0.026	0.025	0.256	100
IPW	-0.025	-0.020	0.244	0.219	0.229	0.221	0.23	0.957	0.932	0.294	100
Raking (vanilla)	-0.004	-0.003	0.098	0.096	0.1	0.096	0.1	0.950	0.947	0.885	100
MICE	0.071	0.073	0.095	0.09	0.096	0.115	0.121	0.886	0.873	0.985	100
MI-RF	0.007	0.007	0.091	0.071	0.091	0.071	0.092	0.949	0.871	0.974	100
IPCW-TMLE-M*	-0.14	-0.139	0.306	0.266	0.305	0.301	0.336	0.929	0.872	0.135	100
IPCW-TMLE-MTO*	-0.146	-0.143	0.243	0.215	0.249	0.26	0.287	0.910	0.855	0.172	100

Table 13: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and complex MAR** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.002	0.002	0.059	0.058	0.059	0.058	0.059	0.947	0.952	1.000	100
Complete-case	0.441	0.442	0.108	0.111	0.11	0.455	0.455	0.022	0.019	1.000	100
Confounded model	0.191	0.191	0.059	0.057	0.058	0.199	0.2	0.096	0.104	1.000	100
IPW	0.256	0.260	0.138	0.138	0.143	0.291	0.296	0.532	0.540	0.988	100
Raking (vanilla)	0.009	0.010	0.083	0.084	0.083	0.085	0.083	0.956	0.946	0.978	100
MICE	0.005	0.005	0.071	0.07	0.073	0.07	0.074	0.954	0.957	0.998	100
MI-RF	0	0.001	0.073	0.066	0.076	0.066	0.076	0.928	0.956	0.999	100
IPCW-TMLE-M	0.063	0.061	0.146	0.162	0.148	0.174	0.16	0.968	0.926	0.709	100
IPCW-TMLE-MTO	0.096	0.096	0.138	0.145	0.14	0.174	0.169	0.911	0.886	0.854	100

Table 14: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and complex MAR** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.001	0.001	0.059	0.058	0.059	0.058	0.059	0.950	0.946	1.000	100
Complete-case	0.44	0.441	0.108	0.111	0.11	0.454	0.454	0.020	0.022	1.000	100
Confounded model	0.19	0.190	0.059	0.057	0.058	0.198	0.198	0.107	0.099	1.000	100
IPW	0.255	0.258	0.138	0.138	0.143	0.29	0.295	0.542	0.534	0.988	100
Raking (vanilla)	0.008	0.009	0.083	0.084	0.083	0.085	0.083	0.946	0.956	0.978	100
MICE	0.004	0.004	0.071	0.07	0.073	0.07	0.074	0.958	0.954	0.998	100
MI-RF	-0.001	0.000	0.073	0.066	0.076	0.066	0.076	0.956	0.927	0.999	100
IPCW-TMLE-M	0.062	0.060	0.146	0.162	0.148	0.174	0.16	0.926	0.968	0.709	100
IPCW-TMLE-MTO	0.095	0.095	0.138	0.145	0.14	0.174	0.169	0.887	0.913	0.854	100

Table 15: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and complex MAR** scenario. The value of the estimand is 0.269. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0	0.000	0.054	0.053	0.054	0.053	0.054	0.948	0.948	1.000	100
Complete-case*	0.339	0.337	0.1	0.103	0.099	0.354	0.352	0.090	0.073	1.000	100
Confounded model*	-0.189	-0.188	0.061	0.061	0.06	0.198	0.197	0.131	0.130	0.261	100
IPW*	0.152	0.153	0.133	0.132	0.134	0.201	0.203	0.782	0.788	0.896	100
Raking (vanilla)*	0.066	0.065	0.087	0.087	0.085	0.109	0.107	0.890	0.888	0.974	100
MICE*	0.17	0.169	0.078	0.073	0.078	0.184	0.186	0.364	0.412	1.000	100
MI-RF*	0.108	0.107	0.077	0.068	0.077	0.127	0.132	0.633	0.712	0.999	100
IPCW-TMLE-M	0.027	0.025	0.156	0.171	0.154	0.173	0.156	0.964	0.944	0.408	100
IPCW-TMLE-MTO	0.021	0.021	0.135	0.136	0.131	0.138	0.133	0.950	0.944	0.575	100

Table 16: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and complex MAR** scenario. The value of the estimand is 0.314. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.002	0.001	0.06	0.06	0.06	0.06	0.06	0.950	0.949	1.000	100
Complete-case	0.294	0.292	0.1	0.103	0.099	0.311	0.309	0.157	0.178	1.000	100
Confounded model	-0.234	-0.233	0.061	0.061	0.06	0.242	0.241	0.030	0.029	0.261	100
IPW	0.107	0.107	0.133	0.132	0.134	0.17	0.171	0.871	0.867	0.896	100
Raking (vanilla)	0.021	0.020	0.087	0.087	0.085	0.09	0.088	0.946	0.945	0.974	100
MICE	0.124	0.124	0.078	0.073	0.078	0.144	0.146	0.648	0.603	1.000	100
MI-RF	0.063	0.062	0.077	0.068	0.077	0.092	0.099	0.878	0.814	0.999	100
IPCW-TMLE-M*	-0.018	-0.021	0.156	0.171	0.154	0.172	0.155	0.946	0.970	0.408	100
IPCW-TMLE-MTO*	-0.024	-0.024	0.135	0.136	0.131	0.138	0.133	0.948	0.952	0.575	100

MAR: 5% outcome proportion, 40% missingness proportion

Table 17: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and simple MAR** scenario. The value of the estimand is 0.374. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.002	0.003	0.096	0.095	0.098	0.095	0.098	0.947	0.946	0.974	100
Complete-case	-0.162	-0.158	0.173	0.169	0.173	0.234	0.234	0.839	0.850	0.250	100
Confounded model	0.212	0.213	0.094	0.093	0.098	0.232	0.234	0.376	0.387	1.000	100
IPW	0	0.001	0.185	0.179	0.181	0.179	0.181	0.941	0.947	0.559	100
Raking (vanilla)	0.002	0.000	0.107	0.106	0.107	0.106	0.107	0.949	0.955	0.941	100
MICE	0.003	0.005	0.104	0.103	0.105	0.103	0.105	0.950	0.951	0.952	100
MI-RF	0.039	0.040	0.106	0.101	0.105	0.109	0.112	0.924	0.939	0.978	100
IPCW-TMLE-M	-0.023	-0.025	0.202	0.196	0.199	0.197	0.2	0.940	0.947	0.440	100
IPCW-TMLE-MTO	-0.029	-0.027	0.193	0.183	0.192	0.185	0.194	0.929	0.942	0.480	100
r-IPCW-TMLE-MTO	-0.03	-0.030	0.193	0.183	0.191	0.185	0.193	0.931	0.942	0.471	100

Table 18: **Synthetic data MAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and simple MAR** scenario. The value of the estimand is 0.369. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.007	0.008	0.096	0.095	0.098	0.096	0.098	0.950	0.947	0.974	100
Complete-case	-0.157	-0.152	0.173	0.169	0.173	0.231	0.231	0.857	0.845	0.250	100
Confounded model	0.217	0.218	0.094	0.093	0.098	0.236	0.239	0.366	0.356	1.000	100
IPW	0.006	0.006	0.185	0.179	0.181	0.179	0.181	0.947	0.943	0.559	100
Raking (vanilla)	0.008	0.006	0.107	0.106	0.107	0.106	0.107	0.953	0.948	0.941	100
MICE	0.008	0.010	0.104	0.103	0.105	0.103	0.105	0.950	0.950	0.952	100
MI-RF	0.044	0.045	0.106	0.101	0.105	0.111	0.114	0.933	0.921	0.978	100
IPCW-TMLE-M	-0.018	-0.019	0.202	0.196	0.199	0.196	0.199	0.947	0.941	0.440	100
IPCW-TMLE-MTO	-0.024	-0.022	0.193	0.183	0.192	0.184	0.193	0.942	0.932	0.480	100
r-IPCW-TMLE-MTO	-0.025	-0.025	0.193	0.183	0.191	0.185	0.193	0.944	0.932	0.471	100

Table 19: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.281. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.003	0.002	0.078	0.081	0.077	0.081	0.077	0.950	0.946	0.941	100
Complete-case*	-0.113	-0.113	0.16	0.16	0.161	0.196	0.197	0.902	0.897	0.192	100
Confounded model*	-0.255	-0.255	0.09	0.092	0.088	0.271	0.27	0.197	0.188	0.061	100
IPW*	0.057	0.052	0.165	0.163	0.162	0.173	0.17	0.935	0.932	0.542	100
Raking (vanilla)*	0.06	0.060	0.101	0.103	0.102	0.119	0.118	0.914	0.910	0.907	100
MICE*	0.143	0.141	0.099	0.101	0.096	0.175	0.171	0.704	0.696	0.987	100
MI-RF*	0.075	0.075	0.099	0.096	0.099	0.122	0.125	0.871	0.884	0.954	100
IPCW-TMLE-M	-0.062	-0.072	0.236	0.21	0.23	0.219	0.241	0.900	0.945	0.184	100
IPCW-TMLE-MTO	-0.061	-0.065	0.189	0.172	0.19	0.183	0.201	0.908	0.937	0.263	100
r-IPCW-TMLE-MTO	-0.03	-0.032	0.194	0.173	0.196	0.175	0.199	0.908	0.944	0.332	100

Table 20: **Synthetic data MAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.349. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.006	-0.005	0.087	0.089	0.087	0.089	0.087	0.954	0.958	0.974	100
Complete-case	-0.181	-0.180	0.16	0.16	0.161	0.242	0.242	0.792	0.802	0.192	100
Confounded model	-0.323	-0.323	0.09	0.092	0.088	0.336	0.335	0.058	0.061	0.061	100
IPW	-0.01	-0.016	0.165	0.163	0.162	0.163	0.163	0.947	0.948	0.542	100
Raking (vanilla)	-0.008	-0.008	0.101	0.103	0.102	0.103	0.102	0.950	0.955	0.907	100
MICE	0.075	0.074	0.099	0.101	0.096	0.126	0.121	0.880	0.880	0.987	100
MI-RF	0.008	0.008	0.099	0.096	0.099	0.097	0.1	0.950	0.943	0.954	100
IPCW-TMLE-M*	-0.129	-0.140	0.236	0.21	0.23	0.247	0.269	0.912	0.850	0.184	100
IPCW-TMLE-MTO*	-0.128	-0.133	0.189	0.172	0.19	0.215	0.232	0.902	0.842	0.263	100
r-IPCW-TMLE-MTO*	-0.098	-0.100	0.194	0.173	0.196	0.198	0.22	0.920	0.876	0.332	100

Table 21: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and complex MAR** scenario. The value of the estimand is 0.374. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal cover-age	Oracle cover-age	Power	Prop. com-pleted
Benchmark model	-0.005	-0.002	0.093	0.095	0.092	0.095	0.092	0.953	0.946	0.968	100
Complete-case	0.205	0.207	0.118	0.12	0.115	0.238	0.237	0.602	0.592	0.998	100
Confounded model	0.207	0.208	0.09	0.093	0.09	0.227	0.226	0.390	0.374	1.000	100
IPW	0.132	0.131	0.126	0.128	0.126	0.183	0.182	0.832	0.824	0.978	100
Raking (vanilla)	-0.004	-0.002	0.099	0.099	0.098	0.1	0.098	0.949	0.949	0.958	100
MICE	-0.005	-0.003	0.096	0.099	0.094	0.099	0.094	0.956	0.947	0.964	100
MI-RF	-0.001	0.002	0.098	0.099	0.096	0.099	0.097	0.949	0.945	0.964	100
IPCW-TMLE-M	0.072	0.073	0.138	0.15	0.139	0.166	0.157	0.950	0.916	0.876	100
IPCW-TMLE-MTO	0.081	0.083	0.133	0.139	0.134	0.161	0.158	0.923	0.903	0.912	100
IPCW-a-TMLE-M	0.078	0.081	0.141	0.15	0.142	0.169	0.164	0.941	0.913	0.875	100
IPCW-a-TMLE-MTO	0.087	0.089	0.136	0.138	0.135	0.164	0.162	0.915	0.907	0.924	100
r-IPCW-TMLE-MTO	0.076	0.078	0.133	0.139	0.134	0.158	0.155	0.929	0.905	0.910	100

Table 22: **Synthetic data MAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and complex MAR** scenario. The value of the estimand is 0.369. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle cover-age	Nominal cover-age	Power	Prop. com-pleted
Benchmark model	0	0.003	0.093	0.095	0.092	0.095	0.092	0.948	0.955	0.968	100
Complete-case	0.21	0.212	0.118	0.12	0.115	0.242	0.242	0.573	0.583	0.998	100
Confounded model	0.212	0.213	0.09	0.093	0.09	0.231	0.231	0.348	0.369	1.000	100
IPW	0.137	0.136	0.126	0.128	0.126	0.187	0.185	0.812	0.825	0.978	100
Raking (vanilla)	0.001	0.003	0.099	0.099	0.098	0.099	0.098	0.950	0.949	0.958	100
MICE	0	0.003	0.096	0.099	0.094	0.099	0.094	0.950	0.956	0.964	100
MI-RF	0.004	0.007	0.098	0.099	0.096	0.099	0.097	0.946	0.952	0.964	100
IPCW-TMLE-M	0.077	0.079	0.138	0.15	0.139	0.168	0.16	0.912	0.946	0.876	100
IPCW-TMLE-MTO	0.086	0.089	0.133	0.139	0.134	0.163	0.16	0.897	0.918	0.912	100
IPCW-a-TMLE-M	0.083	0.086	0.141	0.15	0.142	0.171	0.166	0.906	0.936	0.875	100
IPCW-a-TMLE-MTO	0.092	0.094	0.136	0.138	0.135	0.166	0.164	0.899	0.906	0.924	100
r-IPCW-TMLE-MTO	0.081	0.083	0.133	0.139	0.134	0.161	0.158	0.902	0.923	0.910	100

Table 23: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and complex MAR** scenario. The value of the estimand is 0.281. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0	0.002	0.081	0.081	0.078	0.081	0.078	0.946	0.942	0.933	100
Complete-case*	0.24	0.240	0.107	0.107	0.107	0.263	0.263	0.387	0.388	0.996	100
Confounded model*	-0.26	-0.259	0.092	0.092	0.086	0.276	0.273	0.183	0.184	0.052	100
IPW*	0.141	0.143	0.111	0.113	0.11	0.181	0.18	0.763	0.756	0.960	100
Raking (vanilla)*	0.071	0.071	0.093	0.091	0.089	0.116	0.114	0.864	0.876	0.963	100
MICE*	0.124	0.126	0.092	0.093	0.087	0.155	0.153	0.736	0.730	0.990	100
MI-RF*	0.079	0.079	0.093	0.094	0.089	0.122	0.119	0.860	0.862	0.962	100
IPCW-TMLE-M	0.055	0.049	0.151	0.15	0.15	0.16	0.158	0.948	0.934	0.625	100
IPCW-TMLE-MTO	0.037	0.035	0.125	0.121	0.127	0.126	0.132	0.929	0.938	0.751	100
IPCW-a-TMLE-M	0.068	0.063	0.152	0.15	0.15	0.165	0.163	0.941	0.930	0.646	100
IPCW-a-TMLE-MTO	0.047	0.047	0.126	0.12	0.124	0.128	0.132	0.920	0.933	0.775	100
r-IPCW-TMLE-MTO	0.082	0.083	0.129	0.122	0.13	0.147	0.154	0.880	0.903	0.822	100

Table 24: **Synthetic data MAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and complex MAR** scenario. The value of the estimand is 0.349. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.009	-0.008	0.088	0.089	0.087	0.09	0.088	0.950	0.952	0.966	100
Complete-case	0.172	0.172	0.107	0.107	0.107	0.203	0.203	0.630	0.622	0.996	100
Confounded model	-0.327	-0.327	0.092	0.092	0.086	0.34	0.338	0.054	0.052	0.052	100
IPW	0.074	0.075	0.111	0.113	0.11	0.135	0.133	0.901	0.902	0.960	100
Raking (vanilla)	0.004	0.004	0.093	0.091	0.089	0.091	0.09	0.954	0.950	0.963	100
MICE	0.057	0.058	0.092	0.093	0.087	0.109	0.105	0.907	0.905	0.990	100
MI-RF	0.011	0.011	0.093	0.094	0.089	0.094	0.09	0.948	0.949	0.962	100
IPCW-TMLE-M*	-0.012	-0.019	0.151	0.15	0.15	0.151	0.151	0.948	0.949	0.625	100
IPCW-TMLE-MTO*	-0.03	-0.033	0.125	0.121	0.127	0.124	0.131	0.946	0.925	0.751	100
IPCW-a-TMLE-M*	0	-0.005	0.152	0.15	0.15	0.15	0.15	0.947	0.952	0.646	100
IPCW-a-TMLE-MTO*	-0.021	-0.020	0.126	0.12	0.124	0.121	0.125	0.950	0.933	0.775	100
r-IPCW-TMLE-MTO*	0.015	0.015	0.129	0.122	0.13	0.123	0.131	0.948	0.937	0.822	100

MAR: 5% outcome proportion, 80% missingness proportion

Table 25: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and simple MAR** scenario. The value of the estimand is 0.374. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.001	0.095	0.095	0.096	0.095	0.096	0.946	0.947	0.969	100
Complete-case	-0.093	-0.090	0.342	0.338	0.334	0.351	0.346	0.947	0.939	0.137	100
Confounded model	0.213	0.212	0.093	0.093	0.09	0.232	0.23	0.371	0.379	1.000	100
IPW	-0.085	-0.086	0.407	0.382	0.387	0.392	0.396	0.923	0.941	0.120	100
Raking (vanilla)	-0.006	-0.002	0.153	0.175	0.151	0.175	0.151	0.971	0.944	0.571	100
MICE	0	-0.002	0.132	0.128	0.13	0.128	0.13	0.937	0.948	0.816	100
MI-RF	0.119	0.120	0.114	0.106	0.111	0.159	0.163	0.778	0.825	0.988	100
IPCW-TMLE-M	-0.102	-0.108	0.45	0.395	0.433	0.408	0.446	0.905	0.945	0.135	100
IPCW-TMLE-MTO	-0.086	-0.089	0.422	0.36	0.41	0.37	0.419	0.900	0.942	0.165	100
r-IPCW-TMLE-MTO	-0.09	-0.090	0.427	0.362	0.409	0.373	0.419	0.901	0.947	0.170	100

Table 26: **Synthetic data MAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and simple MAR** scenario. The value of the estimand is 0.369. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.006	0.006	0.095	0.095	0.096	0.096	0.096	0.946	0.946	0.969	100
Complete-case	-0.088	-0.085	0.342	0.338	0.334	0.35	0.345	0.941	0.948	0.137	100
Confounded model	0.218	0.217	0.093	0.093	0.09	0.237	0.235	0.361	0.350	1.000	100
IPW	-0.08	-0.081	0.407	0.382	0.387	0.39	0.395	0.942	0.925	0.120	100
Raking (vanilla)	-0.001	0.003	0.153	0.175	0.151	0.175	0.151	0.945	0.972	0.571	100
MICE	0.005	0.003	0.132	0.128	0.13	0.128	0.13	0.948	0.937	0.816	100
MI-RF	0.124	0.125	0.114	0.106	0.111	0.163	0.167	0.813	0.767	0.988	100
IPCW-TMLE-M	-0.097	-0.102	0.45	0.395	0.433	0.407	0.445	0.945	0.906	0.135	100
IPCW-TMLE-MTO	-0.081	-0.084	0.422	0.36	0.41	0.369	0.418	0.943	0.901	0.165	100
r-IPCW-TMLE-MTO	-0.084	-0.085	0.427	0.362	0.409	0.372	0.418	0.948	0.904	0.170	100

Table 27: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.281. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.003	0.004	0.081	0.081	0.081	0.081	0.081	0.952	0.954	0.942	100
Complete-case*	-0.073	-0.066	0.321	0.315	0.311	0.324	0.318	0.951	0.942	0.120	100
Confounded model*	-0.255	-0.254	0.092	0.092	0.089	0.271	0.269	0.202	0.205	0.057	100
IPW*	-0.043	-0.037	0.357	0.337	0.359	0.34	0.36	0.938	0.946	0.122	100
Raking (vanilla)*	0.056	0.063	0.161	0.174	0.163	0.182	0.175	0.951	0.941	0.515	100
MICE*	0.171	0.173	0.145	0.132	0.144	0.216	0.225	0.720	0.780	0.902	100
MI-RF*	0.028	0.028	0.128	0.106	0.13	0.11	0.133	0.889	0.944	0.786	100
IPCW-TMLE-M	-0.175	-0.195	0.479	0.394	0.448	0.431	0.488	0.869	0.938	0.098	100
IPCW-TMLE-MTO	-0.128	-0.128	0.405	0.341	0.389	0.364	0.41	0.878	0.940	0.119	100
r-IPCW-TMLE-MTO	-0.098	-0.102	0.432	0.345	0.414	0.359	0.427	0.867	0.943	0.157	100

Table 28: **Synthetic data MAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.349. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.006	-0.004	0.089	0.089	0.088	0.089	0.088	0.948	0.949	0.968	100
Complete-case	-0.141	-0.134	0.321	0.315	0.311	0.346	0.338	0.928	0.943	0.120	100
Confounded model	-0.323	-0.322	0.092	0.092	0.089	0.336	0.334	0.058	0.056	0.057	100
IPW	-0.11	-0.105	0.357	0.337	0.359	0.355	0.374	0.941	0.925	0.122	100
Raking (vanilla)	-0.012	-0.005	0.161	0.174	0.163	0.174	0.163	0.949	0.965	0.515	100
MICE	0.103	0.105	0.145	0.132	0.144	0.167	0.179	0.896	0.838	0.902	100
MI-RF	-0.039	-0.039	0.128	0.106	0.13	0.113	0.136	0.938	0.872	0.786	100
IPCW-TMLE-M*	-0.243	-0.263	0.479	0.394	0.448	0.463	0.519	0.926	0.840	0.098	100
IPCW-TMLE-MTO*	-0.195	-0.196	0.405	0.341	0.389	0.393	0.436	0.926	0.854	0.119	100
r-IPCW-TMLE-MTO*	-0.166	-0.170	0.432	0.345	0.414	0.383	0.448	0.932	0.853	0.157	100

Table 29: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and complex MAR** scenario. The value of the estimand is 0.374. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	-0.003	0.095	0.095	0.099	0.095	0.099	0.955	0.953	0.980	100
Complete-case	0.572	0.574	0.189	0.185	0.184	0.601	0.603	0.137	0.140	0.998	100
Confounded model	0.21	0.210	0.091	0.093	0.093	0.23	0.23	0.387	0.376	1.000	100
IPW	0.361	0.361	0.23	0.22	0.224	0.423	0.425	0.628	0.659	0.913	100
Raking (vanilla)	0.005	0.003	0.132	0.139	0.132	0.139	0.132	0.964	0.949	0.792	100
MICE	0.001	-0.001	0.111	0.112	0.113	0.112	0.113	0.947	0.947	0.920	100
MI-RF	0.032	0.031	0.114	0.105	0.113	0.11	0.117	0.916	0.940	0.966	100
IPCW-TMLE-M	0.098	0.101	0.256	0.254	0.248	0.272	0.268	0.944	0.927	0.476	100
IPCW-TMLE-MTO	0.147	0.151	0.244	0.226	0.245	0.269	0.287	0.883	0.907	0.638	100
IPCW-a-TMLE-M	0.098	0.093	0.267	0.257	0.259	0.275	0.275	0.935	0.928	0.461	100
IPCW-a-TMLE-MTO	0.155	0.151	0.252	0.227	0.253	0.275	0.294	0.871	0.902	0.642	100
r-IPCW-TMLE-MTO	0.115	0.117	0.243	0.228	0.244	0.256	0.27	0.907	0.923	0.582	100

Table 30: **Synthetic data MAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and complex MAR** scenario. The value of the estimand is 0.369. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.004	0.002	0.095	0.095	0.099	0.095	0.099	0.954	0.953	0.980	100
Complete-case	0.577	0.579	0.189	0.185	0.184	0.606	0.608	0.134	0.132	0.998	100
Confounded model	0.215	0.215	0.091	0.093	0.093	0.234	0.235	0.360	0.369	1.000	100
IPW	0.366	0.366	0.23	0.22	0.224	0.427	0.429	0.650	0.622	0.913	100
Raking (vanilla)	0.01	0.009	0.132	0.139	0.132	0.139	0.132	0.950	0.964	0.792	100
MICE	0.006	0.004	0.111	0.112	0.113	0.112	0.113	0.948	0.946	0.920	100
MI-RF	0.037	0.036	0.114	0.105	0.113	0.111	0.119	0.935	0.910	0.966	100
IPCW-TMLE-M	0.103	0.106	0.256	0.254	0.248	0.274	0.27	0.927	0.944	0.476	100
IPCW-TMLE-MTO	0.152	0.156	0.244	0.226	0.245	0.272	0.29	0.904	0.880	0.638	100
IPCW-a-TMLE-M	0.104	0.098	0.267	0.257	0.259	0.277	0.277	0.926	0.931	0.461	100
IPCW-a-TMLE-MTO	0.16	0.156	0.252	0.227	0.253	0.278	0.297	0.901	0.866	0.642	100
r-IPCW-TMLE-MTO	0.12	0.122	0.243	0.228	0.244	0.258	0.272	0.920	0.905	0.582	100

Table 31: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and complex MAR** scenario. The value of the estimand is 0.281. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.000	0.083	0.081	0.083	0.081	0.083	0.949	0.952	0.934	100
Complete-case*	0.434	0.435	0.148	0.144	0.143	0.457	0.458	0.168	0.160	0.994	100
Confounded model*	-0.259	-0.261	0.093	0.092	0.094	0.274	0.277	0.200	0.203	0.063	100
IPW*	0.206	0.208	0.183	0.178	0.177	0.273	0.273	0.781	0.805	0.776	100
Raking (vanilla)*	0.095	0.093	0.133	0.134	0.134	0.165	0.163	0.893	0.890	0.804	100
MICE*	0.249	0.249	0.113	0.105	0.109	0.27	0.272	0.355	0.407	0.998	100
MI-RF*	0.163	0.160	0.113	0.1	0.113	0.191	0.196	0.613	0.694	0.986	100
IPCW-TMLE-M	0.08	0.079	0.248	0.241	0.241	0.254	0.254	0.940	0.942	0.330	100
IPCW-TMLE-MTO	0.085	0.085	0.203	0.189	0.204	0.208	0.221	0.911	0.929	0.504	100
IPCW-a-TMLE-M	0.089	0.090	0.254	0.242	0.244	0.258	0.26	0.936	0.940	0.355	100
IPCW-a-TMLE-MTO	0.107	0.108	0.203	0.188	0.2	0.216	0.227	0.889	0.918	0.559	100
r-IPCW-TMLE-MTO	0.168	0.171	0.213	0.194	0.207	0.257	0.269	0.821	0.878	0.647	100

Table 32: **Synthetic data MAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and complex MAR** scenario. The value of the estimand is 0.349. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.008	-0.006	0.091	0.089	0.089	0.09	0.089	0.945	0.944	0.959	100
Complete-case	0.366	0.367	0.148	0.144	0.143	0.394	0.394	0.300	0.294	0.994	100
Confounded model	-0.326	-0.328	0.093	0.092	0.094	0.339	0.342	0.065	0.060	0.063	100
IPW	0.139	0.140	0.183	0.178	0.177	0.226	0.226	0.877	0.862	0.776	100
Raking (vanilla)	0.027	0.026	0.133	0.134	0.134	0.137	0.137	0.948	0.944	0.804	100
MICE	0.181	0.182	0.113	0.105	0.109	0.209	0.212	0.645	0.593	0.998	100
MI-RF	0.095	0.093	0.113	0.1	0.113	0.138	0.146	0.870	0.804	0.986	100
IPCW-TMLE-M*	0.012	0.012	0.248	0.241	0.241	0.242	0.242	0.952	0.953	0.330	100
IPCW-TMLE-MTO*	0.017	0.017	0.203	0.189	0.204	0.19	0.204	0.948	0.931	0.504	100
IPCW-a-TMLE-M*	0.022	0.023	0.254	0.242	0.244	0.243	0.245	0.947	0.950	0.355	100
IPCW-a-TMLE-MTO*	0.04	0.040	0.203	0.188	0.2	0.192	0.204	0.945	0.925	0.559	100
r-IPCW-TMLE-MTO*	0.101	0.104	0.213	0.194	0.207	0.219	0.232	0.926	0.886	0.647	100

MNAR: 12% outcome proportion, 40% missingness proportion

Table 33: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and MNAR-value** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.002	0.06	0.058	0.06	0.058	0.06	0.943	0.948	1.000	100
Complete-case	-0.104	-0.105	0.094	0.095	0.092	0.141	0.14	0.802	0.804	0.676	100
Confounded model	0.189	0.191	0.06	0.057	0.059	0.198	0.2	0.103	0.120	1.000	100
IPW	-0.11	-0.111	0.1	0.101	0.1	0.149	0.15	0.802	0.806	0.599	100
Raking (vanilla)	-0.095	-0.093	0.067	0.072	0.065	0.119	0.114	0.749	0.710	0.923	100
MICE	-0.094	-0.092	0.066	0.064	0.067	0.114	0.114	0.683	0.704	0.954	100
MI-XGB	-0.095	-0.095	0.067	0.081	0.068	0.125	0.116	0.820	0.710	0.864	100
MI-RF	-0.093	-0.091	0.065	0.062	0.066	0.111	0.112	0.679	0.712	0.966	100
IPCW-TMLE-M	-0.106	-0.107	0.118	0.116	0.115	0.157	0.157	0.827	0.853	0.505	100
IPCW-TMLE-MTO	-0.107	-0.105	0.112	0.107	0.107	0.151	0.15	0.808	0.838	0.564	100

Table 34: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and MNAR-value** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0	0.001	0.06	0.058	0.06	0.058	0.06	0.948	0.942	1.000	100
Complete-case	-0.105	-0.106	0.094	0.095	0.092	0.142	0.14	0.802	0.800	0.676	100
Confounded model	0.188	0.190	0.06	0.057	0.059	0.197	0.199	0.124	0.106	1.000	100
IPW	-0.111	-0.113	0.1	0.101	0.1	0.15	0.15	0.803	0.798	0.599	100
Raking (vanilla)	-0.096	-0.095	0.067	0.072	0.065	0.12	0.115	0.704	0.745	0.923	100
MICE	-0.095	-0.093	0.066	0.064	0.067	0.115	0.115	0.699	0.678	0.954	100
MI-XGB	-0.096	-0.096	0.067	0.081	0.068	0.126	0.117	0.705	0.816	0.864	100
MI-RF	-0.094	-0.092	0.065	0.062	0.066	0.112	0.113	0.706	0.672	0.966	100
IPCW-TMLE-M	-0.107	-0.108	0.118	0.116	0.115	0.158	0.158	0.850	0.824	0.505	100
IPCW-TMLE-MTO	-0.108	-0.106	0.112	0.107	0.107	0.152	0.151	0.836	0.806	0.564	100

Table 35: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and MNAR-value** scenario. The value of the estimand is 0.269. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.000	0.054	0.053	0.054	0.053	0.054	0.947	0.949	0.998	100
Complete-case*	-0.072	-0.073	0.1	0.1	0.098	0.123	0.122	0.882	0.888	0.498	100
Confounded model*	-0.189	-0.191	0.061	0.061	0.061	0.199	0.2	0.125	0.130	0.262	100
IPW*	-0.065	-0.067	0.105	0.104	0.103	0.123	0.123	0.894	0.902	0.494	100
Raking (vanilla)*	-0.351	-0.351	0.071	0.079	0.07	0.36	0.358	0.004	0.002	0.150	100
MICE*	-0.35	-0.351	0.066	0.066	0.067	0.356	0.358	0.000	0.000	0.238	100
MI-XGB*	-0.255	-0.255	0.071	0.075	0.068	0.266	0.264	0.065	0.052	0.046	100
MI-RF*	-0.368	-0.370	0.068	0.065	0.065	0.374	0.376	0.000	0.000	0.335	100
IPCW-TMLE-M	-0.1	-0.104	0.129	0.125	0.126	0.16	0.163	0.844	0.879	0.261	100
IPCW-TMLE-MTO	-0.081	-0.083	0.112	0.108	0.11	0.135	0.138	0.854	0.889	0.405	100
IPCW-a-TMLE-M	-0.1	-0.106	0.129	0.124	0.125	0.16	0.164	0.841	0.879	0.257	100
IPCW-a-TMLE-MTO	-0.079	-0.079	0.107	0.102	0.106	0.129	0.132	0.850	0.887	0.472	100

Table 36: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and MNAR-value** scenario. The value of the estimand is 0.314. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.001	0.001	0.06	0.06	0.059	0.06	0.059	0.947	0.946	0.999	100
Complete-case	-0.117	-0.118	0.1	0.1	0.098	0.154	0.153	0.793	0.790	0.498	100
Confounded model	-0.235	-0.236	0.061	0.061	0.061	0.242	0.243	0.029	0.028	0.262	100
IPW	-0.11	-0.112	0.105	0.104	0.103	0.152	0.152	0.821	0.814	0.494	100
Raking (vanilla)	-0.396	-0.396	0.071	0.079	0.07	0.404	0.402	0.000	0.000	0.150	100
MICE	-0.395	-0.397	0.066	0.066	0.067	0.401	0.402	0.000	0.000	0.238	100
MI-XGB	-0.3	-0.300	0.071	0.075	0.068	0.31	0.308	0.014	0.014	0.046	100
MI-RF	-0.413	-0.415	0.068	0.065	0.065	0.418	0.42	0.000	0.000	0.335	100
IPCW-TMLE-M*	-0.146	-0.149	0.129	0.125	0.126	0.192	0.195	0.794	0.738	0.261	100
IPCW-TMLE-MTO*	-0.127	-0.128	0.112	0.108	0.11	0.166	0.169	0.800	0.758	0.405	100
IPCW-a-TMLE-M*	-0.146	-0.151	0.129	0.124	0.125	0.192	0.196	0.795	0.741	0.257	100
IPCW-a-TMLE-MTO*	-0.125	-0.125	0.107	0.102	0.106	0.161	0.163	0.786	0.745	0.472	100

Table 37: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and MNAR-unobserved** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.002	0.058	0.058	0.057	0.058	0.057	0.953	0.948	1.000	100
Complete-case	-0.046	-0.048	0.091	0.092	0.09	0.103	0.102	0.927	0.923	0.884	100
Confounded model	0.191	0.192	0.057	0.057	0.056	0.199	0.2	0.085	0.080	1.000	100
IPW	-0.047	-0.049	0.095	0.096	0.093	0.107	0.106	0.922	0.923	0.856	100
Raking (vanilla)	-0.004	-0.003	0.062	0.071	0.062	0.071	0.062	0.972	0.948	1.000	100
MICE	-0.004	-0.004	0.061	0.062	0.061	0.062	0.061	0.956	0.949	1.000	100
MI-XGB	-0.01	-0.009	0.063	0.064	0.063	0.065	0.063	0.949	0.947	1.000	100
MI-RF	-0.003	-0.003	0.062	0.061	0.063	0.061	0.063	0.944	0.948	1.000	100
IPCW-TMLE-M	-0.051	-0.052	0.11	0.108	0.108	0.12	0.12	0.920	0.933	0.748	100
IPCW-TMLE-MTO	-0.05	-0.052	0.106	0.102	0.104	0.114	0.116	0.915	0.933	0.792	100
IPCW-a-TMLE-M	-0.051	-0.052	0.11	0.108	0.107	0.12	0.119	0.920	0.931	0.750	100
IPCW-a-TMLE-MTO	-0.05	-0.051	0.106	0.102	0.104	0.114	0.116	0.914	0.933	0.791	100

Table 38: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and MNAR-unobserved** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0	0.000	0.058	0.058	0.057	0.058	0.057	0.949	0.953	1.000	100
Complete-case	-0.047	-0.049	0.091	0.092	0.09	0.104	0.103	0.920	0.926	0.884	100
Confounded model	0.189	0.191	0.057	0.057	0.056	0.198	0.199	0.082	0.088	1.000	100
IPW	-0.049	-0.050	0.095	0.096	0.093	0.108	0.106	0.921	0.921	0.856	100
Raking (vanilla)	-0.005	-0.004	0.062	0.071	0.062	0.071	0.062	0.946	0.972	1.000	100
MICE	-0.005	-0.005	0.061	0.062	0.061	0.062	0.061	0.946	0.955	1.000	100
MI-XGB	-0.011	-0.010	0.063	0.064	0.063	0.065	0.063	0.947	0.948	1.000	100
MI-RF	-0.004	-0.004	0.062	0.061	0.063	0.061	0.063	0.947	0.944	1.000	100
IPCW-TMLE-M	-0.052	-0.053	0.11	0.108	0.108	0.12	0.121	0.932	0.918	0.748	100
IPCW-TMLE-MTO	-0.051	-0.053	0.106	0.102	0.104	0.114	0.116	0.931	0.913	0.792	100
IPCW-a-TMLE-M	-0.052	-0.053	0.11	0.108	0.107	0.12	0.12	0.930	0.918	0.750	100
IPCW-a-TMLE-MTO	-0.051	-0.052	0.106	0.102	0.104	0.114	0.116	0.932	0.913	0.791	100

Table 39: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome (unobserved covariate) and MNAR-unobserved** scenario. The value of the estimand is 0.339. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	0.001	0.065	0.063	0.065	0.063	0.065	0.945	0.954	0.999	100
Complete-case*	-0.048	-0.046	0.097	0.097	0.096	0.108	0.106	0.919	0.921	0.856	100
Confounded model*	0.191	0.194	0.063	0.06	0.061	0.2	0.203	0.129	0.146	1.000	100
IPW*	-0.051	-0.049	0.1	0.101	0.098	0.113	0.109	0.918	0.923	0.827	100
Raking (vanilla)*	-0.006	-0.005	0.068	0.074	0.069	0.075	0.069	0.966	0.946	0.996	100
MICE*	-0.005	-0.005	0.067	0.065	0.068	0.065	0.068	0.942	0.948	0.998	100
MI-RF*	-0.004	-0.003	0.068	0.064	0.068	0.064	0.068	0.934	0.948	0.998	100
IPCW-TMLE-M	-0.055	-0.056	0.114	0.113	0.109	0.126	0.122	0.912	0.923	0.730	100
IPCW-TMLE-MTO	-0.055	-0.054	0.109	0.106	0.106	0.12	0.119	0.908	0.921	0.772	100
IPCW-a-TMLE-M	-0.055	-0.056	0.114	0.113	0.109	0.126	0.123	0.912	0.922	0.733	100
IPCW-a-TMLE-MTO	-0.055	-0.055	0.11	0.106	0.105	0.12	0.118	0.907	0.922	0.778	100

Table 40: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome (unobserved covariate) and MNAR-unobserved** scenario. The value of the estimand is 0.339. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0	0.000	0.063	0.061	0.063	0.061	0.063	0.948	0.941	0.999	100
Complete-case	-0.048	-0.046	0.097	0.097	0.096	0.108	0.106	0.921	0.919	0.856	100
Confounded model	0.191	0.194	0.063	0.06	0.061	0.2	0.203	0.144	0.129	1.000	100
IPW	-0.051	-0.048	0.1	0.101	0.098	0.113	0.109	0.923	0.918	0.827	100
Raking (vanilla)	-0.005	-0.005	0.068	0.074	0.069	0.075	0.069	0.946	0.967	0.996	100
MICE	-0.005	-0.005	0.067	0.065	0.068	0.065	0.068	0.948	0.942	0.998	100
MI-RF	-0.003	-0.002	0.068	0.064	0.068	0.064	0.068	0.948	0.934	0.998	100
IPCW-TMLE-M*	-0.055	-0.056	0.114	0.113	0.109	0.126	0.122	0.923	0.912	0.730	100
IPCW-TMLE-MTO*	-0.055	-0.054	0.109	0.106	0.106	0.119	0.119	0.922	0.908	0.772	100
IPCW-a-TMLE-M*	-0.055	-0.056	0.114	0.113	0.109	0.126	0.123	0.922	0.912	0.733	100
IPCW-a-TMLE-MTO*	-0.055	-0.055	0.11	0.106	0.105	0.119	0.118	0.922	0.908	0.778	100

MNAR: 12% outcome proportion, 80% missingness proportion

Table 41: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and MNAR-value** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.004	0.004	0.06	0.058	0.062	0.058	0.062	0.952	0.956	1.000	100
Complete-case	-0.1	-0.106	0.188	0.185	0.192	0.21	0.219	0.912	0.919	0.244	100
Confounded model	0.192	0.191	0.059	0.057	0.061	0.201	0.201	0.087	0.095	1.000	100
IPW	-0.093	-0.094	0.227	0.218	0.23	0.237	0.248	0.910	0.935	0.192	100
Raking (vanilla)	-0.086	-0.083	0.098	0.103	0.094	0.135	0.125	0.880	0.860	0.681	100
MICE	-0.092	-0.092	0.094	0.094	0.093	0.132	0.131	0.804	0.839	0.729	100
MI-XGB	-0.099	-0.097	0.094	0.101	0.091	0.141	0.133	0.853	0.822	0.645	100
MI-RF	-0.076	-0.076	0.086	0.067	0.084	0.101	0.114	0.742	0.857	0.923	100
IPCW-TMLE-M	-0.098	-0.107	0.267	0.241	0.264	0.26	0.285	0.891	0.942	0.162	100
IPCW-TMLE-MTO	-0.092	-0.098	0.245	0.216	0.245	0.235	0.264	0.882	0.935	0.213	100

Table 42: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and MNAR-value** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.003	0.003	0.06	0.058	0.062	0.058	0.062	0.956	0.952	1.000	100
Complete-case	-0.101	-0.107	0.188	0.185	0.192	0.21	0.22	0.920	0.911	0.244	100
Confounded model	0.191	0.190	0.059	0.057	0.061	0.2	0.2	0.096	0.090	1.000	100
IPW	-0.094	-0.095	0.227	0.218	0.23	0.237	0.249	0.934	0.910	0.192	100
Raking (vanilla)	-0.087	-0.084	0.098	0.103	0.094	0.135	0.126	0.856	0.876	0.681	100
MICE	-0.094	-0.093	0.094	0.094	0.093	0.133	0.131	0.836	0.802	0.729	100
MI-XGB	-0.1	-0.098	0.094	0.101	0.091	0.142	0.134	0.817	0.851	0.645	100
MI-RF	-0.077	-0.078	0.086	0.067	0.084	0.102	0.115	0.855	0.739	0.923	100
IPCW-TMLE-M	-0.099	-0.108	0.267	0.241	0.264	0.261	0.286	0.942	0.890	0.162	100
IPCW-TMLE-MTO	-0.093	-0.099	0.245	0.216	0.245	0.236	0.264	0.935	0.882	0.213	100

Table 43: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and MNAR-value** scenario. The value of the estimand is 0.269. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.002	0.003	0.054	0.053	0.054	0.053	0.054	0.950	0.952	0.999	100
Complete-case*	-0.082	-0.084	0.167	0.167	0.164	0.186	0.184	0.918	0.925	0.198	100
Confounded model*	-0.188	-0.188	0.06	0.061	0.062	0.198	0.198	0.133	0.127	0.266	100
IPW*	-0.067	-0.069	0.196	0.19	0.197	0.202	0.209	0.922	0.936	0.178	100
Raking (vanilla)*	-0.468	-0.468	0.098	0.105	0.1	0.479	0.479	0.006	0.003	0.478	100
MICE*	-0.464	-0.465	0.091	0.087	0.091	0.472	0.474	0.013	0.002	0.627	100
MI-RF*	-0.483	-0.483	0.082	0.072	0.082	0.488	0.49	0.000	0.000	0.814	100
IPCW-TMLE-M	-0.102	-0.114	0.242	0.212	0.23	0.235	0.257	0.879	0.936	0.122	100
IPCW-TMLE-MTO	-0.1	-0.110	0.209	0.185	0.206	0.21	0.234	0.870	0.927	0.168	100
IPCW-a-TMLE-M	-0.102	-0.116	0.241	0.211	0.228	0.235	0.256	0.880	0.937	0.125	100
IPCW-a-TMLE-MTO	-0.1	-0.107	0.2	0.177	0.199	0.204	0.226	0.863	0.924	0.181	100

Table 44: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and MNAR-value** scenario. The value of the estimand is 0.314. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.002	0.002	0.059	0.06	0.059	0.06	0.059	0.950	0.954	1.000	100
Complete-case	-0.127	-0.130	0.167	0.167	0.164	0.209	0.209	0.881	0.876	0.198	100
Confounded model	-0.233	-0.233	0.06	0.061	0.062	0.241	0.241	0.024	0.025	0.266	100
IPW	-0.112	-0.114	0.196	0.19	0.197	0.221	0.228	0.912	0.882	0.178	100
Raking (vanilla)	-0.513	-0.513	0.098	0.105	0.1	0.524	0.523	0.000	0.002	0.478	100
MICE	-0.51	-0.510	0.091	0.087	0.091	0.517	0.519	0.000	0.008	0.627	100
MI-RF	-0.528	-0.528	0.082	0.072	0.082	0.533	0.534	0.000	0.000	0.814	100
IPCW-TMLE-M*	-0.147	-0.159	0.242	0.212	0.23	0.258	0.28	0.917	0.836	0.122	100
IPCW-TMLE-MTO*	-0.145	-0.156	0.209	0.185	0.206	0.235	0.259	0.896	0.820	0.168	100
IPCW-a-TMLE-M*	-0.148	-0.161	0.241	0.211	0.228	0.258	0.279	0.916	0.834	0.125	100
IPCW-a-TMLE-MTO*	-0.145	-0.152	0.2	0.177	0.199	0.229	0.25	0.887	0.818	0.181	100

Table 45: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and MNAR-unobserved** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.001	0.057	0.058	0.057	0.058	0.057	0.952	0.949	1.000	100
Complete-case	-0.024	-0.022	0.191	0.193	0.194	0.194	0.196	0.954	0.952	0.353	100
Confounded model	0.19	0.190	0.056	0.057	0.056	0.198	0.198	0.081	0.075	1.000	100
IPW	-0.025	-0.025	0.223	0.222	0.218	0.223	0.219	0.946	0.946	0.272	100
Raking (vanilla)	-0.004	-0.003	0.091	0.1	0.087	0.1	0.087	0.964	0.946	0.922	100
MICE	-0.007	-0.007	0.078	0.078	0.079	0.078	0.079	0.946	0.948	0.980	100
MI-XGB	0.007	0.008	0.091	0.084	0.088	0.084	0.089	0.920	0.950	0.949	100
MI-RF	0.038	0.039	0.081	0.067	0.081	0.077	0.09	0.858	0.924	0.998	100
IPCW-TMLE-M	-0.039	-0.042	0.252	0.239	0.244	0.242	0.248	0.930	0.948	0.229	100
IPCW-TMLE-MTO	-0.032	-0.035	0.239	0.219	0.231	0.221	0.234	0.922	0.948	0.283	100
IPCW-a-TMLE-M	-0.039	-0.042	0.252	0.239	0.241	0.243	0.244	0.928	0.951	0.229	100
IPCW-a-TMLE-MTO	-0.032	-0.035	0.239	0.218	0.228	0.22	0.231	0.919	0.950	0.288	100

Table 46: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and MNAR-unobserved** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0	0.000	0.057	0.058	0.057	0.058	0.057	0.950	0.952	1.000	100
Complete-case	-0.025	-0.023	0.191	0.193	0.194	0.194	0.196	0.952	0.954	0.353	100
Confounded model	0.189	0.189	0.056	0.057	0.056	0.197	0.197	0.078	0.084	1.000	100
IPW	-0.026	-0.026	0.223	0.222	0.218	0.223	0.219	0.946	0.945	0.272	100
Raking (vanilla)	-0.006	-0.004	0.091	0.1	0.087	0.1	0.087	0.947	0.966	0.922	100
MICE	-0.008	-0.008	0.078	0.078	0.079	0.078	0.08	0.947	0.946	0.980	100
MI-XGB	0.006	0.007	0.091	0.084	0.088	0.084	0.089	0.950	0.921	0.949	100
MI-RF	0.037	0.038	0.081	0.067	0.081	0.077	0.089	0.926	0.860	0.998	100
IPCW-TMLE-M	-0.04	-0.044	0.252	0.239	0.244	0.243	0.248	0.949	0.929	0.229	100
IPCW-TMLE-MTO	-0.034	-0.036	0.239	0.219	0.231	0.222	0.234	0.948	0.922	0.283	100
IPCW-a-TMLE-M	-0.04	-0.043	0.252	0.239	0.241	0.243	0.245	0.950	0.927	0.229	100
IPCW-a-TMLE-MTO	-0.033	-0.036	0.239	0.218	0.228	0.22	0.231	0.950	0.919	0.288	100

Table 47: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome (unobserved covariate) and MNAR-unobserved** scenario. The value of the estimand is 0.339. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.002	0.002	0.065	0.063	0.067	0.063	0.067	0.950	0.955	1.000	100
Complete-case*	-0.031	-0.028	0.201	0.203	0.195	0.205	0.197	0.953	0.946	0.327	100
Confounded model*	0.194	0.194	0.062	0.06	0.064	0.203	0.204	0.110	0.122	1.000	100
IPW*	-0.033	-0.033	0.232	0.232	0.228	0.234	0.23	0.938	0.942	0.250	100
Raking (vanilla)*	-0.005	-0.006	0.094	0.106	0.096	0.106	0.096	0.973	0.952	0.902	100
MICE*	-0.008	-0.011	0.084	0.082	0.084	0.082	0.085	0.943	0.951	0.975	100
MI-XGB*	0.002	0.002	0.089	0.083	0.09	0.083	0.09	0.928	0.952	0.970	100
MI-RF*	0.043	0.043	0.086	0.071	0.087	0.083	0.097	0.854	0.922	0.997	100
IPCW-TMLE-M	-0.046	-0.048	0.267	0.25	0.262	0.255	0.266	0.927	0.946	0.212	100
IPCW-TMLE-MTO	-0.039	-0.039	0.251	0.228	0.243	0.232	0.246	0.912	0.944	0.276	100
IPCW-a-TMLE-M	-0.046	-0.050	0.267	0.25	0.26	0.255	0.265	0.928	0.946	0.214	100
IPCW-a-TMLE-MTO	-0.04	-0.038	0.249	0.227	0.239	0.23	0.242	0.915	0.944	0.274	100

Table 48: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome (unobserved covariate) and MNAR-unobserved** scenario. The value of the estimand is 0.339. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.002	0.001	0.063	0.061	0.065	0.061	0.065	0.957	0.949	0.999	100
Complete-case	-0.03	-0.028	0.201	0.203	0.195	0.205	0.197	0.946	0.953	0.327	100
Confounded model	0.194	0.194	0.062	0.06	0.064	0.203	0.204	0.122	0.110	1.000	100
IPW	-0.033	-0.033	0.232	0.232	0.228	0.234	0.23	0.942	0.938	0.250	100
Raking (vanilla)	-0.005	-0.006	0.094	0.106	0.096	0.106	0.096	0.952	0.973	0.902	100
MICE	-0.008	-0.011	0.084	0.082	0.084	0.082	0.085	0.951	0.943	0.975	100
MI-XGB	0.002	0.002	0.089	0.083	0.09	0.083	0.09	0.952	0.928	0.970	100
MI-RF	0.043	0.043	0.086	0.071	0.087	0.083	0.097	0.922	0.854	0.997	100
IPCW-TMLE-M*	-0.046	-0.048	0.267	0.25	0.262	0.255	0.266	0.946	0.927	0.212	100
IPCW-TMLE-MTO*	-0.039	-0.039	0.251	0.228	0.243	0.232	0.246	0.944	0.912	0.276	100
IPCW-a-TMLE-M*	-0.046	-0.050	0.267	0.25	0.26	0.255	0.265	0.946	0.928	0.214	100
IPCW-a-TMLE-MTO*	-0.04	-0.037	0.249	0.227	0.239	0.23	0.242	0.944	0.915	0.274	100

MNAR: 5% outcome proportion, 40% missingness proportion

Table 49: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and MNAR-value** scenario. The value of the estimand is 0.374. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	-0.001	0.091	0.095	0.089	0.095	0.089	0.960	0.952	0.984	100
Complete-case	-0.124	-0.124	0.15	0.154	0.153	0.198	0.197	0.870	0.865	0.367	100
Confounded model	0.211	0.209	0.088	0.093	0.087	0.23	0.226	0.373	0.330	1.000	100
IPW	-0.129	-0.128	0.162	0.163	0.16	0.208	0.205	0.865	0.866	0.326	100
Raking (vanilla)	-0.106	-0.108	0.103	0.119	0.101	0.159	0.148	0.890	0.824	0.627	100
MICE	-0.108	-0.109	0.102	0.104	0.1	0.15	0.148	0.823	0.812	0.728	100
MI-XGB	-0.107	-0.108	0.103	0.116	0.103	0.157	0.149	0.884	0.816	0.648	100
MI-RF	-0.098	-0.098	0.1	0.1	0.099	0.141	0.139	0.830	0.832	0.776	100
IPCW-TMLE-M	-0.132	-0.135	0.184	0.181	0.182	0.224	0.226	0.865	0.887	0.255	100
IPCW-TMLE-MTO	-0.129	-0.130	0.179	0.169	0.173	0.212	0.216	0.855	0.884	0.301	100

Table 50: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and MNAR-value** scenario. The value of the estimand is 0.369. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.004	0.004	0.091	0.095	0.089	0.095	0.089	0.952	0.961	0.984	100
Complete-case	-0.119	-0.119	0.15	0.154	0.153	0.195	0.193	0.872	0.877	0.367	100
Confounded model	0.216	0.214	0.088	0.093	0.087	0.235	0.231	0.308	0.352	1.000	100
IPW	-0.124	-0.123	0.162	0.163	0.16	0.205	0.202	0.874	0.872	0.326	100
Raking (vanilla)	-0.101	-0.103	0.103	0.119	0.101	0.156	0.145	0.836	0.903	0.627	100
MICE	-0.103	-0.104	0.102	0.104	0.1	0.146	0.145	0.833	0.843	0.728	100
MI-XGB	-0.102	-0.103	0.103	0.116	0.103	0.154	0.145	0.833	0.893	0.648	100
MI-RF	-0.093	-0.092	0.1	0.1	0.099	0.137	0.136	0.846	0.847	0.776	100
IPCW-TMLE-M	-0.126	-0.130	0.184	0.181	0.182	0.221	0.223	0.892	0.872	0.255	100
IPCW-TMLE-MTO	-0.124	-0.124	0.179	0.169	0.173	0.209	0.213	0.890	0.860	0.301	100

Table 51: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and MNAR-value** scenario. The value of the estimand is 0.281. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.002	0.004	0.081	0.081	0.081	0.081	0.081	0.946	0.947	0.932	100
Complete-case*	-0.064	-0.067	0.152	0.153	0.148	0.166	0.162	0.933	0.931	0.283	100
Confounded model*	-0.256	-0.253	0.091	0.092	0.091	0.272	0.269	0.196	0.194	0.058	100
IPW*	-0.058	-0.058	0.158	0.159	0.154	0.169	0.165	0.938	0.939	0.280	100
Raking (vanilla)*	-0.454	-0.454	0.109	0.128	0.11	0.471	0.467	0.036	0.014	0.238	100
MICE*	-0.478	-0.478	0.099	0.1	0.098	0.489	0.488	0.003	0.001	0.507	100
MI-RF*	-0.461	-0.459	0.101	0.098	0.1	0.472	0.47	0.002	0.002	0.451	100
IPCW-TMLE-M	-0.103	-0.108	0.193	0.186	0.184	0.213	0.213	0.885	0.920	0.142	100
IPCW-TMLE-MTO	-0.075	-0.079	0.17	0.166	0.167	0.182	0.185	0.914	0.926	0.226	100
IPCW-a-TMLE-M	-0.103	-0.108	0.193	0.186	0.183	0.213	0.213	0.886	0.917	0.142	100
IPCW-a-TMLE-MTO	-0.072	-0.076	0.159	0.154	0.153	0.17	0.171	0.907	0.927	0.267	100
r-IPCW-TMLE-MTO	-0.002	0.001	0.184	0.167	0.179	0.167	0.179	0.926	0.952	0.394	100

Table 52: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and MNAR-value** scenario. The value of the estimand is 0.349. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.006	-0.007	0.088	0.089	0.088	0.089	0.089	0.948	0.953	0.963	100
Complete-case	-0.132	-0.134	0.152	0.153	0.148	0.202	0.2	0.868	0.865	0.283	100
Confounded model	-0.324	-0.321	0.091	0.092	0.091	0.337	0.333	0.050	0.051	0.058	100
IPW	-0.125	-0.126	0.158	0.159	0.154	0.202	0.199	0.880	0.870	0.280	100
Raking (vanilla)	-0.521	-0.522	0.109	0.128	0.11	0.537	0.533	0.002	0.009	0.238	100
MICE	-0.546	-0.546	0.099	0.1	0.098	0.555	0.554	0.000	0.000	0.507	100
MI-RF	-0.529	-0.527	0.101	0.098	0.1	0.538	0.536	0.000	0.000	0.451	100
IPCW-TMLE-M*	-0.171	-0.176	0.193	0.186	0.184	0.253	0.255	0.858	0.814	0.142	100
IPCW-TMLE-MTO*	-0.143	-0.147	0.17	0.166	0.167	0.219	0.222	0.870	0.836	0.226	100
IPCW-a-TMLE-M*	-0.171	-0.176	0.193	0.186	0.183	0.253	0.254	0.857	0.816	0.142	100
IPCW-a-TMLE-MTO*	-0.14	-0.144	0.159	0.154	0.153	0.208	0.21	0.866	0.829	0.267	100
r-IPCW-TMLE-MTO*	-0.069	-0.067	0.184	0.167	0.179	0.181	0.191	0.930	0.896	0.394	100

Table 53: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and MNAR-unobserved** scenario. The value of the estimand is 0.374. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	-0.001	0.096	0.095	0.096	0.095	0.096	0.946	0.950	0.975	100
Complete-case	-0.062	-0.065	0.152	0.149	0.148	0.162	0.162	0.925	0.934	0.542	100
Confounded model	0.21	0.210	0.094	0.093	0.095	0.23	0.23	0.380	0.394	1.000	100
IPW	-0.065	-0.068	0.156	0.155	0.155	0.168	0.169	0.919	0.926	0.511	100
Raking (vanilla)	-0.007	-0.007	0.104	0.119	0.103	0.119	0.103	0.976	0.949	0.904	100
MICE	-0.007	-0.009	0.102	0.101	0.103	0.101	0.103	0.946	0.947	0.953	100
MI-RF	0.015	0.015	0.103	0.1	0.103	0.101	0.104	0.944	0.948	0.968	100
IPCW-TMLE-M	-0.07	-0.072	0.176	0.171	0.175	0.185	0.19	0.920	0.932	0.419	100
IPCW-TMLE-MTO	-0.069	-0.073	0.171	0.162	0.168	0.176	0.183	0.912	0.929	0.465	100
IPCW-a-TMLE-M	-0.07	-0.073	0.176	0.171	0.176	0.185	0.19	0.921	0.934	0.420	100
IPCW-a-TMLE-MTO	-0.069	-0.073	0.17	0.162	0.169	0.176	0.184	0.910	0.930	0.466	100
r-IPCW-TMLE-MTO	-0.071	-0.075	0.171	0.162	0.169	0.177	0.184	0.909	0.928	0.459	100

Table 54: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and MNAR-unobserved** scenario. The value of the estimand is 0.369. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.004	0.004	0.096	0.095	0.096	0.095	0.096	0.950	0.950	0.975	100
Complete-case	-0.057	-0.060	0.152	0.149	0.148	0.16	0.16	0.938	0.929	0.542	100
Confounded model	0.215	0.215	0.094	0.093	0.095	0.234	0.235	0.371	0.363	1.000	100
IPW	-0.06	-0.063	0.156	0.155	0.155	0.166	0.167	0.931	0.925	0.511	100
Raking (vanilla)	-0.002	-0.001	0.104	0.119	0.103	0.119	0.103	0.950	0.977	0.904	100
MICE	-0.002	-0.003	0.102	0.101	0.103	0.101	0.103	0.950	0.950	0.953	100
MI-RF	0.021	0.020	0.103	0.1	0.103	0.102	0.105	0.946	0.940	0.968	100
IPCW-TMLE-M	-0.065	-0.066	0.176	0.171	0.175	0.183	0.188	0.935	0.922	0.419	100
IPCW-TMLE-MTO	-0.064	-0.068	0.171	0.162	0.168	0.174	0.181	0.932	0.915	0.465	100
IPCW-a-TMLE-M	-0.065	-0.068	0.176	0.171	0.176	0.183	0.188	0.935	0.923	0.420	100
IPCW-a-TMLE-MTO	-0.064	-0.068	0.17	0.162	0.169	0.174	0.182	0.934	0.913	0.466	100
r-IPCW-TMLE-MTO	-0.066	-0.070	0.171	0.162	0.169	0.175	0.182	0.930	0.913	0.459	100

Table 55: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome (unobserved covariate) and MNAR-unobserved** scenario. The value of the estimand is 0.378. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0	-0.002	0.103	0.106	0.101	0.106	0.101	0.958	0.951	0.957	100
Complete-case*	-0.06	-0.058	0.161	0.162	0.16	0.172	0.17	0.930	0.932	0.510	100
Confounded model*	0.214	0.212	0.097	0.101	0.095	0.237	0.232	0.440	0.406	1.000	100
IPW*	-0.061	-0.060	0.169	0.168	0.166	0.178	0.176	0.923	0.931	0.478	100
Raking (vanilla)*	-0.005	-0.004	0.108	0.129	0.109	0.129	0.109	0.980	0.952	0.870	100
MICE*	-0.005	-0.006	0.106	0.109	0.104	0.109	0.104	0.956	0.949	0.940	100
MI-RF*	0.024	0.023	0.106	0.108	0.106	0.11	0.108	0.945	0.941	0.966	100
IPCW-TMLE-M	-0.068	-0.067	0.19	0.184	0.189	0.196	0.201	0.922	0.935	0.396	100
IPCW-TMLE-MTO	-0.067	-0.065	0.185	0.174	0.181	0.187	0.192	0.914	0.932	0.439	100
IPCW-a-TMLE-M	-0.068	-0.068	0.19	0.184	0.188	0.196	0.2	0.920	0.936	0.397	100
IPCW-a-TMLE-MTO	-0.067	-0.067	0.185	0.174	0.183	0.186	0.195	0.910	0.932	0.439	100
r-IPCW-TMLE-MTO	-0.069	-0.066	0.184	0.174	0.182	0.187	0.194	0.912	0.932	0.430	100

Table 56: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome (unobserved covariate) and MNAR-unobserved** scenario. The value of the estimand is 0.377. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.001	0.000	0.1	0.103	0.098	0.103	0.098	0.952	0.958	0.966	100
Complete-case	-0.059	-0.057	0.161	0.162	0.16	0.172	0.17	0.933	0.931	0.510	100
Confounded model	0.215	0.213	0.097	0.101	0.095	0.238	0.233	0.401	0.434	1.000	100
IPW	-0.06	-0.059	0.169	0.168	0.166	0.178	0.176	0.932	0.924	0.478	100
Raking (vanilla)	-0.004	-0.003	0.108	0.129	0.109	0.129	0.109	0.951	0.981	0.870	100
MICE	-0.004	-0.005	0.106	0.109	0.104	0.109	0.104	0.948	0.956	0.940	100
MI-RF	0.025	0.024	0.106	0.108	0.106	0.111	0.108	0.942	0.945	0.966	100
IPCW-TMLE-M*	-0.067	-0.066	0.19	0.184	0.189	0.195	0.201	0.935	0.923	0.396	100
IPCW-TMLE-MTO*	-0.066	-0.064	0.185	0.174	0.181	0.186	0.192	0.932	0.914	0.439	100
IPCW-a-TMLE-M*	-0.067	-0.066	0.19	0.184	0.188	0.195	0.2	0.938	0.920	0.397	100
IPCW-a-TMLE-MTO*	-0.066	-0.066	0.185	0.174	0.183	0.186	0.195	0.934	0.911	0.439	100
r-IPCW-TMLE-MTO*	-0.068	-0.065	0.184	0.174	0.182	0.187	0.194	0.932	0.914	0.430	100

MNAR: 5% outcome proportion, 80% missingness proportion

Table 57: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and MNAR-value** scenario. The value of the estimand is 0.374. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	-0.002	0.096	0.095	0.097	0.095	0.097	0.955	0.954	0.977	100
Complete-case	-0.111	-0.115	0.316	0.3	0.311	0.32	0.332	0.915	0.932	0.135	100
Confounded model	0.21	0.210	0.093	0.093	0.095	0.23	0.23	0.394	0.399	1.000	100
IPW	-0.109	-0.121	0.372	0.349	0.373	0.366	0.392	0.911	0.942	0.113	100
Raking (vanilla)	-0.105	-0.104	0.159	0.171	0.16	0.201	0.191	0.922	0.902	0.356	100
MICE	-0.111	-0.107	0.146	0.147	0.144	0.184	0.18	0.865	0.875	0.464	100
MI-XGB	-0.093	-0.091	0.149	0.14	0.148	0.168	0.174	0.886	0.900	0.536	100
MI-RF	-0.028	-0.027	0.133	0.109	0.137	0.113	0.14	0.884	0.946	0.832	100
IPCW-TMLE-M	-0.127	-0.142	0.419	0.367	0.403	0.388	0.427	0.894	0.944	0.107	100
IPCW-TMLE-MTO	-0.114	-0.120	0.389	0.335	0.375	0.354	0.394	0.890	0.942	0.140	100

Table 58: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and MNAR-value** scenario. The value of the estimand is 0.369. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.004	0.003	0.096	0.095	0.097	0.095	0.097	0.954	0.955	0.977	100
Complete-case	-0.106	-0.110	0.316	0.3	0.311	0.318	0.33	0.933	0.917	0.135	100
Confounded model	0.215	0.215	0.093	0.093	0.095	0.235	0.235	0.376	0.370	1.000	100
IPW	-0.104	-0.116	0.372	0.349	0.373	0.364	0.391	0.942	0.913	0.113	100
Raking (vanilla)	-0.1	-0.099	0.159	0.171	0.16	0.198	0.188	0.906	0.928	0.356	100
MICE	-0.106	-0.102	0.146	0.147	0.144	0.181	0.177	0.881	0.874	0.464	100
MI-XGB	-0.088	-0.086	0.149	0.14	0.148	0.165	0.171	0.903	0.892	0.536	100
MI-RF	-0.023	-0.022	0.133	0.109	0.137	0.112	0.139	0.948	0.890	0.832	100
IPCW-TMLE-M	-0.122	-0.137	0.419	0.367	0.403	0.387	0.426	0.945	0.896	0.107	100
IPCW-TMLE-MTO	-0.108	-0.115	0.389	0.335	0.375	0.352	0.392	0.944	0.892	0.140	100

Table 59: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and MNAR-value** scenario. The value of the estimand is 0.281. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.003	0.002	0.084	0.081	0.083	0.081	0.083	0.938	0.944	0.931	100
Complete-case*	-0.057	-0.063	0.248	0.246	0.244	0.252	0.252	0.944	0.947	0.136	100
Confounded model*	-0.256	-0.255	0.093	0.092	0.092	0.272	0.271	0.203	0.207	0.065	100
IPW*	-0.051	-0.059	0.285	0.275	0.275	0.28	0.281	0.928	0.946	0.116	100
Raking (vanilla)*	-0.63	-0.632	0.154	0.163	0.147	0.651	0.649	0.039	0.019	0.599	100
MICE*	-0.66	-0.662	0.132	0.124	0.135	0.672	0.676	0.006	0.002	0.832	100
MI-RF*	-0.621	-0.624	0.119	0.105	0.119	0.63	0.635	0.000	0.000	0.868	100
IPCW-TMLE-M	-0.103	-0.125	0.32	0.29	0.297	0.308	0.322	0.902	0.939	0.098	100
IPCW-TMLE-MTO	-0.097	-0.102	0.295	0.264	0.28	0.281	0.298	0.897	0.940	0.121	100
IPCW-a-TMLE-M	-0.102	-0.123	0.319	0.29	0.296	0.307	0.321	0.902	0.940	0.094	100
IPCW-a-TMLE-MTO	-0.093	-0.099	0.285	0.255	0.269	0.271	0.286	0.895	0.934	0.124	100
r-IPCW-TMLE-MTO	-0.08	-0.090	0.307	0.267	0.286	0.279	0.3	0.896	0.946	0.138	100

Table 60: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and MNAR-value** scenario. The value of the estimand is 0.349. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.005	-0.006	0.091	0.089	0.09	0.089	0.091	0.949	0.946	0.971	100
Complete-case	-0.124	-0.131	0.248	0.246	0.244	0.275	0.277	0.928	0.918	0.136	100
Confounded model	-0.323	-0.323	0.093	0.092	0.092	0.336	0.336	0.065	0.062	0.065	100
IPW	-0.119	-0.126	0.285	0.275	0.275	0.3	0.302	0.927	0.904	0.116	100
Raking (vanilla)	-0.698	-0.700	0.154	0.163	0.147	0.717	0.715	0.008	0.023	0.599	100
MICE	-0.728	-0.730	0.132	0.124	0.135	0.738	0.742	0.000	0.004	0.832	100
MI-RF	-0.689	-0.691	0.119	0.105	0.119	0.697	0.702	0.000	0.000	0.868	100
IPCW-TMLE-M*	-0.171	-0.193	0.32	0.29	0.297	0.337	0.354	0.919	0.872	0.098	100
IPCW-TMLE-MTO*	-0.164	-0.169	0.295	0.264	0.28	0.311	0.327	0.915	0.862	0.121	100
IPCW-a-TMLE-M*	-0.17	-0.190	0.319	0.29	0.296	0.336	0.352	0.920	0.873	0.094	100
IPCW-a-TMLE-MTO*	-0.161	-0.166	0.285	0.255	0.269	0.301	0.316	0.914	0.862	0.124	100
r-IPCW-TMLE-MTO*	-0.147	-0.158	0.307	0.267	0.286	0.305	0.327	0.927	0.858	0.138	100

Table 61: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and MNAR-unobserved** scenario. The value of the estimand is 0.374. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.002	0.004	0.097	0.095	0.097	0.095	0.097	0.951	0.952	0.978	100
Complete-case	-0.044	-0.050	0.32	0.313	0.313	0.316	0.317	0.947	0.954	0.179	100
Confounded model	0.214	0.215	0.094	0.093	0.096	0.233	0.235	0.370	0.384	1.000	100
IPW	-0.038	-0.048	0.372	0.354	0.362	0.356	0.366	0.936	0.951	0.154	100
Raking (vanilla)	-0.006	-0.005	0.146	0.17	0.144	0.17	0.144	0.973	0.942	0.600	100
MICE	-0.008	-0.006	0.127	0.126	0.125	0.126	0.125	0.944	0.952	0.814	100
MI-RF	0.104	0.110	0.114	0.106	0.112	0.148	0.158	0.815	0.855	0.986	100
IPCW-TMLE-M	-0.05	-0.071	0.41	0.371	0.395	0.374	0.401	0.924	0.944	0.150	100
IPCW-TMLE-MTO	-0.041	-0.063	0.381	0.341	0.37	0.344	0.376	0.916	0.946	0.190	100
IPCW-a-TMLE-M	-0.05	-0.077	0.409	0.371	0.398	0.374	0.406	0.924	0.947	0.153	100
IPCW-a-TMLE-MTO	-0.04	-0.056	0.377	0.338	0.365	0.341	0.369	0.919	0.947	0.189	100
r-IPCW-TMLE-MTO	-0.044	-0.066	0.384	0.343	0.381	0.345	0.387	0.915	0.947	0.184	100

Table 62: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome and MNAR-unobserved** scenario. The value of the estimand is 0.369. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.007	0.009	0.097	0.095	0.097	0.096	0.097	0.950	0.951	0.978	100
Complete-case	-0.039	-0.045	0.32	0.313	0.313	0.315	0.316	0.955	0.948	0.179	100
Confounded model	0.219	0.220	0.094	0.093	0.096	0.238	0.24	0.358	0.355	1.000	100
IPW	-0.033	-0.043	0.372	0.354	0.362	0.356	0.365	0.951	0.937	0.154	100
Raking (vanilla)	-0.001	0.000	0.146	0.17	0.144	0.17	0.144	0.943	0.973	0.600	100
MICE	-0.003	-0.001	0.127	0.126	0.125	0.126	0.125	0.953	0.946	0.814	100
MI-RF	0.109	0.116	0.114	0.106	0.112	0.152	0.161	0.845	0.802	0.986	100
IPCW-TMLE-M	-0.045	-0.066	0.41	0.371	0.395	0.374	0.401	0.944	0.924	0.150	100
IPCW-TMLE-MTO	-0.036	-0.058	0.381	0.341	0.37	0.343	0.375	0.945	0.917	0.190	100
IPCW-a-TMLE-M	-0.045	-0.072	0.409	0.371	0.398	0.374	0.405	0.946	0.924	0.153	100
IPCW-a-TMLE-MTO	-0.035	-0.051	0.377	0.338	0.365	0.34	0.368	0.947	0.921	0.189	100
r-IPCW-TMLE-MTO	-0.039	-0.061	0.384	0.343	0.381	0.345	0.386	0.947	0.917	0.184	100

Table 63: **Synthetic data MNAR simulation: oracle marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome (unobserved covariate) and MNAR-unobserved** scenario. The value of the estimand is 0.378. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0	-0.001	0.106	0.106	0.107	0.106	0.107	0.952	0.950	0.949	100
Complete-case*	-0.034	-0.043	0.347	0.34	0.338	0.341	0.341	0.945	0.946	0.168	100
Confounded model*	0.214	0.211	0.1	0.101	0.101	0.236	0.233	0.436	0.442	1.000	100
IPW*	-0.034	-0.040	0.404	0.384	0.398	0.385	0.4	0.931	0.951	0.142	100
Raking (vanilla)*	-0.005	-0.004	0.161	0.186	0.159	0.186	0.159	0.974	0.946	0.532	100
MICE*	-0.006	-0.005	0.138	0.136	0.142	0.136	0.142	0.944	0.948	0.768	100
MI-XGB*	0.053	0.055	0.14	0.126	0.145	0.137	0.155	0.892	0.937	0.890	100
MI-RF*	0.117	0.117	0.12	0.114	0.121	0.163	0.168	0.803	0.830	0.985	100
IPCW-TMLE-M	-0.059	-0.068	0.442	0.397	0.428	0.401	0.433	0.918	0.948	0.135	100
IPCW-TMLE-MTO	-0.043	-0.043	0.415	0.368	0.395	0.37	0.397	0.914	0.947	0.166	100
IPCW-a-TMLE-M	-0.059	-0.065	0.442	0.397	0.429	0.401	0.433	0.915	0.947	0.133	100
IPCW-a-TMLE-MTO	-0.04	-0.042	0.41	0.364	0.394	0.366	0.397	0.918	0.948	0.168	100

Table 64: **Synthetic data MNAR simulation: census marginal relative risk (mRR), 5% outcome proportion, 80% missing proportion**. Comparing estimators under the **simple outcome (unobserved covariate) and MNAR-unobserved** scenario. The value of the estimand is 0.377. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.001	0.000	0.103	0.103	0.102	0.103	0.102	0.950	0.950	0.956	100
Complete-case	-0.033	-0.042	0.347	0.34	0.338	0.341	0.341	0.946	0.945	0.168	100
Confounded model	0.215	0.212	0.1	0.101	0.101	0.237	0.234	0.440	0.432	1.000	100
IPW	-0.033	-0.039	0.404	0.384	0.398	0.385	0.4	0.951	0.932	0.142	100
Raking (vanilla)	-0.004	-0.003	0.161	0.186	0.159	0.186	0.159	0.946	0.973	0.532	100
MICE	-0.005	-0.004	0.138	0.136	0.142	0.136	0.142	0.949	0.945	0.768	100
MI-XGB	0.054	0.056	0.14	0.126	0.145	0.137	0.156	0.935	0.891	0.890	100
MI-RF	0.118	0.118	0.12	0.114	0.121	0.164	0.169	0.829	0.800	0.985	100
IPCW-TMLE-M*	-0.058	-0.067	0.442	0.397	0.428	0.401	0.433	0.948	0.918	0.135	100
IPCW-TMLE-MTO*	-0.042	-0.042	0.415	0.368	0.395	0.37	0.397	0.947	0.914	0.166	100
IPCW-a-TMLE-M*	-0.058	-0.064	0.442	0.397	0.429	0.401	0.433	0.948	0.915	0.133	100
IPCW-a-TMLE-MTO*	-0.039	-0.041	0.41	0.364	0.394	0.366	0.397	0.948	0.918	0.168	100

Other scenarios

Table 65: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome (no treatment effect) and simple MAR (no dependence on Y)** scenario. The value of the estimand is 0. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.003	-0.003	0.064	0.064	0.065	0.064	0.065	0.951	0.949	0.049	100
Complete-case	-0.003	-0.003	0.085	0.085	0.085	0.085	0.085	0.944	0.945	0.056	100
Confounded model	0.193	0.193	0.063	0.063	0.065	0.203	0.204	0.139	0.141	0.862	100
IPW	-0.004	-0.004	0.098	0.097	0.098	0.098	0.098	0.944	0.949	0.056	100
Raking (vanilla)	-0.002	-0.004	0.07	0.069	0.069	0.069	0.069	0.948	0.950	0.052	100
MICE	-0.002	-0.003	0.067	0.067	0.067	0.067	0.067	0.948	0.952	0.052	100
MI-XGB	-0.006	-0.006	0.069	0.069	0.07	0.07	0.071	0.948	0.946	0.052	100
MI-RF	0.007	0.006	0.068	0.067	0.069	0.068	0.069	0.946	0.948	0.054	100
IPCW-TMLE-M	-0.007	-0.006	0.121	0.115	0.123	0.115	0.123	0.938	0.949	0.062	100
IPCW-TMLE-MTO	-0.005	-0.004	0.112	0.104	0.112	0.104	0.112	0.934	0.950	0.067	100
IPCW-a-TMLE-M	-0.007	-0.006	0.121	0.115	0.123	0.115	0.123	0.939	0.950	0.061	100
IPCW-a-TMLE-MTO	-0.005	-0.005	0.111	0.103	0.109	0.103	0.109	0.931	0.949	0.069	100

Table 66: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome (no treatment effect) and simple MAR (no dependence on Y)** scenario. The value of the estimand is 0.004. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.006	-0.007	0.064	0.064	0.065	0.064	0.065	0.946	0.949	0.049	100
Complete-case	-0.007	-0.007	0.085	0.085	0.085	0.085	0.085	0.944	0.945	0.056	100
Confounded model	0.189	0.189	0.063	0.063	0.065	0.199	0.2	0.159	0.156	0.862	100
IPW	-0.008	-0.008	0.098	0.097	0.098	0.098	0.098	0.949	0.943	0.056	100
Raking (vanilla)	-0.006	-0.008	0.07	0.069	0.069	0.069	0.069	0.949	0.946	0.052	100
MICE	-0.006	-0.007	0.067	0.067	0.067	0.067	0.067	0.949	0.945	0.052	100
MI-XGB	-0.009	-0.009	0.069	0.069	0.07	0.07	0.071	0.943	0.945	0.052	100
MI-RF	0.003	0.003	0.068	0.067	0.069	0.067	0.069	0.948	0.946	0.054	100
IPCW-TMLE-M	-0.011	-0.010	0.121	0.115	0.123	0.116	0.123	0.950	0.938	0.062	100
IPCW-TMLE-MTO	-0.009	-0.008	0.112	0.104	0.112	0.105	0.112	0.949	0.932	0.067	100
IPCW-a-TMLE-M	-0.011	-0.010	0.121	0.115	0.123	0.115	0.123	0.950	0.936	0.061	100
IPCW-a-TMLE-MTO	-0.009	-0.009	0.111	0.103	0.109	0.104	0.109	0.948	0.930	0.069	100

Table 67: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome (no treatment effect) and simple MAR** scenario. The value of the estimand is 0. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	0.000	0.064	0.064	0.064	0.064	0.064	0.945	0.944	0.055	100
Complete-case	-0.177	-0.176	0.119	0.117	0.12	0.212	0.213	0.665	0.680	0.335	100
Confounded model	0.194	0.195	0.063	0.063	0.063	0.204	0.205	0.134	0.132	0.868	100
IPW	-0.007	-0.006	0.122	0.121	0.123	0.121	0.123	0.945	0.952	0.054	100
Raking (vanilla)	-0.001	0.000	0.07	0.071	0.07	0.071	0.07	0.951	0.948	0.049	100
MICE	0	0.001	0.068	0.069	0.068	0.069	0.068	0.950	0.947	0.050	100
MI-XGB	-0.003	-0.001	0.07	0.07	0.069	0.07	0.069	0.952	0.949	0.047	100
MI-RF	0.01	0.013	0.07	0.068	0.07	0.069	0.071	0.942	0.948	0.058	100
IPCW-TMLE-M	-0.027	-0.025	0.144	0.14	0.144	0.142	0.147	0.941	0.946	0.058	100
IPCW-TMLE-MTO	-0.032	-0.030	0.135	0.129	0.139	0.133	0.142	0.935	0.946	0.065	100

Table 68: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome (no treatment effect) and simple MAR** scenario. The value of the estimand is 0.004. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.005	-0.004	0.064	0.064	0.064	0.064	0.064	0.944	0.944	0.055	100
Complete-case	-0.181	-0.180	0.119	0.117	0.12	0.215	0.216	0.669	0.654	0.335	100
Confounded model	0.19	0.191	0.063	0.063	0.063	0.2	0.201	0.149	0.146	0.868	100
IPW	-0.011	-0.010	0.122	0.121	0.123	0.121	0.123	0.949	0.945	0.054	100
Raking (vanilla)	-0.005	-0.004	0.07	0.071	0.07	0.071	0.07	0.950	0.952	0.049	100
MICE	-0.004	-0.003	0.068	0.069	0.068	0.069	0.068	0.947	0.951	0.050	100
MI-XGB	-0.007	-0.005	0.07	0.07	0.069	0.07	0.07	0.946	0.949	0.047	100
MI-RF	0.006	0.009	0.07	0.068	0.07	0.069	0.07	0.946	0.943	0.058	100
IPCW-TMLE-M	-0.031	-0.029	0.144	0.14	0.144	0.143	0.147	0.944	0.938	0.058	100
IPCW-TMLE-MTO	-0.036	-0.034	0.135	0.129	0.139	0.134	0.143	0.945	0.930	0.065	100

Table 69: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and simple MAR (no dependence on Y)** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.004	0.004	0.058	0.058	0.059	0.058	0.059	0.953	0.952	1.000	100
Complete-case	0.006	0.004	0.079	0.078	0.081	0.078	0.081	0.946	0.946	0.993	100
Confounded model	0.193	0.194	0.058	0.057	0.058	0.201	0.202	0.080	0.081	1.000	100
IPW	0.001	-0.002	0.092	0.088	0.091	0.088	0.091	0.939	0.947	0.969	100
Raking (vanilla)	0.003	0.004	0.064	0.063	0.064	0.063	0.065	0.947	0.951	1.000	100
MICE	0.003	0.004	0.061	0.061	0.063	0.061	0.064	0.953	0.952	1.000	100
MI-XGB	-0.002	-0.001	0.062	0.063	0.064	0.063	0.064	0.955	0.950	1.000	100
MI-RF	0.01	0.011	0.062	0.061	0.063	0.062	0.064	0.949	0.949	1.000	100
IPCW-TMLE-M	0	-0.004	0.108	0.102	0.104	0.102	0.104	0.936	0.948	0.908	100
IPCW-TMLE-MTO	0.001	-0.001	0.102	0.093	0.099	0.093	0.099	0.919	0.944	0.944	100

Table 70: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and simple MAR (no dependence on Y)** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.003	0.002	0.058	0.058	0.059	0.058	0.059	0.952	0.954	1.000	100
Complete-case	0.004	0.003	0.079	0.078	0.081	0.078	0.081	0.946	0.946	0.993	100
Confounded model	0.192	0.193	0.058	0.057	0.058	0.2	0.201	0.083	0.081	1.000	100
IPW	0	-0.003	0.092	0.088	0.091	0.088	0.091	0.947	0.940	0.969	100
Raking (vanilla)	0.002	0.003	0.064	0.063	0.064	0.063	0.064	0.950	0.946	1.000	100
MICE	0.002	0.003	0.061	0.061	0.063	0.061	0.064	0.955	0.954	1.000	100
MI-XGB	-0.003	-0.003	0.062	0.063	0.064	0.063	0.064	0.950	0.953	1.000	100
MI-RF	0.009	0.009	0.062	0.061	0.063	0.062	0.063	0.951	0.950	1.000	100
IPCW-TMLE-M	-0.001	-0.005	0.108	0.102	0.104	0.102	0.104	0.948	0.936	0.908	100
IPCW-TMLE-MTO	0	-0.002	0.102	0.093	0.099	0.093	0.099	0.943	0.918	0.944	100

Table 71: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and simple MAR (no dependence on Y)** scenario. The value of the estimand is 0.333. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.003	0.005	0.059	0.058	0.06	0.058	0.06	0.946	0.950	1.000	100
Complete-case	0.007	0.004	0.143	0.14	0.14	0.141	0.14	0.944	0.947	0.679	100
Confounded model	0.191	0.192	0.058	0.057	0.059	0.199	0.201	0.091	0.098	1.000	100
IPW	0.012	-0.005	0.65	0.202	0.214	0.202	0.214	0.938	0.998	0.373	100
Raking (vanilla)	0.001	0.000	0.092	0.089	0.092	0.089	0.092	0.940	0.952	0.950	100
MICE	0.001	0.001	0.073	0.071	0.075	0.071	0.075	0.945	0.954	0.994	100
MI-RF	0.027	0.027	0.078	0.069	0.078	0.074	0.082	0.900	0.937	0.997	100
IPCW-TMLE-M	-0.011	-0.010	0.235	0.216	0.242	0.216	0.242	0.932	0.949	0.333	100
IPCW-TMLE-MTO	-0.004	-0.002	0.212	0.187	0.216	0.187	0.216	0.914	0.954	0.430	100

Table 72: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **simple outcome and simple MAR (no dependence on Y)** scenario. The value of the estimand is 0.334. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.002	0.003	0.059	0.058	0.06	0.058	0.06	0.951	0.948	1.000	100
Complete-case	0.006	0.003	0.143	0.14	0.14	0.141	0.14	0.948	0.944	0.679	100
Confounded model	0.19	0.191	0.058	0.057	0.059	0.198	0.2	0.098	0.094	1.000	100
IPW	0.011	-0.006	0.65	0.202	0.214	0.202	0.214	0.998	0.938	0.373	100
Raking (vanilla)	0	-0.002	0.092	0.089	0.092	0.089	0.092	0.952	0.940	0.950	100
MICE	0	0.000	0.073	0.071	0.075	0.071	0.075	0.955	0.944	0.994	100
MI-RF	0.026	0.026	0.078	0.069	0.078	0.073	0.082	0.938	0.902	0.997	100
IPCW-TMLE-M	-0.013	-0.012	0.235	0.216	0.242	0.217	0.242	0.949	0.931	0.333	100
IPCW-TMLE-MTO	-0.005	-0.004	0.212	0.187	0.216	0.187	0.216	0.954	0.913	0.430	100

Table 73: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is 0. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on Z.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	-0.001	0.034	0.033	0.034	0.033	0.034	0.945	0.952	0.055	100
Complete-case*	0.073	0.075	0.105	0.102	0.1	0.126	0.125	0.878	0.892	0.122	100
Confounded model*	0.114	0.114	0.043	0.043	0.041	0.122	0.121	0.244	0.238	0.756	100
IPW*	0.06	0.061	0.094	0.091	0.093	0.109	0.111	0.888	0.898	0.112	100
Raking (vanilla)*	0.063	0.063	0.05	0.05	0.05	0.081	0.081	0.750	0.758	0.250	100
MICE*	0.068	0.069	0.049	0.049	0.048	0.084	0.084	0.716	0.711	0.284	100
MI-XGB*	0.084	0.084	0.05	0.049	0.049	0.097	0.098	0.598	0.615	0.402	100
MI-RF*	0.089	0.088	0.049	0.047	0.048	0.101	0.1	0.541	0.564	0.460	100
IPCW-TMLE-M	-0.063	-0.063	0.166	0.145	0.163	0.159	0.175	0.860	0.928	0.140	100
IPCW-TMLE-MTO	-0.024	-0.024	0.09	0.079	0.084	0.082	0.087	0.896	0.939	0.104	100

Table 74: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is 0.068. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on Z.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.004	-0.003	0.045	0.045	0.043	0.045	0.044	0.943	0.947	0.297	100
Complete-case	0.005	0.007	0.105	0.102	0.1	0.102	0.101	0.950	0.938	0.122	100
Confounded model	0.046	0.046	0.043	0.043	0.041	0.063	0.062	0.814	0.806	0.756	100
IPW	-0.008	-0.007	0.094	0.091	0.093	0.092	0.093	0.951	0.941	0.112	100
Raking (vanilla)	-0.004	-0.005	0.05	0.05	0.05	0.05	0.05	0.950	0.952	0.250	100
MICE	0	0.001	0.049	0.049	0.048	0.049	0.048	0.948	0.948	0.284	100
MI-XGB	0.016	0.016	0.05	0.049	0.049	0.052	0.052	0.932	0.926	0.402	100
MI-RF	0.021	0.020	0.049	0.047	0.048	0.052	0.052	0.925	0.915	0.460	100
IPCW-TMLE-M*	-0.131	-0.131	0.166	0.145	0.163	0.196	0.209	0.877	0.778	0.140	100
IPCW-TMLE-MTO*	-0.092	-0.092	0.09	0.079	0.084	0.121	0.124	0.832	0.740	0.104	100

Table 75: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is -0.159. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on Z.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	-0.001	0.035	0.034	0.034	0.034	0.034	0.941	0.944	0.997	100
Complete-case*	0.064	0.065	0.11	0.11	0.109	0.127	0.127	0.898	0.912	0.128	100
Confounded model*	0.131	0.131	0.047	0.046	0.048	0.138	0.139	0.190	0.196	0.086	100
IPW*	0.077	0.078	0.098	0.098	0.098	0.125	0.125	0.873	0.884	0.134	100
Raking (vanilla)*	0.081	0.082	0.055	0.053	0.055	0.097	0.098	0.657	0.679	0.309	100
MICE*	0.088	0.088	0.053	0.052	0.052	0.102	0.102	0.606	0.621	0.279	100
MI-XGB*	0.103	0.104	0.053	0.052	0.054	0.116	0.117	0.481	0.502	0.180	100
MI-RF*	0.109	0.109	0.053	0.05	0.052	0.12	0.121	0.416	0.448	0.176	100
IPCW-TMLE-M	-0.071	-0.069	0.18	0.156	0.177	0.172	0.19	0.860	0.929	0.384	100
IPCW-TMLE-MTO	-0.027	-0.023	0.103	0.087	0.102	0.092	0.104	0.885	0.939	0.561	100

Table 76: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is -0.075. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on Z.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.002	-0.002	0.048	0.048	0.048	0.048	0.048	0.951	0.944	0.374	100
Complete-case	-0.02	-0.019	0.11	0.11	0.109	0.112	0.111	0.945	0.950	0.128	100
Confounded model	0.047	0.047	0.047	0.046	0.048	0.065	0.067	0.828	0.812	0.086	100
IPW	-0.007	-0.006	0.098	0.098	0.098	0.098	0.098	0.948	0.944	0.134	100
Raking (vanilla)	-0.003	-0.002	0.055	0.053	0.055	0.053	0.055	0.950	0.939	0.309	100
MICE	0.004	0.004	0.053	0.052	0.052	0.052	0.052	0.950	0.944	0.279	100
MI-XGB	0.019	0.020	0.053	0.052	0.054	0.055	0.058	0.934	0.918	0.180	100
MI-RF	0.025	0.025	0.053	0.05	0.052	0.056	0.058	0.924	0.903	0.176	100
IPCW-TMLE-M*	-0.155	-0.153	0.18	0.156	0.177	0.22	0.234	0.865	0.750	0.384	100
IPCW-TMLE-MTO*	-0.111	-0.107	0.103	0.087	0.102	0.141	0.147	0.812	0.704	0.561	100

Table 77: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is 0. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on W.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.001	0.001	0.033	0.033	0.034	0.033	0.034	0.948	0.950	0.051	100
Complete-case*	0.024	0.026	0.089	0.088	0.089	0.091	0.093	0.932	0.939	0.068	100
Confounded model*	-0.223	-0.223	0.065	0.063	0.065	0.232	0.232	0.060	0.072	0.940	100
IPW*	0.063	0.064	0.081	0.082	0.079	0.103	0.102	0.877	0.880	0.122	100
Raking (vanilla)*	0.068	0.068	0.065	0.062	0.065	0.092	0.094	0.790	0.819	0.208	100
MICE*	0.051	0.051	0.051	0.053	0.052	0.074	0.073	0.853	0.832	0.146	100
MI-XGB*	0.06	0.061	0.075	0.069	0.074	0.091	0.096	0.818	0.884	0.181	100
MI-RF*	0.111	0.111	0.059	0.056	0.059	0.125	0.126	0.488	0.525	0.510	100
IPCW-TMLE-M	-0.048	-0.045	0.139	0.127	0.133	0.135	0.14	0.894	0.936	0.107	100
IPCW-TMLE-MTO	-0.017	-0.017	0.078	0.071	0.078	0.073	0.08	0.918	0.946	0.082	100

Table 78: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is 0.067. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on W.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0	0.000	0.046	0.045	0.045	0.045	0.045	0.951	0.943	0.330	100
Complete-case	-0.044	-0.042	0.089	0.088	0.089	0.099	0.098	0.928	0.932	0.068	100
Confounded model	-0.291	-0.291	0.065	0.063	0.065	0.298	0.298	0.006	0.006	0.940	100
IPW	-0.005	-0.004	0.081	0.082	0.079	0.082	0.079	0.950	0.952	0.122	100
Raking (vanilla)	0	0.000	0.065	0.062	0.065	0.062	0.065	0.950	0.939	0.208	100
MICE	-0.017	-0.017	0.051	0.053	0.052	0.056	0.054	0.939	0.945	0.146	100
MI-XGB	-0.008	-0.006	0.075	0.069	0.074	0.069	0.074	0.949	0.920	0.181	100
MI-RF	0.044	0.043	0.059	0.056	0.059	0.071	0.073	0.884	0.854	0.510	100
IPCW-TMLE-M*	-0.116	-0.113	0.139	0.127	0.133	0.171	0.174	0.864	0.780	0.107	100
IPCW-TMLE-MTO*	-0.085	-0.085	0.078	0.071	0.078	0.111	0.115	0.808	0.736	0.082	100

Table 79: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is -0.157. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on W.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	0.000	0.035	0.034	0.036	0.034	0.036	0.947	0.950	0.997	100
Complete-case*	0.02	0.021	0.093	0.094	0.096	0.096	0.098	0.950	0.951	0.302	100
Confounded model*	-0.239	-0.238	0.069	0.068	0.07	0.248	0.248	0.053	0.063	1.000	100
IPW*	0.081	0.081	0.087	0.087	0.087	0.119	0.119	0.832	0.843	0.138	100
Raking (vanilla)*	0.085	0.085	0.066	0.066	0.067	0.107	0.108	0.742	0.745	0.190	100
MICE*	0.095	0.095	0.051	0.056	0.049	0.11	0.107	0.616	0.538	0.176	100
MI-XGB*	0.091	0.090	0.075	0.072	0.076	0.116	0.118	0.734	0.770	0.160	100
MI-RF*	0.133	0.134	0.059	0.059	0.061	0.145	0.147	0.380	0.377	0.064	100
IPCW-TMLE-M	-0.05	-0.056	0.151	0.134	0.152	0.144	0.162	0.894	0.942	0.410	100
IPCW-TMLE-MTO	-0.015	-0.016	0.089	0.078	0.089	0.079	0.09	0.906	0.944	0.594	100

Table 80: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is -0.075. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on W.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.002	0.002	0.048	0.047	0.047	0.047	0.047	0.951	0.949	0.324	100
Complete-case	-0.063	-0.061	0.093	0.094	0.096	0.114	0.114	0.892	0.911	0.302	100
Confounded model	-0.322	-0.321	0.069	0.068	0.07	0.329	0.329	0.004	0.003	1.000	100
IPW	-0.001	-0.002	0.087	0.087	0.087	0.087	0.087	0.950	0.952	0.138	100
Raking (vanilla)	0.002	0.002	0.066	0.066	0.067	0.066	0.067	0.951	0.950	0.190	100
MICE	0.012	0.012	0.051	0.056	0.049	0.057	0.051	0.944	0.963	0.176	100
MI-XGB	0.008	0.007	0.075	0.072	0.076	0.073	0.076	0.951	0.930	0.160	100
MI-RF	0.05	0.051	0.059	0.059	0.061	0.077	0.079	0.857	0.855	0.064	100
IPCW-TMLE-M*	-0.133	-0.139	0.151	0.134	0.152	0.189	0.206	0.862	0.752	0.410	100
IPCW-TMLE-MTO*	-0.098	-0.098	0.089	0.078	0.089	0.125	0.133	0.808	0.709	0.594	100

Table 81: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR (no dependence on Y)** scenario. The value of the estimand is -0.157. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on W.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.002	-0.002	0.035	0.034	0.034	0.034	0.034	0.951	0.951	0.997	100
Complete-case*	0.056	0.057	0.131	0.128	0.126	0.14	0.138	0.910	0.924	0.114	100
Confounded model*	-0.242	-0.241	0.067	0.068	0.068	0.251	0.251	0.048	0.050	1.000	100
IPW*	0.088	0.079	0.64	0.162	0.173	0.184	0.19	0.894	1.000	0.104	100
Raking (vanilla)*	0.086	0.086	0.134	0.121	0.134	0.148	0.159	0.838	0.904	0.116	100
MICE*	-0.008	-0.007	0.058	0.067	0.056	0.068	0.057	0.974	0.945	0.726	100
MI-RF*	0.14	0.142	0.084	0.072	0.084	0.157	0.165	0.494	0.604	0.099	100
IPCW-TMLE-M	-0.068	-0.070	0.276	0.225	0.264	0.235	0.274	0.872	0.945	0.249	100
IPCW-TMLE-MTO	-0.011	0.002	0.176	0.141	0.161	0.141	0.161	0.891	0.953	0.269	100

Table 82: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR (no dependence on Y)** scenario. The value of the estimand is -0.075. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on W.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.001	0.000	0.047	0.047	0.049	0.047	0.049	0.951	0.954	0.342	100
Complete-case	-0.027	-0.026	0.131	0.128	0.126	0.131	0.128	0.944	0.941	0.114	100
Confounded model	-0.325	-0.324	0.067	0.068	0.068	0.332	0.331	0.002	0.001	1.000	100
IPW	0.005	-0.004	0.64	0.162	0.173	0.162	0.173	1.000	0.923	0.104	100
Raking (vanilla)	0.003	0.003	0.134	0.121	0.134	0.121	0.134	0.949	0.922	0.116	100
MICE	-0.091	-0.090	0.058	0.067	0.056	0.113	0.106	0.662	0.756	0.726	100
MI-RF	0.057	0.059	0.084	0.072	0.084	0.092	0.103	0.903	0.817	0.099	100
IPCW-TMLE-M*	-0.151	-0.153	0.276	0.225	0.264	0.271	0.305	0.916	0.818	0.249	100
IPCW-TMLE-MTO*	-0.094	-0.081	0.176	0.141	0.161	0.169	0.18	0.912	0.839	0.269	100

Table 83: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is -0.157. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on W.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	0.000	0.035	0.034	0.035	0.034	0.035	0.948	0.952	0.996	100
Complete-case*	0.081	0.087	0.204	0.198	0.191	0.214	0.21	0.904	0.936	0.059	100
Confounded model*	-0.242	-0.241	0.068	0.068	0.065	0.251	0.249	0.049	0.053	1.000	100
IPW*	0.06	0.068	0.193	0.175	0.187	0.185	0.198	0.901	0.942	0.098	100
Raking (vanilla)*	0.084	0.084	0.125	0.114	0.121	0.142	0.147	0.859	0.897	0.126	100
MICE*	0.102	0.098	0.076	0.075	0.076	0.127	0.124	0.735	0.743	0.133	100
MI-RF*	0.168	0.167	0.089	0.07	0.092	0.182	0.191	0.369	0.534	0.132	100
IPCW-TMLE-M	-0.132	-0.134	0.324	0.246	0.308	0.279	0.336	0.836	0.930	0.300	100
IPCW-TMLE-MTO	-0.065	-0.044	0.207	0.159	0.194	0.172	0.199	0.868	0.936	0.331	100

Table 84: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **semi-complex outcome and simple MAR** scenario. The value of the estimand is -0.075. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star. The semi-complex outcome is a function of exponentiated and squared terms on W.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.001	0.001	0.047	0.047	0.048	0.047	0.048	0.953	0.956	0.345	100
Complete-case	-0.002	0.005	0.204	0.198	0.191	0.198	0.191	0.950	0.945	0.059	100
Confounded model	-0.325	-0.323	0.068	0.068	0.065	0.332	0.33	0.003	0.003	1.000	100
IPW	-0.023	-0.015	0.193	0.175	0.187	0.177	0.187	0.948	0.932	0.098	100
Raking (vanilla)	0.001	0.002	0.125	0.114	0.121	0.114	0.121	0.947	0.924	0.126	100
MICE	0.019	0.015	0.076	0.075	0.076	0.078	0.078	0.942	0.941	0.133	100
MI-RF	0.086	0.084	0.089	0.07	0.092	0.11	0.125	0.844	0.712	0.132	100
IPCW-TMLE-M*	-0.215	-0.217	0.324	0.246	0.308	0.326	0.376	0.907	0.781	0.300	100
IPCW-TMLE-MTO*	-0.147	-0.127	0.207	0.159	0.194	0.217	0.232	0.896	0.788	0.331	100

Table 85: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.001. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	-0.001	-0.002	0.057	0.058	0.057	0.058	0.057	0.955	0.950	0.044	100
Complete-case*	-0.125	-0.124	0.115	0.119	0.116	0.172	0.17	0.836	0.808	0.162	100
Confounded model*	-0.202	-0.203	0.065	0.066	0.065	0.213	0.213	0.134	0.130	0.862	100
IPW*	0.049	0.053	0.117	0.12	0.116	0.13	0.128	0.938	0.936	0.061	100
Raking (vanilla)*	0.051	0.052	0.072	0.074	0.068	0.09	0.086	0.894	0.890	0.109	100
MICE*	0.111	0.112	0.072	0.073	0.07	0.133	0.132	0.682	0.664	0.326	100
MI-XGB*	0.083	0.082	0.07	0.071	0.066	0.109	0.106	0.797	0.790	0.206	100
MI-RF*	0.062	0.062	0.073	0.071	0.07	0.094	0.094	0.846	0.858	0.156	100
IPCW-TMLE-M	-0.05	-0.050	0.168	0.159	0.168	0.167	0.176	0.908	0.943	0.092	100
IPCW-TMLE-MTO	-0.045	-0.041	0.133	0.127	0.132	0.135	0.139	0.914	0.938	0.084	100

Table 86: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and simple MAR** scenario. The value of the estimand is 0.055. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	-0.002	-0.003	0.064	0.065	0.063	0.065	0.063	0.953	0.956	0.128	100
Complete-case	-0.179	-0.178	0.115	0.119	0.116	0.215	0.212	0.655	0.680	0.162	100
Confounded model	-0.256	-0.257	0.065	0.066	0.065	0.265	0.265	0.022	0.024	0.862	100
IPW	-0.005	-0.001	0.117	0.12	0.116	0.12	0.116	0.952	0.956	0.061	100
Raking (vanilla)	-0.003	-0.002	0.072	0.074	0.068	0.074	0.068	0.949	0.955	0.109	100
MICE	0.057	0.058	0.072	0.073	0.07	0.093	0.091	0.878	0.884	0.326	100
MI-XGB	0.029	0.028	0.07	0.071	0.066	0.077	0.072	0.930	0.934	0.206	100
MI-RF	0.008	0.008	0.073	0.071	0.07	0.071	0.07	0.943	0.936	0.156	100
IPCW-TMLE-M*	-0.104	-0.104	0.168	0.159	0.168	0.19	0.198	0.903	0.852	0.092	100
IPCW-TMLE-MTO*	-0.099	-0.095	0.133	0.127	0.132	0.161	0.163	0.887	0.856	0.084	100

Table 87: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and complex MAR (no dependence on Y)** scenario. The value of the estimand is 0.269. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal cover-age	Oracle cover-age	Power	Prop. com-pleted
Benchmark model	0	0.001	0.054	0.053	0.053	0.053	0.053	0.951	0.953	0.999	100.00
Complete-case*	0.019	0.015	0.134	0.134	0.14	0.135	0.141	0.950	0.952	0.563	100.00
Confounded model*	-0.19	-0.191	0.062	0.061	0.062	0.2	0.201	0.126	0.130	0.256	100.00
IPW*	-0.175	-0.197	abs > ln(10)	abs > ln(10)	0.523	abs > ln(10)	0.559	0.835	0.969	0.140	100.00
Raking (vanilla)*	0.431	0.176	abs > ln(10)	0.406	0.49	0.592	0.521	0.873	0.987	0.310	94.24
MICE*	-0.009	-0.006	0.101	0.085	0.101	0.086	0.101	0.887	0.949	0.833	100.00
MI-RF*	-0.06	-0.056	0.085	0.078	0.087	0.098	0.103	0.854	0.891	0.740	100.00
IPCW-TMLE-M	-0.12	-0.115	0.423	0.349	0.403	0.369	0.419	0.856	0.940	0.135	100.00

Table 88: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 80% missing proportion**. Comparing estimators under the **complex outcome and complex MAR (no dependence on Y)** scenario. The value of the estimand is 0.314. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle cover-age	Nominal cover-age	Power	Prop. com-pleted
Benchmark model	0.001	0.000	0.061	0.06	0.059	0.06	0.059	0.949	0.943	0.999	100.00
Complete-case	-0.026	-0.030	0.134	0.134	0.14	0.137	0.143	0.944	0.944	0.563	100.00
Confounded model	-0.235	-0.236	0.062	0.061	0.062	0.243	0.244	0.032	0.028	0.256	100.00
IPW	-0.22	-0.242	abs > ln(10)	abs > ln(10)	0.523	abs > ln(10)	0.576	0.969	0.826	0.140	100.00
Raking (vanilla)	0.386	0.131	abs > ln(10)	0.406	0.49	0.56	0.507	0.987	0.881	0.310	94.24
MICE	-0.054	-0.052	0.101	0.085	0.101	0.101	0.113	0.911	0.837	0.833	100.00
MI-RF	-0.105	-0.101	0.085	0.078	0.087	0.131	0.133	0.763	0.708	0.740	100.00
IPCW-TMLE-M*	-0.165	-0.160	0.423	0.349	0.403	0.386	0.434	0.932	0.844	0.135	100.00

Table 89: **Synthetic data MAR simulation: oracle marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and simple MAR (no dependence on Y)** scenario. The value of the estimand is 0.269. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Nominal coverage	Oracle coverage	Power	Prop. completed
Benchmark model	0.003	0.003	0.053	0.053	0.053	0.053	0.053	0.948	0.948	0.999	100
Complete-case*	0.013	0.011	0.138	0.135	0.14	0.136	0.14	0.947	0.951	0.545	100
Confounded model*	-0.188	-0.187	0.06	0.061	0.059	0.198	0.196	0.122	0.118	0.261	100
IPW*	0.054	0.032	1.569	0.192	0.211	0.199	0.213	0.929	0.997	0.357	100
Raking (vanilla)*	0.044	0.045	0.103	0.097	0.101	0.106	0.111	0.910	0.928	0.886	100
MICE*	0.133	0.132	0.082	0.08	0.083	0.155	0.156	0.625	0.633	0.997	100
MI-RF*	0.054	0.054	0.082	0.073	0.081	0.091	0.098	0.850	0.895	0.983	100
IPCW-TMLE-M	-0.041	-0.053	0.268	0.235	0.263	0.239	0.269	0.911	0.940	0.193	100
IPCW-TMLE-MTO	-0.033	-0.034	0.214	0.185	0.212	0.188	0.215	0.902	0.948	0.288	100

Table 90: **Synthetic data MAR simulation: census marginal relative risk (mRR), 12% outcome proportion, 40% missing proportion**. Comparing estimators under the **complex outcome and simple MAR (no dependence on Y)** scenario. The value of the estimand is 0.314. The sample size is n = 10000. Maximum observed Monte-Carlo error over the 2500 simulation replications was 0.009 for all summaries besides coverage and 0.012 for coverage. ESE = empirical standard error, ASE = asymptotic standard error, MAD = mean absolute deviation, RMSE = root mean squared error, rRMSE = robust RMSE (using median bias and MAD), Oracle coverage = coverage of a confidence interval based on the ESE, Nominal coverage = coverage of a confidence interval based on the ASE. Estimators that are mismatched with the estimand (i.e., are estimating a different parameter) are emphasized using a star.

Estimator	Mean bias	Median bias	ESE	ASE	MAD	RMSE	rRMSE	Oracle coverage	Nominal coverage	Power	Prop. completed
Benchmark model	0.003	0.003	0.059	0.06	0.059	0.06	0.059	0.946	0.947	0.999	100
Complete-case	-0.033	-0.034	0.138	0.135	0.14	0.139	0.144	0.944	0.944	0.545	100
Confounded model	-0.233	-0.232	0.06	0.061	0.059	0.241	0.24	0.026	0.027	0.261	100
IPW	0.009	-0.013	1.569	0.192	0.211	0.192	0.211	0.997	0.927	0.357	100
Raking (vanilla)	-0.001	0.000	0.103	0.097	0.101	0.097	0.101	0.946	0.932	0.886	100
MICE	0.087	0.087	0.082	0.08	0.083	0.119	0.12	0.802	0.794	0.997	100
MI-RF	0.009	0.009	0.082	0.073	0.081	0.073	0.082	0.947	0.913	0.983	100
IPCW-TMLE-M*	-0.086	-0.098	0.268	0.235	0.263	0.25	0.281	0.936	0.894	0.193	100
IPCW-TMLE-MTO*	-0.078	-0.079	0.214	0.185	0.212	0.201	0.226	0.938	0.879	0.288	100