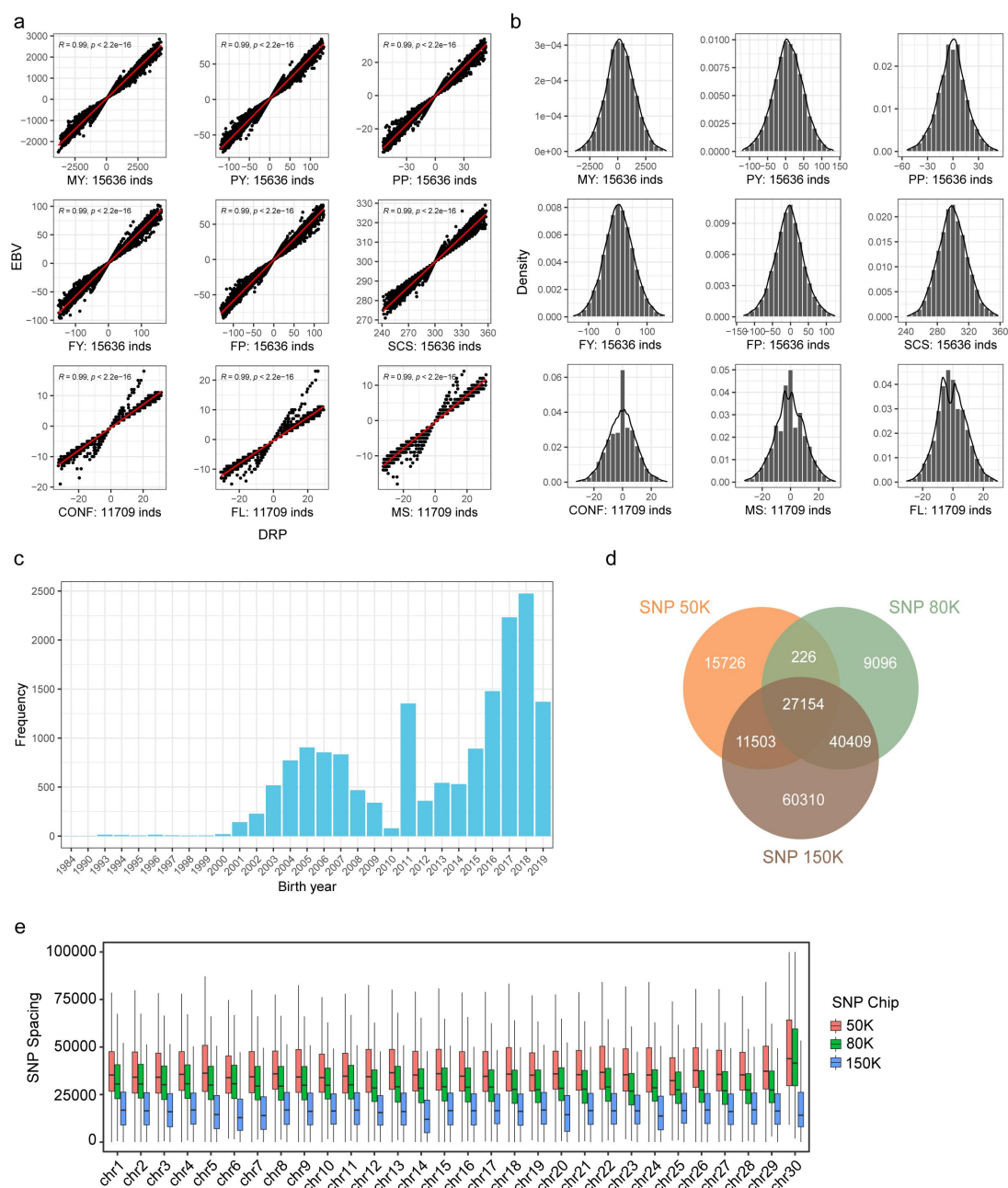
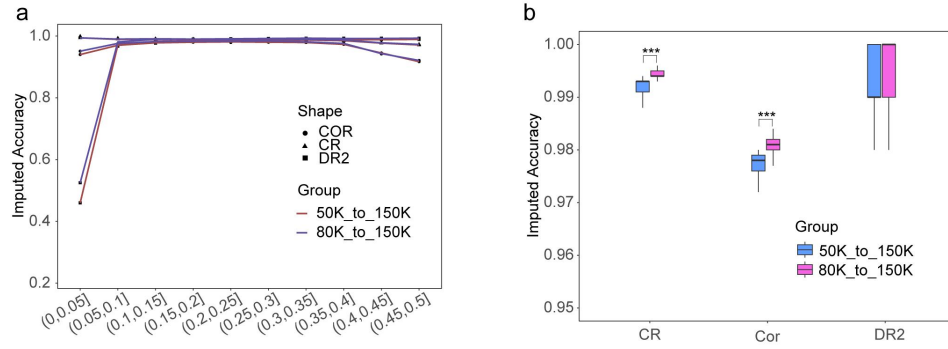
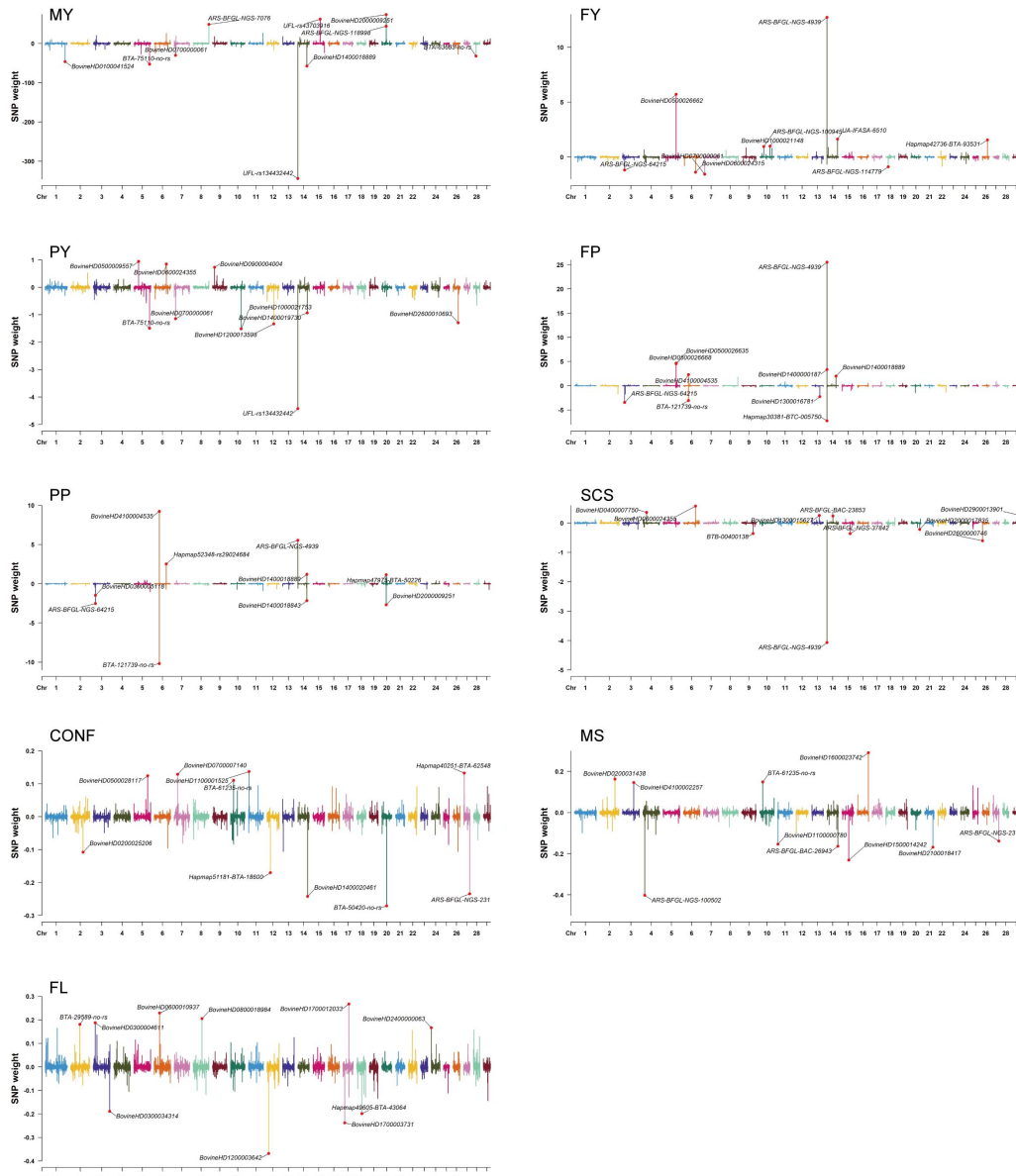




Supplementary Figure 1. Data landscape. **a**, Scatter plots displaying the correlations between the EBV and DRP for nine traits. **b**, Curve plots illustrating the normal distributions of DRPs for nine traits. **c**, Bar charts showing the birth year distribution within the reference population. **d**, Venn diagrams depicting the shared SNP counts among the three SNP panels. **e**, Box charts represents the SNP spacing distribution of the three types of SNP chips.



Supplementary Figure 2. Imputation Performance for SNP chips. a. Line plot showing the effect of MAF on imputation accuracy. **b.** Box plot comparing imputation accuracy; *** denotes P -value < 0.001 (Wilcoxon test).



Supplementary Figure 3. Manhattan plot displaying the SNP effects of nine traits estimated by BayesB π .

Supplementary Table 1. Lambda value of GWAS for nine traits

Traits	Lambda
MY	0.958±0.005
FY	0.95±0.005
PY	0.989±0.006
FP	0.952±0.004
PP	0.901±0.005
SCS	0.965±0.005
CONF	0.983±0.006
MS	0.993±0.007
FL	0.975±0.006

Supplementary Table 2. Significant SNPs identified by GWAS

Trait	MY	FY	PY	FP	PP	SCS	CONF	MS	FL
Chr3				1	8				
Chr5	2	2	8	24	1				
Chr6	2	4	1	1	26	3			
Chr8	1								
Chr10					7				
Chr12							1		
Chr14	36	9	43	114	58	35			
Chr15		1							
Chr17			3						
Chr20	20			7	51				
Chr23					1				
Chr26						1			
Chr29					7				
Total	61	16	55	147	159	39	1	0	0

Supplementary Table 3. Go terms of genes identified by GWAS

Description	GeneRatio	pvalue	qvalue	geneID
acetylcholine receptor regulator activity	5/155	6.14E-08	7.34E-06	GPIHBP1/LY6H/LY6E/LYPD2/ SLURP1
neurotransmitter receptor regulator activity	5/155	6.14E-08	7.34E-06	GPIHBP1/LY6H/LY6E/LYPD2/ SLURP1
signaling receptor inhibitor activity	5/155	8.53E-07	6.79E-05	GPIHBP1/LY6H/LY6E/LYPD2/ SLURP1
ephrin receptor binding	3/155	1.03E-04	6.17E-03	EFNA1/EFNA3/EFNA4
potassium channel activity	6/155	7.54E-04	3.60E-02	KCNK9/HCN3/KCNN3/PKD2/ KCNS2/HCN1

Supplementary Table 4. Prediction performance of 11 methods in 5 replicates of 5-fold CV

Indicator	Trait	GBLUP	WGBLUP_BayesBpi	WGBLUP_GWAS	WGBLUP_P-value	DPAnet	BayesA	BayesBpi	BayesCpi	BayesR	KRR_hyper	SVR_hyper
Accuracy	MY	0.524±0.004	0.534±0.004	0.539±0.004	0.517±0.004	0.505±0.004	0.544±0.004	0.543±0.004	0.541±0.004	0.545±0.004	0.524±0.004	0.501±0.004
	FY	0.495±0.004	0.509±0.004	0.508±0.004	0.481±0.004	0.484±0.005	0.514±0.003	0.513±0.003	0.512±0.003	0.516±0.003	0.488±0.004	0.485±0.004
	PY	0.496±0.003	0.496±0.003	0.494±0.004	0.473±0.003	0.474±0.004	0.5±0.004	0.496±0.004	0.498±0.003	0.497±0.003	0.489±0.003	0.486±0.004
	FP	0.574±0.004	0.624±0.003	0.633±0.003	0.605±0.004	0.604±0.005	0.645±0.003	0.653±0.003	0.639±0.003	0.656±0.003	0.572±0.004	0.505±0.004
	PP	0.631±0.003	0.646±0.004	0.676±0.003	0.648±0.003	0.641±0.004	0.679±0.003	0.689±0.003	0.679±0.003	0.69±0.003	0.626±0.004	0.562±0.004
	SCS	0.487±0.004	0.5±0.004	0.503±0.004	0.48±0.004	0.46±0.005	0.509±0.005	0.509±0.005	0.509±0.005	0.511±0.005	0.485±0.002	0.456±0.004
	CONF	0.721±0.003	0.721±0.003	0.714±0.004	0.675±0.004	0.721±0.004	0.718±0.003	0.718±0.003	0.722±0.003	0.721±0.003	0.705±0.005	0.721±0.004
	MS	0.659±0.006	0.658±0.006	0.647±0.006	0.61±0.007	0.659±0.006	0.656±0.006	0.653±0.006	0.659±0.006	0.659±0.006	0.657±0.007	0.67±0.006
	FL	0.834±0.004	0.834±0.004	0.824±0.004	0.801±0.004	0.844±0.007	0.838±0.005	0.826±0.004	0.835±0.005	0.833±0.004	0.867±0.004	0.875±0.004
Unbiased ness	MY	0.998±0.009	0.996±0.009	0.904±0.008	0.711±0.006	0.833±0.016	1.019±0.009	0.975±0.009	1.017±0.009	1.016±0.009	0.809±0.006	1.085±0.009
	FY	0.991±0.012	0.99±0.011	0.894±0.01	0.688±0.008	0.832±0.013	0.971±0.009	0.974±0.01	1.009±0.01	1.01±0.01	0.761±0.007	1.048±0.009
	PY	0.99±0.009	0.988±0.009	0.883±0.007	0.68±0.005	0.806±0.01	0.993±0.009	0.965±0.009	1.01±0.009	1.012±0.009	0.763±0.005	1.039±0.008
	FP	0.994±0.008	0.99±0.006	0.933±0.006	0.757±0.006	0.924±0.015	0.983±0.005	0.981±0.006	0.995±0.006	1.002±0.006	0.877±0.006	1.045±0.009
	PP	0.986±0.008	0.985±0.007	0.922±0.006	0.767±0.005	0.919±0.017	1.047±0.007	0.972±0.006	0.996±0.007	0.999±0.007	0.921±0.005	1.093±0.009
	SCS	0.991±0.012	0.99±0.013	0.866±0.011	0.642±0.008	0.803±0.013	0.958±0.012	0.972±0.014	1.017±0.014	1.017±0.014	0.703±0.004	0.966±0.01
	CONF	0.998±0.008	0.997±0.008	0.912±0.008	0.726±0.006	0.901±0.009	0.985±0.007	0.995±0.008	1.022±0.008	1.026±0.008	0.815±0.006	1.053±0.009
	MS	0.99±0.012	0.988±0.012	0.883±0.011	0.687±0.009	0.894±0.013	0.974±0.011	0.979±0.012	1.011±0.012	1.015±0.012	0.792±0.008	1.055±0.01
	FL	0.991±0.007	0.99±0.007	0.911±0.007	0.764±0.006	0.854±0.009	1.103±0.009	0.968±0.008	1.018±0.008	1.016±0.008	0.956±0.005	1.048±0.005

Supplementary Table 5. Prediction performance of 2 machine learning methods in 5 replicates of 5-fold CV

Indicator	Trait	KRR_default	KRR_hyper	SVR_default	SVR_hyper
Accuracy	MY	0.348±0.004	0.524±0.004	0.459±0.004	0.501±0.004
	FY	0.318±0.003	0.488±0.004	0.421±0.004	0.485±0.004
	PY	0.315±0.002	0.489±0.003	0.431±0.003	0.486±0.004
	FP	0.417±0.004	0.572±0.004	0.468±0.005	0.505±0.004
	PP	0.48±0.002	0.626±0.004	0.523±0.002	0.562±0.004
	SCS	0.326±0.004	0.485±0.002	0.41±0.005	0.456±0.004
	CONF	0.446±0.005	0.705±0.005	0.655±0.005	0.721±0.004
	MS	0.406±0.007	0.657±0.007	0.611±0.006	0.67±0.006
	FL	0.606±0.004	0.867±0.004	0.873±0.005	0.875±0.004
Unbiasedness	MY	0.27±0.002	0.809±0.006	0.732±0.007	1.085±0.009
	FY	0.248±0.002	0.761±0.007	0.656±0.008	1.048±0.009
	PY	0.244±0.002	0.763±0.005	0.687±0.005	1.039±0.008
	FP	0.327±0.003	0.877±0.006	0.724±0.008	1.045±0.009
	PP	0.382±0.002	0.921±0.005	0.795±0.006	1.093±0.009
	SCS	0.217±0.003	0.703±0.004	0.593±0.008	0.966±0.01
	CONF	0.288±0.003	0.815±0.006	0.756±0.008	1.053±0.009
	MS	0.263±0.004	0.792±0.008	0.74±0.008	1.055±0.01
	FL	0.404±0.003	0.956±0.005	0.985±0.005	1.048±0.005

Supplementary Table 6. Average computing time to complete 5 replicates of 5-fold CV using different methods

Model	MY	FY	PY	FP	PP	SCS	CONF	MS	FL
GBLUP	38.13	37.64	37.46	38.63	38.67	37.20	36.52	36.44	35.91
WGBLUP_GWAS	39.99	40.61	40.26	40.28	41.08	40.06	40.06	39.36	40.15
WGBLUP_BayesBpi	40.94	41.01	41.38	41.31	41.86	41.24	41.01	40.27	40.88
WGBLUP_P-value	41.33	42.19	41.28	41.73	41.96	41.12	40.76	40.43	40.94
DPAnet	37.15	38.08	16.99	26.15	19.03	30.78	30.99	16.18	22.45
BayesA	202.06	224.74	235.28	240.90	241.33	274.74	205.73	192.52	209.02
BayesBpi	158.44	163.03	212.32	184.17	181.70	191.88	221.72	223.56	219.71
BayesCpi	141.16	174.92	221.24	151.65	179.02	187.26	225.31	232.31	228.91
BayesR	211.70	208.07	373.31	208.36	190.00	260.89	332.85	334.40	334.63
KRR	14.31	16.22	14.15	15.80	14.45	14.98	8.25	7.82	8.12
SVR	172.69	189.84	186.05	183.54	162.39	181.03	71.06	67.41	68.36
GWAS	369.27	289.74	358.08	341.54	393.67	342.34	211.87	218.18	217.97
KRR_hyper_tuning	22.11	22.14	20.15	22.36	19.49	20.88	11.98	12.32	13.37
SVR_hyper_tuning	471.62	605.59	762.72	480.68	769.97	372.03	521.56	673.38	582.36
DPAnet_hyper_tuning	438.55	340.17	407.01	309.48	354.33	387.99	331.10	335.10	339.97