

Supplemental Data

Robust Score Statistics for QTL Linkage Analysis

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Table S1A. Type I Errors

Type I Errors for Single Proband Ascertainment															
SINGLE	Model 1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model 3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NAÏVE	0.058	0.013	0.008	0.058	0.171	0.266	0.160	0.353	0.408	0.049	0.107	0.170	0.048	0.160	0.247
SCORE.CIBD	0.013	0.012	0.012	0.011	0.013	0.013	0.015	0.015	0.018	0.012	0.010	0.013	0.011	0.012	0.012
SCORE.NULL.CT	0.013	0.012	0.011	0.010	0.013	0.012	0.015	0.015	0.018	0.011	0.010	0.013	0.011	0.011	0.011
SCORE.CT	0.013	0.012	0.011	0.010	0.013	0.012	0.015	0.015	0.018	0.012	0.010	0.013	0.011	0.011	0.012
SCORE.NULL.EV	0.006	0.005	0.003	0.004	0.007	0.005	0.004	0.002	0.002	0.005	0.005	0.004	0.005	0.006	0.005
SCORE.EV	0.007	0.005	0.004	0.005	0.007	0.006	0.004	0.003	0.002	0.006	0.005	0.004	0.006	0.007	0.005
SCORE.MERLIN	0.013	0.012	0.011	0.010	0.013	0.012	0.015	0.016	0.018	0.012	0.010	0.012	0.011	0.011	0.012
SCORE.MERLIN.AV	0.012	0.012	0.011	0.010	0.013	0.012	0.014	0.015	0.018	0.012	0.010	0.013	0.011	0.011	0.012
HM.NAÏVE	0.059	0.009	0.005	0.059	0.192	0.275	0.165	0.370	0.425	0.050	0.116	0.172	0.047	0.177	0.254
HM.MERLIN	0.013	0.012	0.012	0.011	0.011	0.010	0.014	0.012	0.014	0.012	0.010	0.011	0.011	0.010	0.011
HM.CT	0.012	0.012	0.012	0.011	0.012	0.011	0.014	0.012	0.014	0.012	0.009	0.011	0.011	0.011	0.011
SCORE.MAX	0.014	0.013	0.012	0.011	0.014	0.014	0.016	0.016	0.019	0.013	0.011	0.015	0.011	0.012	0.012
SCORE.2DF.CT	0.014	0.010	0.012	0.011	0.014	0.015	0.015	0.017	0.019	0.012	0.011	0.012	0.012	0.012	0.011
HM.2DF.CT	0.014	0.011	0.015	0.011	0.012	0.014	0.016	0.017	0.020	0.012	0.011	0.015	0.011	0.012	0.013
Type I Errors for Extreme Concordant Sampling															
EC	Model1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NAÏVE	0.085	0.017	0.008	0.077	0.224	0.308	0.208	0.389	0.435	0.065	0.160	0.213	0.066	0.222	0.293
SCORE.CIBD	0.016	0.015	0.016	0.014	0.014	0.013	0.016	0.014	0.014	0.014	0.016	0.013	0.013	0.013	0.010
SCORE.NULL.CT	0.015	0.012	0.012	0.013	0.013	0.013	0.015	0.014	0.013	0.013	0.015	0.012	0.012	0.012	0.010
SCORE.CT	0.015	0.013	0.013	0.013	0.014	0.013	0.016	0.015	0.014	0.014	0.016	0.013	0.013	0.012	0.010
SCORE.NULL.EV	0.004	0.004	0.005	0.004	0.006	0.006	0.002	0.002	0.002	0.004	0.008	0.005	0.003	0.006	0.005
SCORE.EV	0.007	0.005	0.006	0.006	0.007	0.006	0.004	0.002	0.002	0.006	0.009	0.005	0.006	0.007	0.005
SCORE.MERLIN	0.014	0.013	0.012	0.013	0.013	0.013	0.016	0.016	0.013	0.013	0.016	0.013	0.013	0.013	0.010
SCORE.MERLIN.AV	0.014	0.012	0.013	0.013	0.013	0.013	0.016	0.016	0.014	0.013	0.016	0.013	0.013	0.012	0.010
HM.NAÏVE	0.090	0.012	0.006	0.080	0.251	0.323	0.224	0.405	0.451	0.066	0.186	0.233	0.064	0.253	0.317
HM.MERLIN	0.014	0.012	0.010	0.012	0.012	0.011	0.014	0.012	0.012	0.013	0.015	0.010	0.013	0.012	0.010
HM.CT	0.014	0.012	0.011	0.013	0.012	0.011	0.015	0.012	0.012	0.013	0.014	0.010	0.013	0.012	0.010
SCORE.MAX	0.016	0.014	0.015	0.014	0.015	0.015	0.017	0.016	0.014	0.014	0.018	0.015	0.014	0.013	0.011
SCORE.2DF.CT	0.016	0.012	0.011	0.014	0.016	0.014	0.016	0.017	0.014	0.013	0.017	0.012	0.014	0.012	0.011
HM.2DF.CT	0.015	0.013	0.013	0.014	0.013	0.015	0.016	0.017	0.015	0.013	0.017	0.013	0.014	0.013	0.013

Type I Errors for EDAC 3-Corner Sampling															
EDAC3	Model1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NAÏVE	0.138	0.103	0.080	0.145	0.222	0.309	0.235	0.382	0.426	0.134	0.202	0.245	0.133	0.216	0.296
SCORE.CIBD	0.011	0.012	0.012	0.014	0.012	0.013	0.015	0.013	0.016	0.013	0.012	0.012	0.013	0.010	0.012
SCORE.NULL.CT	0.010	0.010	0.011	0.012	0.012	0.012	0.013	0.013	0.015	0.012	0.011	0.012	0.012	0.009	0.012
SCORE.CT	0.011	0.011	0.011	0.013	0.012	0.012	0.014	0.013	0.015	0.012	0.011	0.012	0.013	0.010	0.012
SCORE.NULL.EV	0.004	0.005	0.004	0.005	0.005	0.004	0.004	0.002	0.002	0.004	0.006	0.005	0.005	0.006	0.005
SCORE.EV	0.006	0.005	0.005	0.007	0.006	0.005	0.005	0.003	0.002	0.007	0.007	0.005	0.008	0.007	0.006
SCORE.MERLIN	0.011	0.011	0.011	0.013	0.011	0.013	0.015	0.013	0.015	0.013	0.012	0.011	0.012	0.010	0.012
SCORE.MERLIN.AV	0.011	0.011	0.011	0.013	0.012	0.012	0.015	0.013	0.015	0.012	0.012	0.012	0.012	0.010	0.012
HM.NAÏVE	0.139	0.078	0.039	0.146	0.240	0.323	0.238	0.395	0.442	0.135	0.205	0.256	0.133	0.236	0.320
HM.MERLIN	0.011	0.010	0.011	0.013	0.012	0.011	0.014	0.012	0.012	0.013	0.011	0.011	0.012	0.012	0.011
HM.CT	0.011	0.009	0.011	0.013	0.012	0.012	0.014	0.013	0.013	0.012	0.011	0.011	0.012	0.011	0.011
SCORE.MAX	0.011	0.011	0.013	0.014	0.013	0.014	0.015	0.014	0.016	0.013	0.012	0.013	0.014	0.012	0.014
SCORE.2DF.CT	0.010	0.010	0.010	0.013	0.012	0.013	0.015	0.015	0.018	0.012	0.011	0.014	0.013	0.012	0.013
HM.2DF.CT	0.011	0.010	0.012	0.013	0.013	0.013	0.015	0.015	0.016	0.012	0.011	0.014	0.013	0.013	0.014
Type I Errors for MDAC 3-Corner Sampling															
MDAC3	Model1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NAÏVE	0.067	0.042	0.037	0.068	0.107	0.190	0.122	0.308	0.380	0.063	0.081	0.119	0.061	0.112	0.178
SCORE.CIBD	0.014	0.012	0.013	0.012	0.013	0.011	0.011	0.017	0.015	0.012	0.010	0.013	0.011	0.013	0.011
SCORE.NULL.CT	0.013	0.012	0.013	0.012	0.013	0.011	0.010	0.017	0.015	0.011	0.010	0.013	0.011	0.012	0.011
SCORE.CT	0.014	0.012	0.013	0.012	0.013	0.011	0.010	0.017	0.015	0.011	0.010	0.013	0.011	0.012	0.011
SCORE.NULL.EV	0.008	0.006	0.005	0.006	0.007	0.004	0.004	0.003	0.002	0.007	0.006	0.007	0.006	0.007	0.006
SCORE.EV	0.009	0.006	0.005	0.007	0.007	0.005	0.005	0.003	0.002	0.007	0.007	0.007	0.007	0.007	0.006
SCORE.MERLIN	0.013	0.012	0.014	0.012	0.013	0.010	0.010	0.016	0.014	0.012	0.010	0.013	0.011	0.013	0.011
SCORE.MERLIN.AV	0.014	0.012	0.013	0.011	0.013	0.011	0.011	0.018	0.015	0.012	0.010	0.013	0.011	0.013	0.011
HM.NAÏVE	0.067	0.024	0.014	0.069	0.114	0.197	0.122	0.328	0.388	0.063	0.078	0.117	0.061	0.116	0.188
HM.MERLIN	0.014	0.012	0.011	0.011	0.010	0.010	0.011	0.013	0.012	0.012	0.010	0.012	0.010	0.011	0.011
HM.CT	0.014	0.011	0.011	0.012	0.010	0.009	0.011	0.013	0.012	0.012	0.010	0.012	0.011	0.011	0.010
SCORE.MAX	0.014	0.012	0.014	0.012	0.014	0.013	0.011	0.018	0.016	0.012	0.011	0.016	0.011	0.013	0.013
SCORE.2DF.CT	0.012	0.010	0.013	0.011	0.013	0.011	0.012	0.017	0.016	0.011	0.009	0.014	0.012	0.013	0.012
HM.2DF.CT	0.012	0.011	0.013	0.011	0.011	0.013	0.013	0.017	0.018	0.011	0.010	0.014	0.012	0.012	0.011

Detailed type I error results (SINGLE, EC, EDAC-3 and MDAC-3) for all the statistics considered in the simulation study.

Note: Type I error values departing by 0.005 or more, from the nominal value 0.01, are highlighted in bold.

Table S1B. Power Results

Power Comparison for Population Sampling															
POPULATION	Model 1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model 3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NAIVE	0.74	0.52	0.36	0.73	0.87	0.76	0.65	1.00	1.00	0.75	0.78	0.57	0.74	0.56	0.38
SCORE.CIBD	0.74	0.39	0.14	0.73	0.78	0.45	0.53	0.96	0.94	0.76	0.69	0.31	0.74	0.44	0.15
SCORE.NULL.CT	0.74	0.39	0.14	0.73	0.78	0.45	0.53	0.96	0.94	0.76	0.69	0.31	0.74	0.44	0.15
SCORE.CT	0.74	0.39	0.14	0.73	0.78	0.45	0.53	0.96	0.94	0.76	0.69	0.31	0.74	0.44	0.15
SCORE.NULL.EV	0.67	0.34	0.11	0.67	0.73	0.40	0.23	0.75	0.72	0.69	0.65	0.32	0.69	0.41	0.11
SCORE.EV	0.67	0.35	0.11	0.68	0.73	0.40	0.24	0.75	0.73	0.70	0.65	0.32	0.70	0.41	0.11
SCORE.MERLIN	0.74	0.39	0.14	0.73	0.78	0.45	0.53	0.97	0.95	0.75	0.68	0.31	0.74	0.44	0.16
SCORE.MERLIN.AV	0.74	0.38	0.14	0.73	0.78	0.45	0.53	0.96	0.94	0.76	0.69	0.31	0.74	0.44	0.15
HM.NAIVE	0.74	0.46	0.31	0.73	0.83	0.75	0.62	0.99	0.99	0.75	0.74	0.57	0.74	0.53	0.35
HM.MERLIN	0.74	0.37	0.14	0.73	0.74	0.48	0.51	0.92	0.91	0.75	0.67	0.34	0.75	0.42	0.16
HM.CT	0.74	0.36	0.14	0.73	0.74	0.49	0.51	0.90	0.91	0.76	0.67	0.33	0.74	0.42	0.16
SCORE.MAX	0.74	0.41	0.16	0.74	0.81	0.50	0.53	0.98	0.96	0.76	0.71	0.37	0.75	0.46	0.18
SCORE.2DF.CT	0.71	0.37	0.14	0.72	0.75	0.43	0.62	0.98	0.97	0.72	0.66	0.29	0.76	0.45	0.15
HM.2DF.CT	0.71	0.34	0.12	0.72	0.70	0.45	0.58	0.93	0.91	0.72	0.62	0.32	0.76	0.42	0.16
Power Comparison for Single Proband Ascertainment															
SINGLE	Model 1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model 3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NULL.CT	0.69	0.78	0.53	0.69	0.78	0.53	0.79	0.99	0.99	0.38	0.43	0.24	0.20	0.19	0.12
SCORE.CT	0.69	0.78	0.54	0.70	0.78	0.53	0.79	0.99	0.99	0.38	0.43	0.24	0.20	0.19	0.12
SCORE.NULL.EV	0.55	0.71	0.48	0.56	0.72	0.51	0.37	0.91	0.91	0.27	0.36	0.17	0.11	0.15	0.08
SCORE.EV	0.59	0.71	0.49	0.59	0.74	0.52	0.40	0.93	0.92	0.29	0.37	0.18	0.13	0.16	0.09
SCORE.MERLIN	0.69	0.78	0.53	0.69	0.78	0.55	0.80	1.00	0.99	0.38	0.43	0.23	0.20	0.19	0.12
SCORE.MERLIN.AV	0.68	0.78	0.53	0.69	0.78	0.54	0.79	0.99	0.99	0.38	0.43	0.23	0.20	0.19	0.12
HM.MERLIN	0.69	0.81	0.66	0.69	0.73	0.58	0.78	0.99	0.99	0.38	0.38	0.22	0.20	0.17	0.11
HM.CT	0.69	0.80	0.65	0.69	0.73	0.57	0.76	0.98	0.98	0.38	0.37	0.22	0.20	0.17	0.11
SCORE.MAX	0.70	0.81	0.61	0.70	0.80	0.61	0.79	1.00	0.99	0.39	0.45	0.28	0.21	0.20	0.13
SCORE.2DF.CT	0.66	0.76	0.52	0.65	0.75	0.51	0.85	1.00	0.99	0.36	0.40	0.21	0.21	0.20	0.11
HM.2DF.CT	0.66	0.78	0.63	0.65	0.70	0.53	0.83	0.99	0.99	0.36	0.35	0.21	0.22	0.18	0.11

Power Comparison for Extreme Discordant Sampling															
ED	Model 1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model 3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NULL.CT	0.58	0.78	0.74	0.58	0.81	0.85	0.15	0.77	0.92	0.24	0.76	0.87	0.52	0.67	0.70
SCORE.CT	0.59	0.78	0.74	0.59	0.81	0.85	0.15	0.77	0.92	0.25	0.77	0.87	0.53	0.68	0.70
SCORE.NULL.EV	0.42	0.67	0.70	0.46	0.75	0.84	0.03	0.38	0.74	0.15	0.70	0.85	0.39	0.61	0.69
SCORE.EV	0.48	0.70	0.72	0.52	0.78	0.85	0.04	0.43	0.75	0.18	0.73	0.85	0.46	0.64	0.70
SCORE.MERLIN	0.60	0.79	0.74	0.59	0.81	0.85	0.15	0.78	0.93	0.23	0.77	0.87	0.52	0.67	0.69
SCORE.MERLIN.AV	0.59	0.78	0.73	0.59	0.81	0.85	0.16	0.77	0.92	0.23	0.77	0.86	0.52	0.68	0.69
HM.MERLIN	0.59	0.82	0.84	0.59	0.81	0.90	0.14	0.70	0.89	0.15	0.77	0.91	0.52	0.69	0.77
HM.CT	0.59	0.81	0.85	0.59	0.80	0.90	0.15	0.68	0.87	0.14	0.77	0.91	0.52	0.70	0.76
SCORE.MAX	0.60	0.79	0.79	0.60	0.83	0.89	0.15	0.82	0.95	0.25	0.79	0.89	0.55	0.71	0.76
SCORE.2DF.CT	0.55	0.75	0.71	0.56	0.79	0.85	0.18	0.88	0.97	0.22	0.74	0.84	0.54	0.69	0.71
HM.2DF.CT	0.55	0.79	0.81	0.56	0.77	0.88	0.17	0.77	0.91	0.15	0.73	0.89	0.54	0.70	0.77
Power Comparison for Extreme Concordant Sampling															
EC	Model 1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model 3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NULL.CT	0.60	0.75	0.69	0.54	0.68	0.57	0.80	0.99	1.00	0.21	0.26	0.22	0.12	0.10	0.09
SCORE.CT	0.61	0.75	0.69	0.55	0.68	0.57	0.81	0.99	1.00	0.23	0.26	0.22	0.12	0.10	0.09
SCORE.NULL.EV	0.40	0.60	0.60	0.33	0.59	0.54	0.37	0.85	0.98	0.11	0.17	0.17	0.06	0.06	0.06
SCORE.EV	0.48	0.63	0.61	0.40	0.62	0.55	0.46	0.88	0.98	0.13	0.18	0.18	0.07	0.07	0.07
SCORE.MERLIN	0.60	0.74	0.69	0.53	0.68	0.58	0.81	0.99	1.00	0.22	0.26	0.23	0.11	0.10	0.09
SCORE.MERLIN.AV	0.60	0.75	0.68	0.53	0.68	0.57	0.80	0.99	1.00	0.22	0.26	0.22	0.11	0.10	0.08
HM.MERLIN	0.60	0.76	0.74	0.53	0.63	0.65	0.81	0.99	1.00	0.22	0.25	0.25	0.12	0.10	0.11
HM.CT	0.60	0.75	0.73	0.53	0.63	0.65	0.79	0.98	1.00	0.22	0.25	0.24	0.11	0.10	0.11
SCORE.MAX	0.62	0.77	0.75	0.55	0.70	0.64	0.81	0.99	1.00	0.23	0.28	0.27	0.13	0.11	0.10
SCORE.2DF.CT	0.57	0.71	0.65	0.51	0.65	0.54	0.86	1.00	1.00	0.19	0.25	0.21	0.12	0.11	0.09
HM.2DF.CT	0.57	0.72	0.69	0.51	0.61	0.61	0.85	0.99	1.00	0.19	0.23	0.23	0.12	0.11	0.12

Power Comparison for EDAC 3-Corner Sampling															
EDAC3	Model 1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model 3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NULL.CT	0.59	0.72	0.66	0.54	0.71	0.64	0.78	0.99	1.00	0.43	0.56	0.45	0.37	0.28	0.17
SCORE.CT	0.60	0.73	0.66	0.55	0.71	0.64	0.78	0.99	1.00	0.44	0.57	0.45	0.38	0.29	0.18
SCORE.NULL.EV	0.43	0.64	0.61	0.41	0.63	0.59	0.39	0.91	0.98	0.29	0.47	0.41	0.25	0.21	0.14
SCORE.EV	0.49	0.66	0.62	0.46	0.65	0.61	0.48	0.92	0.98	0.35	0.51	0.42	0.30	0.24	0.14
SCORE.MERLIN	0.60	0.73	0.66	0.55	0.71	0.63	0.78	1.00	1.00	0.44	0.56	0.46	0.37	0.29	0.18
SCORE.MERLIN.AV	0.60	0.73	0.66	0.54	0.71	0.63	0.78	0.99	1.00	0.45	0.56	0.45	0.38	0.29	0.17
HM.MERLIN	0.61	0.77	0.80	0.54	0.66	0.62	0.79	0.99	1.00	0.44	0.50	0.40	0.37	0.22	0.13
HM.CT	0.61	0.76	0.80	0.55	0.66	0.61	0.79	0.99	1.00	0.45	0.50	0.40	0.38	0.22	0.13
SCORE.MAX	0.61	0.74	0.71	0.56	0.74	0.71	0.78	1.00	1.00	0.46	0.59	0.51	0.39	0.32	0.20
SCORE.2DF.CT	0.56	0.70	0.61	0.52	0.68	0.59	0.85	1.00	1.00	0.42	0.51	0.41	0.40	0.29	0.17
HM.2DF.CT	0.56	0.74	0.77	0.52	0.63	0.56	0.84	0.99	1.00	0.42	0.45	0.37	0.40	0.22	0.13
Power Comparison for MDAC 3-Corner Sampling															
MDAC3	Model 1	Model 1'	Model 1''	Model 2	Model 2'	Model 2''	Model 3	Model 3'	Model 3''	Model 4	Model 4'	Model 4''	Model 5	Model 5'	Model 5''
SCORE.NULL.CT	0.74	0.73	0.50	0.69	0.85	0.64	0.58	0.98	0.98	0.63	0.68	0.44	0.56	0.42	0.20
SCORE.CT	0.74	0.73	0.50	0.69	0.85	0.64	0.59	0.98	0.98	0.63	0.68	0.44	0.56	0.42	0.20
SCORE.NULL.EV	0.64	0.68	0.48	0.60	0.81	0.61	0.23	0.85	0.91	0.53	0.63	0.41	0.48	0.37	0.16
SCORE.EV	0.66	0.69	0.48	0.62	0.81	0.62	0.25	0.86	0.92	0.56	0.64	0.41	0.50	0.38	0.17
SCORE.MERLIN	0.74	0.73	0.50	0.68	0.85	0.65	0.58	0.98	0.99	0.63	0.68	0.44	0.57	0.42	0.19
SCORE.MERLIN.AV	0.73	0.74	0.50	0.68	0.85	0.64	0.58	0.98	0.97	0.63	0.69	0.44	0.56	0.42	0.19
HM.MERLIN	0.73	0.80	0.67	0.68	0.79	0.64	0.59	0.98	0.98	0.63	0.64	0.44	0.57	0.38	0.17
HM.CT	0.73	0.79	0.65	0.69	0.80	0.63	0.59	0.97	0.97	0.63	0.65	0.44	0.57	0.38	0.17
SCORE.MAX	0.74	0.75	0.56	0.70	0.86	0.72	0.59	0.98	0.99	0.63	0.70	0.50	0.57	0.44	0.22
SCORE.2DF.CT	0.71	0.69	0.48	0.67	0.83	0.61	0.66	0.99	0.99	0.60	0.65	0.41	0.58	0.43	0.19
HM.2DF.CT	0.71	0.75	0.62	0.67	0.76	0.60	0.66	0.97	0.97	0.60	0.60	0.40	0.58	0.38	0.17

Detailed power results (all selection schemes) for all the statistics considered in the simulation study.

Note: For each model, power values within 3% of the maximum are highlighted in bold.