Supplementary file for "Outcome-sensitive Multiple Imputation: a Simulation Study"

Table S1: Performance results for covariate X, datasets of 1,000 observations*†

		% miss	A	B	C‡	D‡	E‡	F‡	G‡
MCAR	Mean bias§	20	-0.002	0.083	-0.026	-0.045	-0.023	-0.024	-0.044
		40	-0.012	0.162	-0.058	-0.085	-0.056	-0.061	-0.083
		60	-0.048	0.234	-0.098	-0.117	-0.101	-0.093	-0.120
		80	-0.076	0.316	-0.191	-0.141	-0.116	-0.170	-0.127
	Mean error§	20	0.186	0.163	0.165	0.151	0.164	0.165	0.152
		40	0.254	0.204	0.195	0.175	0.188	0.194	0.177
		60	0.397	0.260	0.263	0.237	0.269	0.261	0.240
		80	0.843	0.340	0.553	0.451	0.504	0.528	0.428
	Coverage	20	0.949	0.959	0.960	0.980	0.972	0.964	0.974
		40	0.943	0.972	0.983	0.987	0.982	0.985	0.984
		60	0.960	0.986	0.990	0.971	0.985	0.987	0.970
		80	0.996	0.999	0.994	0.957	0.992	0.998	0.963
	Power	20	0.855	0.960	0.863	0.872	0.870	0.855	0.876
		40	0.625	0.932	0.608	0.680	0.628	0.630	0.670
		60	0.339	0.841	0.303	0.423	0.322	0.320	0.413
		80	0.093	0.414	0.104	0.182	0.103	0.110	0.188
MAR	Mean bias§	20	0.003	0.065	-0.012	-0.027	-0.018	-0.012	-0.026
		40	-0.007	0.121	-0.035	-0.052	-0.029	-0.034	-0.053
		60	-0.014	0.228	-0.073	-0.102	-0.075	-0.075	-0.106
		80	-0.096	0.292	-0.097	-0.055	-0.089	-0.079	-0.038
	Mean error§	20	0.176	0.158	0.161	0.152	0.158	0.161	0.152
		40	0.206	0.173	0.177	0.165	0.181	0.179	0.170
		60	0.336	0.253	0.258	0.241	0.258	0.252	0.241
		80	0.687	0.311	0.544	0.461	0.494	0.525	0.446
	Coverage	20	0.939	0.956	0.959	0.967	0.961	0.960	0.972
		40	0.956	0.969	0.975	0.974	0.975	0.976	0.973
		60	0.957	0.989	0.982	0.965	0.982	0.984	0.962
		80	0.979	0.994	0.966	0.947	0.979	0.970	0.955
	Power	20	0.887	0.965	0.902	0.900	0.896	0.897	0.916
		40	0.760	0.955	0.756	0.776	0.777	0.763	0.775
		60	0.400	0.882	0.368	0.433	0.399	0.383	0.441
		80	0.190	0.584	0.172	0.217	0.163	0.186	0.235
MNAR	Mean bias§	20	0.002	0.079	-0.021	-0.040	-0.029	-0.020	-0.041
		40	-0.008	0.152	-0.060	-0.097	-0.058	-0.056	-0.096
		60	-0.033	0.236	-0.109	-0.151	-0.122	-0.109	-0.158
		80	-0.024	0.281	-0.054	-0.065	-0.068	-0.057	-0.043
	Mean error§	20	0.191	0.171	0.171	0.158	0.168	0.170	0.156
		40	0.334	0.238	0.258	0.232	0.246	0.260	0.232
		60	0.426	0.271	0.305	0.302	0.311	0.313	0.302
		80	0.893	0.441	0.819	0.765	0.764	0.835	0.680
	Coverage	20	0.936	0.966	0.957	0.967	0.974	0.960	0.976
		40	0.940	0.986	0.981	0.974	0.985	0.978	0.973
		60	0.964	0.994	0.989	0.950	0.983	0.980	0.954
		80	0.992	1.000	0.993	0.970	0.995	0.995	0.973

		% miss	A	B	C‡	D‡	E‡	F‡	G‡
	Power	20	0.826	0.930	0.836	0.842	0.810	0.834	0.833
		40	0.445	0.723	0.415	0.435	0.432	0.420	0.424
		60	0.283	0.731	0.253	0.313	0.257	0.258	0.307
		80	0.050	0.056	0.037	0.084	0.051	0.053	0.090

*Analysis model A: complete case analysis (no multiple imputation [mi]); B: no outcome imputation, not included in mi model; C: no outcome imputation, outcome imputed in mi model; D: outcome imputed and included in mi model; E: outcome imputed and included in mi model but then observations where it was imputed are deleted; F as in C but also including a second correlated outcome in the mi model; G as in D but also including a second correlated outcome in the mi model.

† Analysis model H does not include the covariate and hence not reported.

‡ Main models of interest, other models provided for comparison purposes.

§ Reported on log-odds scale and based on a true effect of log(1.5)

Table S2: Performance results for interaction term E*X, datasets of 1,000 observations*†

		% miss	A	B	C‡	D‡	E‡	F‡	G‡
MCAR	Mean bias§	20	-0.006	0.038	0.031	0.063	0.034	0.030	0.061
		40	-0.003	0.080	0.073	0.115	0.066	0.077	0.114
		60	0.011	0.125	0.117	0.148	0.106	0.119	0.155
		80	-0.117	0.153	0.165	0.176	0.147	0.172	0.178
	Mean error§	20	0.219	0.178	0.181	0.153	0.181	0.180	0.154
		40	0.310	0.195	0.194	0.151	0.192	0.199	0.154
		60	0.488	0.214	0.217	0.158	0.217	0.216	0.163
		80	1.120	0.249	0.288	0.177	0.266	0.278	0.180
	Coverage	20	0.942	0.977	0.979	0.991	0.977	0.979	0.991
		40	0.931	0.993	0.992	0.997	0.992	0.993	0.996
		60	0.963	1.000	1.000	1.000	1.000	0.998	0.998
		80	0.996	1.000	1.000	1.000	1.000	1.000	1.000
	Power	20	0.733	0.822	0.812	0.902	0.829	0.813	0.908
		40	0.452	0.682	0.658	0.939	0.650	0.660	0.937
		60	0.238	0.436	0.388	0.945	0.363	0.381	0.956
		80	0.032	0.066	0.027	0.850	0.036	0.036	0.857
MAR	Mean bias§	20	-0.003	0.094	0.034	0.061	0.037	0.034	0.061
		40	-0.024	0.175	0.063	0.112	0.072	0.067	0.110
		60	-0.060	0.148	0.098	0.146	0.106	0.096	0.149
		80	-0.078	0.221	0.141	0.178	0.149	0.126	0.179
	Mean error§	20	0.226	0.197	0.185	0.158	0.177	0.185	0.158
		40	0.296	0.234	0.187	0.150	0.192	0.190	0.150
		60	0.464	0.216	0.204	0.158	0.210	0.205	0.157
		80	1.248	0.288	0.265	0.180	0.272	0.267	0.181
	Coverage	20	0.939	0.964	0.985	0.992	0.982	0.980	0.992
		40	0.957	0.981	0.996	0.998	0.990	0.997	0.998
		60	0.959	0.997	1.000	1.000	1.000	1.000	1.000
		80	0.990	1.000	1.000	1.000	1.000	1.000	1.000
	Power	20	0.722	0.885	0.801	0.916	0.822	0.808	0.916
		40	0.466	0.836	0.678	0.935	0.672	0.670	0.940
		60	0.217	0.500	0.353	0.942	0.376	0.381	0.959
		80	0.048	0.114	0.040	0.896	0.050	0.043	0.891
MNAR	Mean bias§	20	-0.001	0.090	0.038	0.067	0.044	0.038	0.066
		40	-0.003	0.169	0.078	0.121	0.076	0.075	0.115
		60	-0.024	0.168	0.110	0.149	0.112	0.111	0.153
		80	0.003	0.237	0.203	0.177	0.201	0.179	0.184
	Mean error§	20	0.238	0.198	0.193	0.163	0.188	0.191	0.161
		40	0.419	0.276	0.243	0.177	0.227	0.243	0.172
		60	0.518	0.245	0.218	0.162	0.231	0.218	0.164
		80	1.413	0.409	0.421	0.201	0.431	0.437	0.203
	Coverage	20	0.936	0.967	0.977	0.994	0.981	0.983	0.991
		40	0.941	0.990	0.996	1.000	0.996	0.994	1.000
		60	0.966	0.999	1.000	1.000	1.000	1.000	1.000
		80	0.992	1.000	1.000	1.000	1.000	1.000	1.000
	Power	20	0.675	0.831	0.773	0.867	0.780	0.765	0.881
		40	0.323	0.535	0.396	0.693	0.393	0.399	0.672
		60	0.173	0.388	0.264	0.828	0.284	0.269	0.864
		80	0.023	0.009	0.000	0.169	0.002	0.006	0.202

*Analysis model A: complete case analysis (no multiple imputation [mi]); B: no outcome imputation, not included in mi model; C: no outcome imputation, outcome imputed in mi model; D: outcome imputed and included in mi model; E: outcome imputed and included in mi model but then observations where it was imputed are deleted; F as in C but also including a second correlated outcome in the mi model; G as in D but also including a second correlated outcome in the mi model.

† Analysis model H does not include the covariate and hence not reported.

‡ Main models of interest, other models provided for comparison purposes.

§ Reported on log-odds scale and based on a true effect of log(1.2)

Table S3: Performance results for covariate X, datasets of 10,000 observations*†

		% miss	A	B	C‡	D‡	E‡	F‡	G‡
MCAR	Mean bias§	20	-0.003	0.081	-0.026	-0.045	-0.026	-0.026	-0.045
		40	-0.002	0.164	-0.049	-0.077	-0.049	-0.050	-0.075
		60	0.001	0.248	-0.069	-0.098	-0.073	-0.068	-0.096
		80	-0.040	0.318	-0.116	-0.118	-0.101	-0.112	-0.117
	Mean error§	20	0.056	0.086	0.054	0.058	0.053	0.054	0.059
		40	0.078	0.164	0.071	0.083	0.071	0.072	0.082
		60	0.111	0.248	0.095	0.108	0.099	0.095	0.107
		80	0.233	0.318	0.170	0.164	0.163	0.167	0.163
	Coverage	20	0.945	0.815	0.955	0.932	0.958	0.954	0.923
		40	0.941	0.500	0.951	0.888	0.943	0.947	0.890
		60	0.955	0.318	0.964	0.883	0.949	0.960	0.870
		80	0.941	0.511	0.955	0.884	0.960	0.950	0.881
	Power	20	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		40	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		60	0.995	1.000	0.999	1.000	0.999	0.999	1.000
		80	0.631	1.000	0.778	0.889	0.809	0.790	0.905
MAR	Mean bias§	20	-0.004	0.060	-0.020	-0.034	-0.019	-0.020	-0.033
		40	0.002	0.126	-0.026	-0.045	-0.026	-0.025	-0.043
		60	-0.001	0.229	-0.056	-0.081	-0.059	-0.057	-0.079
		80	-0.017	0.301	-0.059	-0.065	-0.052	-0.057	-0.061
	Mean error§	20	0.054	0.069	0.052	0.054	0.048	0.052	0.053
		40	0.061	0.126	0.058	0.062	0.060	0.058	0.062
		60	0.105	0.229	0.092	0.099	0.088	0.092	0.099
		80	0.182	0.301	0.153	0.145	0.149	0.151	0.144
	Coverage	20	0.939	0.873	0.946	0.934	0.965	0.948	0.936
		40	0.970	0.655	0.970	0.944	0.957	0.971	0.941
		60	0.944	0.340	0.952	0.873	0.957	0.952	0.900
		80	0.949	0.398	0.953	0.924	0.952	0.947	0.928
	Power	20	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		40	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		60	1.000	1.000	0.999	1.000	1.000	1.000	1.000
		80	0.843	1.000	0.891	0.924	0.901	0.883	0.930
MNAR	Mean bias§	20	-0.002	0.076	-0.026	-0.045	-0.025	-0.025	-0.046
		40	-0.001	0.154	-0.049	-0.084	-0.052	-0.048	-0.086
		60	0.000	0.242	-0.084	-0.129	-0.098	-0.083	-0.128
		80	0.006	0.304	-0.055	-0.077	-0.049	-0.058	-0.069
	Mean error§	20	0.060	0.082	0.058	0.061	0.053	0.058	0.062
		40	0.092	0.156	0.087	0.100	0.088	0.085	0.101
		60	0.115	0.242	0.108	0.138	0.121	0.108	0.136
		80	0.308	0.304	0.240	0.229	0.252	0.238	0.226
	Coverage	20	0.950	0.849	0.959	0.946	0.972	0.958	0.941
		40	0.947	0.770	0.965	0.923	0.955	0.965	0.919
		60	0.965	0.456	0.942	0.822	0.925	0.947	0.800
		80	0.964	0.960	0.964	0.951	0.960	0.965	0.935
	Power	20	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		40	1.000	1.000	1.000	1.000	0.999	1.000	1.000
		60	0.996	1.000	0.999	0.999	0.996	0.997	0.999
		80	0.412	0.999	0.439	0.546	0.472	0.456	0.574

*Analysis model A: complete case analysis (no multiple imputation [mi]); B: no outcome imputation, not included in mi model; C: no outcome imputation, outcome imputed in mi model; D: outcome imputed and included in mi model; E: outcome imputed and included in mi model but then observations where it was imputed are deleted; F as in C but also including a second correlated outcome in the mi model; G as in D but also including a second correlated outcome in the mi model.

† Analysis model H does not include the covariate and hence not reported.

‡ Main models of interest, other models provided for comparison purposes.

§ Reported on log-odds scale and based on a true effect of log(1.5)

Table S4: Performance results for interaction term E*X, datasets of 10,000 observations*†

		% miss	A	B	C‡	D‡	E‡	F‡	G‡
MCAR	Mean bias§	20	0.001	0.043	0.038	0.066	0.037	0.037	0.066
		40	0.002	0.081	0.073	0.118	0.073	0.076	0.115
		60	0.000	0.115	0.110	0.154	0.107	0.109	0.152
		80	0.027	0.157	0.152	0.175	0.144	0.152	0.176
	Mean error§	20	0.069	0.066	0.064	0.074	0.063	0.065	0.074
		40	0.096	0.090	0.085	0.118	0.082	0.087	0.115
		60	0.135	0.118	0.113	0.154	0.112	0.113	0.152
		80	0.285	0.159	0.154	0.175	0.148	0.154	0.176
	Coverage	20	0.940	0.955	0.966	0.948	0.964	0.961	0.944
		40	0.941	0.956	0.963	0.866	0.965	0.953	0.878
		60	0.960	0.970	0.987	0.757	0.987	0.986	0.784
		80	0.943	0.996	0.999	0.695	1.000	0.998	0.648
	Power	20	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		40	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		60	0.988	1.000	1.000	1.000	1.000	1.000	1.000
		80	0.558	1.000	1.000	1.000	1.000	1.000	1.000
MAR	Mean bias§	20	0.001	0.095	0.035	0.063	0.035	0.036	0.063
		40	-0.006	0.178	0.072	0.114	0.073	0.070	0.111
		60	-0.001	0.158	0.109	0.152	0.112	0.109	0.151
		80	-0.010	0.210	0.150	0.176	0.146	0.146	0.176
	Mean error§	20	0.070	0.101	0.064	0.071	0.061	0.064	0.071
		40	0.087	0.178	0.081	0.114	0.084	0.080	0.112
		60	0.131	0.158	0.113	0.152	0.115	0.113	0.151
		80	0.292	0.210	0.152	0.176	0.148	0.148	0.176
	Coverage	20	0.935	0.817	0.952	0.930	0.963	0.951	0.936
		40	0.957	0.597	0.971	0.885	0.959	0.973	0.893
		60	0.951	0.913	0.983	0.795	0.979	0.987	0.789
		80	0.951	0.981	0.999	0.640	0.998	0.998	0.627
	Power	20	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		40	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		60	0.981	1.000	1.000	1.000	1.000	1.000	1.000
		80	0.497	1.000	1.000	1.000	1.000	1.000	1.000
MNAR	Mean bias§	20	0.001	0.088	0.040	0.068	0.037	0.039	0.065
		40	0.000	0.169	0.080	0.118	0.072	0.080	0.116
		60	-0.008	0.165	0.111	0.151	0.111	0.110	0.151
		80	-0.009	0.222	0.148	0.176	0.147	0.149	0.175
	Mean error§	20	0.074	0.097	0.068	0.077	0.064	0.068	0.074
		40	0.115	0.170	0.095	0.119	0.090	0.095	0.116
		60	0.149	0.166	0.115	0.151	0.115	0.115	0.151
		80	0.453	0.227	0.164	0.176	0.163	0.164	0.175
	Coverage	20	0.933	0.878	0.959	0.940	0.974	0.960	0.949
		40	0.959	0.832	0.983	0.957	0.981	0.982	0.959
		60	0.952	0.933	0.987	0.863	0.991	0.990	0.853
		80	0.957	0.998	1.000	0.987	1.000	1.000	0.993
	Power	20	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		40	0.997	1.000	1.000	1.000	1.000	1.000	1.000
		60	0.947	1.000	1.000	1.000	1.000	1.000	1.000
		80	0.217	0.965	0.883	1.000	0.879	0.902	1.000

*Analysis model A: complete case analysis (no multiple imputation [mi]); B: no outcome imputation, not included in mi model; C: no outcome imputation, outcome imputed in mi model; D: outcome imputed and included in mi model; E: outcome imputed and included in mi model but then observations where it was imputed are deleted; F as in C but also including a second correlated outcome in the mi model; G as in D but also including a second correlated outcome in the mi model.

† Analysis model H does not include the covariate and hence not reported.

‡ Main models of interest, other models provided for comparison purposes.

§ Reported on log-odds scale and based on a true effect of log(1.2)

Table S5: Successful convergences in 1000 simulations*

1000 observations									
	% miss	A	B	C†	D†	E†	F†	G†	H
MCAR	20%	1000	1000	1000	1000	1000	1000	1000	1000
	40%	1000	1000	1000	1000	1000	1000	1000	1000
	60%	999	1000	1000	1000	1000	1000	1000	1000
	80%	751	997	993	997	999	866	997	997
MAR	20%	1000	1000	1000	1000	1000	1000	1000	1000
	40%	1000	1000	1000	1000	1000	1000	1000	1000
	60%	999	1000	1000	1000	1000	1000	1000	1000
	80%	714	997	991	997	998	938	997	997
MNAR	20%	1000	1000	1000	1000	1000	1000	1000	1000
	40%	1000	1000	1000	1000	1000	1000	1000	1000
	60%	996	1000	1000	1000	1000	1000	1000	1000
	80%	397	968	887	961	943	855	962	982
10000 observations									
	% miss	A	B	C†	D†	E†	F†	G†	H
MCAR	20%	1000	1000	1000	1000	1000	1000	1000	1000
	40%	1000	1000	1000	1000	1000	1000	1000	1000
	60%	1000	1000	1000	1000	1000	1000	1000	1000
	80%	1000	1000	1000	1000	1000	1000	1000	1000
MAR	20%	1000	1000	1000	1000	1000	1000	1000	1000
	40%	1000	1000	1000	1000	1000	1000	1000	1000
	60%	1000	1000	1000	1000	1000	1000	1000	1000
	80%	1000	1000	1000	1000	1000	1000	1000	1000
MNAR	20%	1000	1000	1000	1000	1000	1000	1000	1000
	40%	1000	1000	1000	1000	1000	1000	1000	1000
	60%	1000	1000	1000	1000	1000	1000	1000	1000
	80%	1000	1000	1000	1000	1000	1000	1000	1000

*Analysis model A: complete case analysis (no multiple imputation [mi]); B: no outcome imputation, not included in mi model; C: no outcome imputation, outcome imputed in mi model; D: outcome imputed and included in mi model; E: outcome imputed and included in mi model but then observations where it was imputed are deleted; F as in C but also including a second correlated outcome in the mi model; G as in D but also including a second correlated outcome in the mi model; H as in D but the mi and analysis models do not include the covariate.

† Main models of interest, other models provided for comparison purposes.

Figure S1: Mean Bias (top) and Mean absolute Error (bottom) for exposure E in datasets of 1000 observations, continuous outcome

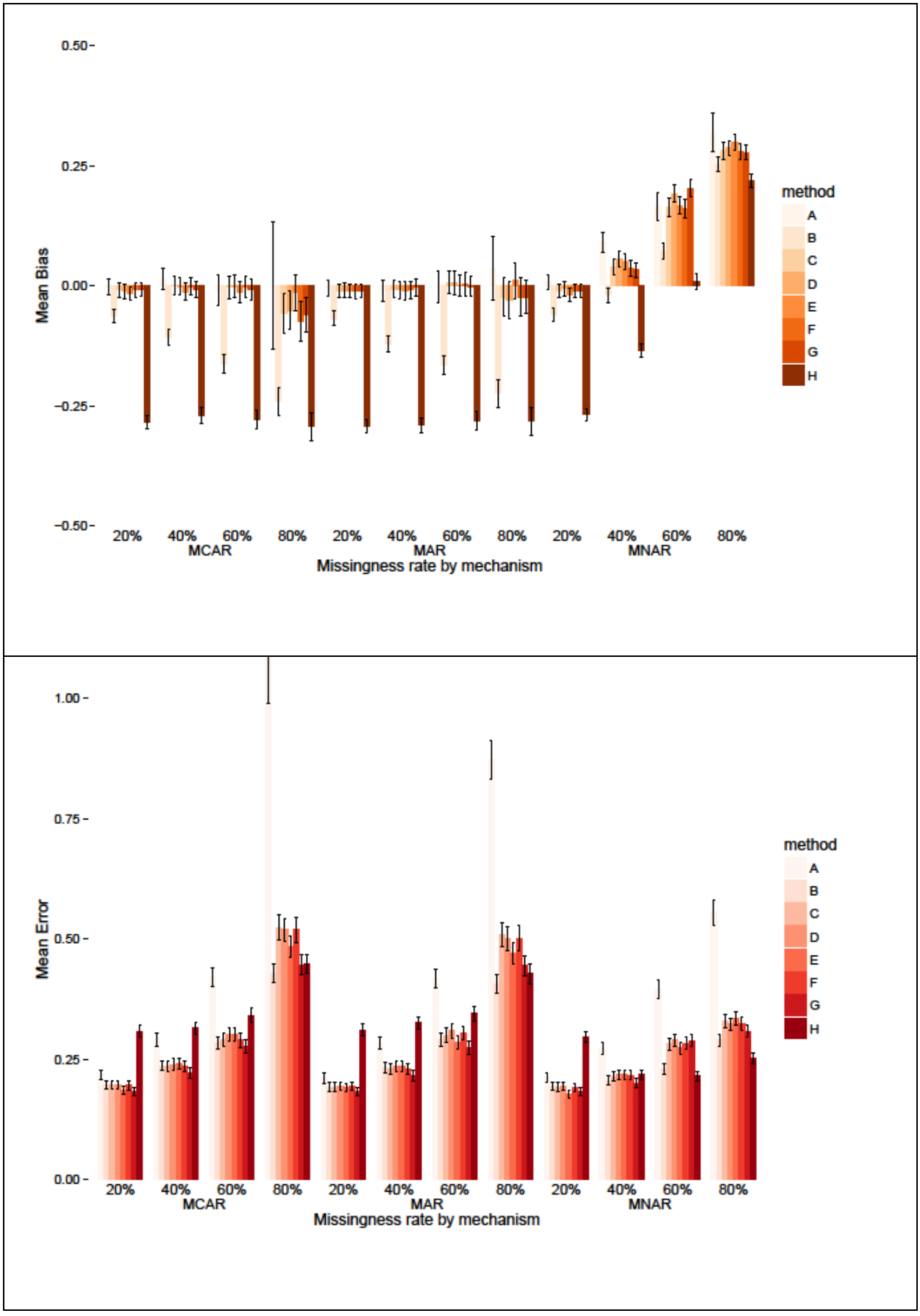

Figure S2: Coverage (top) and Power (bottom) for exposure E in datasets of 1000 observations, continuous outcome