## SUPPLEMENTARY TABLES

**Supplementary Table 1. The associations of phenylalanine and tyrosine with all-cause mortality excluding deaths from accidents in UK Biobank using Cox regression.**

| Exposure | Sex | HR[1] | 95% CI[2] | *p* |
|---|---|---|---|---|
| Phenylalanine | Overall | 1.04 | 1.03, 1.05 | $3.3 \times 10^{-9}$ |
| | Men | 1.04 | 1.02, 1.05 | $3.2 \times 10^{-7}$ |
| | Women | 1.04 | 1.02, 1.07 | $8.7 \times 10^{-4}$ |
| Tyrosine | Overall | 1.02 | 1.00, 1.03 | $1.9 \times 10^{-2}$ |
| | Men | 1.03 | 1.01, 1.05 | $3.4 \times 10^{-3}$ |
| | Women | 1.00 | 0.98, 1.03 | $7.8 \times 10^{-1}$ |

[1]HR: hazard ratio. In overall analysis we adjusted for age, body mass index (BMI), Townsend Deprivation Index, smoking status, alcohol consumption, physical activity, ethnicity, and education (in years). For combined-sex analyses, we additionally adjusted for sex. [2]CI: confidence interval.

**Supplementary Table 2. The associations of phenylalanine and tyrosine with all-cause mortality stratified by amino acid level in UK Biobank using Cox regression.**

| Exposure | Stratified by amino acids levels[1] | HR[2] | 95% CI[3] | *p* |
|---|---|---|---|---|
| Phenylalanine | Lower level | 0.95 | 0.91, 0.99 | $2.5 \times 10^{-2}$ |
| | Higher level | 1.05 | 1.04, 1.06 | $8.4 \times 10^{-17}$ |
| Tyrosine | Lower level | 0.89 | 0.85, 0.93 | $2.7 \times 10^{-13}$ |
| | Higher level | 1.10 | 1.07, 1.13 | $4.5 \times 10^{-7}$ |

[1]Higher or lower level means above or below standardized concentration of 0 for phenylalanine and tyrosine. [2]HR: hazard ratio. We adjusted for age, sex, BMI, Townsend Deprivation Index, smoking status, alcohol consumption, physical activity, ethnicity, and education (in years). [3]CI: confidence interval.

**Supplementary Table 3. The associations of phenylalanine and tyrosine with cardiovascular disease (CVD) and cancer mortality in UK Biobank using Cox regression.**

| Exposure | Outcome | Sex | HR[1] | 95% CI[2] | *p* |
|---|---|---|---|---|---|
| Phenylalanine | CVD mortality | Overall | 1.03 | 1.00, 1.06 | $3.4 \times 10^{-2}$ |
| | | Men | 1.03 | 0.99, 1.07 | $1.7 \times 10^{-1}$ |
| | | Women | 1.05 | 0.99, 1.12 | $9.3 \times 10^{-2}$ |
| Tyrosine | CVD mortality | Overall | 1.01 | 0.98, 1.04 | $6.3 \times 10^{-1}$ |
| | | Men | 1.01 | 0.97, 1.05 | $7.0 \times 10^{-1}$ |
| | | Women | 1.00 | 0.94, 1.07 | $9.8 \times 10^{-1}$ |
| Phenylalanine | Cancer mortality | Overall | 1.04 | 1.02, 1.05 | $6.3 \times 10^{-5}$ |
| | | Men | 1.04 | 1.01, 1.06 | $2.7 \times 10^{-3}$ |
| | | Women | 1.04 | 1.01, 1.07 | $2.2 \times 10^{-2}$ |
| Tyrosine | Cancer mortality | Overall | 1.02 | 0.99, 1.04 | $1.6 \times 10^{-1}$ |
| | | Men | 1.01 | 0.99, 1.04 | $3.3 \times 10^{-1}$ |
| | | Women | 1.02 | 0.99, 1.06 | $1.9 \times 10^{-1}$ |

[1]HR: hazard ratio. In overall analysis we adjusted for age, BMI, Townsend Deprivation Index, smoking status, alcohol consumption, physical activity, ethnicity, and education (in years). For combined-sex analyses, we additionally adjusted for sex. [2]CI: confidence interval.

**Supplementary Table 4. Linkage disequilibrium score regression.**

| Phenotype | Population | Sex | $h^2$ | $h^2$_se | lambda | intercept | intercept_se | ratio | ratio_se |
|---|---|---|---|---|---|---|---|---|---|
| Phenylalanine | EUR | Overall | 0.036 | 0.009 | 1.121 | 1.028 | 0.009 | 0.143 | 0.043 |
| Phenylalanine | EUR | Female | 0.031 | 0.008 | 1.068 | 1.014 | 0.008 | 0.145 | 0.080 |
| Phenylalanine | EUR | Male | 0.042 | 0.010 | 1.059 | 1.011 | 0.009 | 0.110 | 0.082 |
| Tyrosine | EUR | Overall | 0.087 | 0.018 | 1.250 | 1.062 | 0.011 | 0.120 | 0.022 |
| Tyrosine | EUR | Female | 0.080 | 0.023 | 1.127 | 1.040 | 0.009 | 0.153 | 0.035 |
| Tyrosine | EUR | Male | 0.114 | 0.026 | 1.152 | 1.035 | 0.010 | 0.114 | 0.032 |

**Supplementary Table 5. Genetic instruments for phenylalanine in the overall analysis.**

| SNP | effect_allele | other_allele | gene | beta | se | *p*-value | F-statistics |
|---|---|---|---|---|---|---|---|
| rs1009062 | G | T | *GSTA2* | −0.02 | 0.003 | 1.76E-11 | 45.2 |
| rs1043011 | T | G | *GLS2, SPRYD4* | 0.033 | 0.004 | 1.40E-18 | 77.4 |
| rs1047891 | A | C | *CPS1* | −0.029 | 0.003 | 1.25E-20 | 86.7 |
| rs10750864 | T | A | *SLC43A1* | −0.055 | 0.003 | 3.37E-59 | 263.2 |
| rs10826337 | A | G | *SLC16A9, MRPL50P4* | 0.017 | 0.003 | 1.30E-08 | 32.3 |
| rs117040573 | A | G | *C12orf42* | 0.037 | 0.006 | 3.92E-10 | 39.2 |
| rs12830698 | G | T | *STAB2* | 0.115 | 0.014 | 6.48E-17 | 69.8 |
| rs13254494 | C | T | *SLC25A37* | −0.018 | 0.003 | 1.02E-09 | 37.3 |
| rs140584594 | A | G | *GSTM1* | 0.022 | 0.003 | 6.40E-12 | 47.2 |
| rs1522298 | C | G | *PAH* | −0.06 | 0.003 | 7.19E-85 | 381.1 |
| rs17253619 | C | T | *WDHD1* | 0.054 | 0.004 | 1.45E-33 | 145.8 |
| rs1800759 | T | G | *ADH4, LOC100507053* | 0.018 | 0.003 | 7.58E-10 | 37.9 |
| rs2239328 | T | C | *ABCC6* | −0.026 | 0.003 | 2.29E-16 | 67.3 |
| rs34121855 | G | T | *MLXIPL* | −0.021 | 0.004 | 1.04E-08 | 32.8 |
| rs3757132 | T | C | *SLC17A1* | −0.036 | 0.003 | 1.83E-27 | 117.9 |
| rs61935426 | A | C | *LINC02456* | 0.086 | 0.012 | 9.04E-13 | 51 |
| rs73063122 | C | A | *SLCO1B1* | −0.029 | 0.004 | 2.36E-13 | 53.7 |
| rs75017413 | A | T | *SLC38A4* | 0.041 | 0.006 | 2.41E-12 | 49.1 |
| rs870072 | C | T | *PAH* | 0.111 | 0.003 | 2.66E-303 | 1408.7 |
| rs932316 | C | T | *SCGN, CARMIL1* | −0.021 | 0.004 | 1.44E-08 | 32.1 |
| rs99780 | T | C | *FADS2* | 0.02 | 0.003 | 9.88E-11 | 41.8 |

**Supplementary Table 6. Genetic instruments for tyrosine in the overall analysis.**

| SNP | effect_allele | other_allele | gene | beta | se | *p*-value | F-statistics |
|---|---|---|---|---|---|---|---|
| rs10027275 | G | C | *ARHGAP10* | 0.032 | 0.003 | 4.72E-22 | 93.2 |
| rs10164853 | G | A | *ACVR1C* | 0.036 | 0.006 | 1.27E-10 | 41.3 |
| rs10217762 | C | T | *CDKN2B-AS1* | −0.019 | 0.003 | 9.61E-11 | 41.9 |
| rs1043011 | T | G | *GLS2, SPRYD4* | 0.065 | 0.004 | 3.94E-69 | 308.8 |
| rs10750864 | T | A | *SLC43A1* | −0.02 | 0.003 | 2.06E-09 | 35.9 |
| rs11263465 | G | A | *LOC105369370* | 0.027 | 0.004 | 1.86E-10 | 40.6 |
| rs114232169 | T | G | *HRG, HRG-AS1* | 0.025 | 0.003 | 1.88E-16 | 67.7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| rs11614623 | T | C | *HPD* | 0.049 | 0.004 | 4.14E-29 | 125.4 |
| rs11643623 | T | C | *ZNF276* | 0.018 | 0.003 | 1.86E-08 | 31.6 |
| rs11706810 | C | T | *TRIM59, TRIM59-IFT80* | −0.02 | 0.003 | 4.93E-12 | 47.7 |
| rs12212085 | C | A | *SLC16A10* | 0.171 | 0.004 | 0 | 1699.8 |
| rs123698 | G | C | *PTBP1* | 0.018 | 0.003 | 9.64E-10 | 37.4 |
| rs12596084 | C | A | *RNA5SP427, MPHOSPH10P1* | −0.02 | 0.003 | 4.99E-10 | 38.7 |
| rs12811045 | G | A | *LOC102723639* | 0.023 | 0.004 | 6.24E-11 | 42.7 |
| rs12824518 | T | C | / | 0.028 | 0.004 | 4.60E-11 | 43.3 |
| rs13107325 | T | C | *SLC39A8* | −0.037 | 0.005 | 2.36E-11 | 44.6 |
| rs13142887 | T | A | / | −0.018 | 0.003 | 7.40E-09 | 33.4 |
| rs13281892 | G | A | *SLC7A2* | −0.021 | 0.003 | 2.55E-11 | 44.5 |
| rs1345901 | C | T | *LOC105371356* | 0.022 | 0.003 | 1.15E-13 | 55.1 |
| rs140584594 | A | G | *GSTM1* | 0.019 | 0.003 | 4.71E-09 | 34.3 |
| rs1433210 | C | A | *LINC01091* | −0.02 | 0.003 | 5.78E-09 | 33.9 |
| rs150851429 | C | G | *LOC105371334* | 0.376 | 0.013 | 5.51E-198 | 901.1 |
| rs151175127 | T | C | / | −0.059 | 0.007 | 4.22E-17 | 70.7 |
| rs1531022 | A | G | *UGT2B15* | 0.018 | 0.003 | 6.05E-10 | 38.3 |
| rs17050272 | A | G | *LOC105373585* | 0.023 | 0.003 | 7.05E-15 | 60.6 |
| rs174537 | T | G | *MYRF* | 0.036 | 0.003 | 5.38E-32 | 138.6 |
| rs1800961 | T | C | *HNF4A* | −0.084 | 0.008 | 4.67E-24 | 102.3 |
| rs183657985 | T | C | *EXOC3L2* | 0.021 | 0.003 | 4.65E-10 | 38.8 |
| rs1883711 | C | G | *LINC01370, MAFB* | 0.067 | 0.009 | 6.17E-15 | 60.8 |
| rs194742 | T | C | *MAGOH3P, ZFP36L1* | −0.024 | 0.004 | 7.99E-10 | 37.8 |
| rs204926 | G | A | *LMO1* | 0.017 | 0.003 | 3.09E-09 | 35.1 |
| rs2126263 | G | A | *LOC157273* | 0.034 | 0.005 | 1.13E-12 | 50.6 |
| rs2189966 | C | T | *JAZF1* | −0.037 | 0.004 | 3.74E-25 | 107.3 |
| rs2393775 | G | A | *HNF1A* | 0.052 | 0.003 | 2.32E-69 | 309.9 |
| rs28601761 | G | C | *TRIB1AL* | −0.044 | 0.003 | 4.79E-49 | 216.7 |
| rs34396849 | C | A | *PGBD1* | 0.031 | 0.004 | 1.80E-12 | 49.7 |
| rs35048664 | G | T | *PAH* | 0.02 | 0.003 | 5.65E-10 | 38.4 |
| rs35757209 | T | C | *UNK* | 0.024 | 0.003 | 1.42E-15 | 63.7 |
| rs41289886 | A | G | *RPF2* | 0.066 | 0.012 | 1.88E-08 | 31.6 |
| rs4416405 | A | G | / | 0.016 | 0.003 | 3.95E-08 | 30.2 |
| rs4493565 | A | C | *SHROOM3* | 0.016 | 0.003 | 1.40E-08 | 32.2 |
| rs4665972 | T | C | *SNX17* | −0.022 | 0.003 | 7.13E-14 | 56 |
| rs4722551 | C | T | *LOC105375199* | −0.023 | 0.004 | 3.18E-09 | 35.1 |
| rs4921914 | C | T | *PSD3, NAT2* | −0.026 | 0.003 | 2.30E-14 | 58.3 |
| rs511154 | A | G | *RPL31P23, PCCB* | −0.037 | 0.003 | 1.24E-27 | 118.7 |
| rs529565 | C | T | *ABO* | 0.019 | 0.003 | 1.50E-09 | 36.5 |
| rs56058728 | A | G | *INSR* | 0.021 | 0.004 | 1.03E-08 | 32.8 |
| rs56337219 | T | C | *SLC16A10* | −0.066 | 0.007 | 3.57E-21 | 89.2 |
| rs56401710 | C | A | *SLC22A7,* | 0.024 | 0.003 | 3.35E-16 | 66.6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | *LOC124901319* | | | | |
| rs60718363 | C | T | *WWC2* | 0.02 | 0.003 | 8.86E-09 | 33.1 |
| rs61676179 | A | C | *DEPDC5* | −0.046 | 0.007 | 1.88E-12 | 49.6 |
| rs62062797 | G | T | *MAPT* | −0.019 | 0.003 | 2.44E-08 | 31.1 |
| rs62466318 | T | C | *MLXIPL* | −0.027 | 0.004 | 3.27E-14 | 57.6 |
| rs6575900 | C | G | *WDR20, LOC105370677* | −0.036 | 0.004 | 6.02E-23 | 97.3 |
| rs6754311 | C | T | *DARS1* | −0.021 | 0.003 | 2.01E-09 | 36 |
| rs6831352 | T | C | *ADH4, LOC100507053* | 0.045 | 0.003 | 4.21E-46 | 203.2 |
| rs6906327 | A | G | *CDKAL1* | 0.017 | 0.003 | 2.17E-08 | 31.3 |
| rs715 | C | T | *CPS1* | −0.026 | 0.003 | 3.28E-17 | 71.2 |
| rs73079476 | C | A | *SLCO1B1* | −0.053 | 0.004 | 1.67E-38 | 168.4 |
| rs73158176 | G | C | *PRKAG2* | −0.019 | 0.003 | 2.24E-08 | 31.3 |
| rs738408 | T | C | *PNPLA3* | 0.025 | 0.003 | 8.18E-13 | 51.2 |
| rs7404381 | A | G | *AP1G1* | −0.052 | 0.003 | 4.54E-67 | 299.4 |
| rs7537281 | T | A | *PPIAP34, ZBTB40* | −0.024 | 0.004 | 1.12E-10 | 41.6 |
| rs75891099 | A | C | *REV3L* | 0.154 | 0.02 | 3.78E-15 | 61.8 |
| rs77042499 | C | T | *TRAF3IP2-AS1* | 0.089 | 0.01 | 2.69E-17 | 71.6 |
| rs78424108 | G | C | *WBP4, MIR3168* | −0.034 | 0.006 | 3.89E-10 | 39.2 |
| rs78802502 | A | G | *SLC38A4* | 0.082 | 0.006 | 1.07E-45 | 201.3 |
| rs7909960 | A | T | *JMJD1C* | 0.038 | 0.003 | 5.61E-39 | 170.6 |
| rs79687284 | C | G | *PROX1-AS1* | 0.051 | 0.008 | 1.38E-10 | 41.2 |
| rs8021303 | A | G | *WDHD1* | −0.019 | 0.003 | 1.42E-10 | 41.1 |
| rs8100204 | A | G | *SUGP1* | 0.029 | 0.004 | 4.64E-12 | 47.8 |
| rs8122094 | G | C | *TOP1* | 0.019 | 0.003 | 4.37E-08 | 30 |
| rs814573 | T | A | *APOC1P1, APOC1* | −0.029 | 0.004 | 1.41E-14 | 59.2 |
| rs9972653 | T | G | *FTO* | 0.019 | 0.003 | 1.81E-10 | 40.7 |

**Supplementary Table 7. Genetic instruments for phenylalanine in the sex-specific analysis.**

| SNP | effect_allele | other_allele | gene | beta | se | *p*-value | F-statistics |
|---|---|---|---|---|---|---|---|
| ***Male*** | | | | | | | |
| rs1321250 | C | T | / | −0.036 | 0.005 | 3.46E-11 | 43.9 |
| rs3757132 | T | C | *SLC17A1* | −0.038 | 0.005 | 9.59E-15 | 60.0 |
| rs1009062 | G | T | *GSTA2* | −0.025 | 0.004 | 2.08E-08 | 31.4 |
| rs10750864 | T | A | *SLC43A1* | −0.063 | 0.005 | 3.54E-37 | 162.3 |
| rs75918019 | G | A | *SLC38A4* | 0.056 | 0.009 | 3.89E-09 | 34.7 |
| rs76169231 | C | T | *LINC02456* | −0.032 | 0.005 | 1.44E-09 | 36.6 |
| rs1718292 | G | A | *PAH* | 0.115 | 0.004 | 3.15E-152 | 690.7 |
| rs1498691 | G | A | *PAH* | −0.060 | 0.005 | 1.28E-39 | 173.5 |
| rs12367892 | C | G | *C12orf42* | 0.088 | 0.015 | 1.76E-09 | 36.2 |
| rs17253619 | C | T | *WDHD1* | 0.062 | 0.007 | 1.72E-21 | 90.6 |
| rs2239327 | A | C | *ABCC6* | −0.031 | 0.005 | 7.45E-11 | 42.4 |
| rs2229742 | C | G | *NRIP1* | 0.043 | 0.007 | 8.81E-10 | 37.6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ***Female*** | | | | | | | |
| rs1047891 | A | C | *CPS1* | −0.039 | 0.004 | 1.13E-19 | 82.4 |
| rs1408268 | A | T | *SLC17A1* | −0.035 | 0.005 | 1.08E-14 | 59.7 |
| rs10750864 | T | A | *SLC43A1* | −0.048 | 0.005 | 2.24E-25 | 108.4 |
| rs4149058 | G | A | *SLCO1B1* | −0.026 | 0.005 | 4.82E-08 | 29.8 |
| rs2694917 | C | T | *RBMS2* | 0.037 | 0.005 | 1.69E-13 | 54.3 |
| rs1498694 | A | G | *PAH, LOC124902999* | 0.111 | 0.004 | 2.08E-164 | 746.7 |
| rs9804734 | T | C | *PAH* | −0.061 | 0.004 | 1.97E-47 | 209.3 |
| rs12830698 | G | T | *STAB2* | 0.114 | 0.019 | 1.36E-09 | 36.7 |
| rs17253619 | C | T | *WDHD1* | 0.047 | 0.006 | 7.39E-15 | 60.5 |
| rs2239328 | T | C | *ABCC6* | −0.024 | 0.004 | 4.38E-08 | 30.0 |

**Supplementary Table 8. Genetic instruments for tyrosine in the sex-specific analysis.**

| SNP | effect_allele | other_allele | gene | beta | se | *p*-value | F-statistics |
|---|---|---|---|---|---|---|---|
| ***Male*** | | | | | | | |
| rs17050272 | A | G | *LOC105373585* | 0.025 | 0.004 | 4.28E-09 | 34.5 |
| rs12614487 | T | C | *ACVR1C* | 0.047 | 0.008 | 5.43E-09 | 34.0 |
| rs511154 | A | G | *RPL31P23, PCCB* | −0.037 | 0.005 | 1.35E-13 | 54.8 |
| rs12632030 | C | T | *SMC4, TRIM59-IFT80* | −0.024 | 0.004 | 2.28E-08 | 31.2 |
| rs5402 | A | T | *SLC2A2* | 0.040 | 0.007 | 1.27E-09 | 36.9 |
| rs114232169 | T | G | *HRG, HRG-AS1* | 0.031 | 0.005 | 8.50E-12 | 46.6 |
| rs10020631 | A | G | *TMPRSS11E* | 0.031 | 0.005 | 4.99E-10 | 38.7 |
| rs1531022 | A | G | *UGT2B15* | 0.030 | 0.004 | 2.93E-12 | 48.7 |
| rs1800759 | T | G | *ADH4, LOC100507053* | 0.048 | 0.004 | 8.85E-28 | 119.3 |
| rs13107325 | T | C | *SLC39A8* | −0.044 | 0.008 | 3.65E-08 | 30.3 |
| rs10027275 | G | C | *ARHGAP10* | 0.028 | 0.005 | 1.53E-08 | 32.0 |
| rs72839445 | A | G | *CDCA7P1, POM121L2* | 0.038 | 0.007 | 3.03E-08 | 30.7 |
| rs1051952 | C | A | *TEAD3, TULP1, LOC124901309* | −0.025 | 0.004 | 3.79E-09 | 34.7 |
| rs62646255 | C | T | *SLC22A7* | 0.029 | 0.004 | 4.19E-11 | 43.5 |
| rs12206654 | C | T | *MFSD4B-DT* | 0.192 | 0.006 | 5.81E-215 | 979.3 |
| rs17717962 | C | T | *LOC105377944* | 0.088 | 0.015 | 1.08E-08 | 32.7 |
| rs35614968 | A | G | *FYN* | −0.129 | 0.014 | 3.85E-21 | 89.0 |
| rs116862171 | G | A | *FYN* | 0.100 | 0.017 | 6.55E-09 | 33.7 |
| rs4719841 | G | A | *LOC105375199* | 0.027 | 0.004 | 7.84E-10 | 37.8 |
| rs73091233 | C | T | *JAZF1* | −0.085 | 0.010 | 1.83E-16 | 67.8 |
| rs9987289 | A | G | *LOC157273* | 0.044 | 0.007 | 2.22E-09 | 35.8 |
| rs2980888 | T | C | *TRIB1AL* | 0.061 | 0.005 | 6.00E-39 | 170.4 |
| rs10761756 | T | C | *JMJD1C* | 0.049 | 0.004 | 1.00E-30 | 132.8 |
| rs2297644 | C | T | *HOGA1* | −0.031 | 0.006 | 4.63E-08 | 29.9 |
| rs174537 | T | G | *MYRF* | 0.035 | 0.004 | 3.80E-15 | 61.8 |
| rs4766214 | G | A | *LOC105369612* | −0.025 | 0.004 | 4.88E-09 | 34.2 |
| rs1871395 | G | A | *SLCO1B1* | −0.059 | 0.006 | 1.07E-22 | 96.1 |
| rs79295634 | G | A | *SLC38A4* | 0.086 | 0.009 | 1.82E-23 | 99.6 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| rs1043011 | T | G | *GLS2, SPRYD4* | 0.067 | 0.006 | 1.70E-34 | 150.0 |
| rs12811045 | G | A | *LOC102723639* | 0.032 | 0.005 | 7.46E-10 | 37.9 |
| rs2464190 | C | T | *HNF1A* | 0.047 | 0.004 | 1.27E-26 | 114.0 |
| rs4760099 | A | G | *HPD* | 0.052 | 0.006 | 9.16E-16 | 64.6 |
| rs78424108 | G | C | *WBP4, MIR3168* | −0.047 | 0.008 | 1.19E-08 | 32.5 |
| rs3783642 | C | T | *GCH1* | −0.024 | 0.004 | 3.71E-08 | 30.3 |
| rs6575900 | C | G | *WDR20, LOC105370677* | −0.042 | 0.005 | 5.89E-15 | 60.9 |
| rs9746832 | A | G | *LOC105371334* | 0.087 | 0.004 | 2.37E-92 | 415.5 |
| rs116992380 | C | T | *PKD1L3* | 0.206 | 0.015 | 3.23E-45 | 199.1 |
| rs8047723 | T | G | */* | 0.029 | 0.004 | 7.98E-11 | 42.3 |
| rs10221244 | G | A | *UNK* | 0.026 | 0.004 | 8.30E-09 | 33.2 |
| rs123698 | G | C | *PTBP1* | 0.024 | 0.004 | 4.04E-08 | 30.1 |
| rs58542926 | T | C | *TM6SF2* | 0.060 | 0.008 | 8.09E-14 | 55.8 |
| rs814573 | T | A | *APOC1P1, APOC1* | −0.032 | 0.006 | 1.18E-08 | 32.5 |
| rs1883711 | C | G | *LINC01370, MAFB* | 0.078 | 0.013 | 9.02E-10 | 37.5 |
| rs1800961 | T | C | *HNF4A* | −0.085 | 0.012 | 3.17E-12 | 48.6 |
| rs738408 | T | C | *PNPLA3* | 0.031 | 0.005 | 2.30E-09 | 35.7 |
| ***Female*** | | | | | | | |
| rs4665972 | T | C | *SNX17* | −0.025 | 0.004 | 1.11E-09 | 37.1 |
| rs1047891 | A | C | *CPS1* | −0.032 | 0.004 | 1.15E-14 | 59.6 |
| rs895893 | C | T | *RPL31P23, PCCB* | −0.037 | 0.005 | 1.12E-15 | 64.2 |
| rs35491981 | C | T | *LOC100507053* | 0.045 | 0.004 | 2.94E-24 | 103.3 |
| rs7697204 | C | T | *ARHGAP10* | 0.035 | 0.004 | 2.53E-15 | 62.6 |
| rs35261542 | A | C | *CDKAL1* | 0.027 | 0.004 | 2.24E-09 | 35.8 |
| rs11961853 | T | C | *UBQLN1P1, MICC* | 0.028 | 0.005 | 4.84E-08 | 29.8 |
| rs75661418 | G | A | *SLC16A10* | −0.076 | 0.012 | 9.66E-10 | 37.4 |
| rs12206654 | C | T | *MFSD4B-DT* | 0.177 | 0.006 | 7.63E-218 | 992.5 |
| rs56236906 | A | G | *FYN* | 0.083 | 0.014 | 5.28E-09 | 34.1 |
| rs35614968 | A | G | *FYN* | −0.109 | 0.012 | 1.11E-18 | 77.9 |
| rs146133919 | C | T | *FYN* | −0.076 | 0.013 | 4.92E-09 | 34.2 |
| rs2189966 | C | T | *JAZF1* | −0.034 | 0.005 | 1.79E-12 | 49.7 |
| rs34346326 | C | T | *MLXIPL* | −0.030 | 0.005 | 4.09E-10 | 39.1 |
| rs330093 | G | C | *PPP1R3B-DT* | 0.026 | 0.005 | 2.61E-08 | 31.0 |
| rs28601761 | G | C | *TRIB1AL* | −0.037 | 0.004 | 3.83E-20 | 84.5 |
| rs7902343 | T | C | *JMJD1C* | 0.029 | 0.004 | 1.83E-13 | 54.2 |
| rs174555 | C | T | *FADS1* | 0.038 | 0.004 | 3.29E-19 | 80.3 |
| rs4149059 | T | C | *SLCO1B1* | −0.041 | 0.005 | 5.37E-18 | 74.7 |
| rs76943648 | C | T | *SLC38A4* | 0.078 | 0.008 | 6.15E-24 | 101.8 |
| rs2657879 | G | A | *GLS2, SPRYD4* | 0.064 | 0.005 | 2.31E-37 | 163.2 |
| rs2393775 | G | A | *HNF1A* | 0.057 | 0.004 | 1.22E-45 | 201.1 |
| rs372273603 | G | A | *HPD* | 0.047 | 0.006 | 5.04E-16 | 65.8 |
| rs1595261 | C | A | */* | 0.025 | 0.004 | 1.12E-08 | 32.6 |
| rs6575900 | C | G | *WDR20, LOC105370677* | −0.031 | 0.005 | 3.16E-10 | 39.6 |
| rs150851429 | C | G | *LOC105371334* | 0.389 | 0.017 | 3.12E-119 | 539.0 |
| rs11640725 | A | G | *AP1G1, LOC124903714* | −0.046 | 0.004 | 9.96E-30 | 128.2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| rs1135688 | C | T | *UNC13D* | 0.025 | 0.004 | 2.82E-09 | 35.3 |
| rs1800961 | T | C | *HNF4A* | −0.083 | 0.011 | 1.96E-13 | 54.0 |

**Supplementary Table 9. The outliers detected in MR-PRESSO.**

| Phenotype | Sex | Outlier |
|---|---|---|
| Phenylalanine | Overall | rs73063122 |
| | Female | rs1047891 |
| Tyrosine | Overall | rs183657985, rs4493565 |

**Supplementary Table 10. MR results after exclusion of SNPs significantly associated with potential confounders.**

| Phenotype | Sex | Method | beta | se | *p*-value |
|---|---|---|---|---|---|
| Phenylalanine | Overall | Inverse variance weighted | −0.05 | 0.43 | 0.90 |
| | | Weighted median | −0.20 | 0.37 | 0.58 |
| | | Weighted mode | −0.09 | 0.35 | 0.80 |
| | | MR-PRESSO | 0.17 | 0.33 | 0.61 |
| Phenylalanine | Male | Inverse variance weighted | 0.76 | 0.31 | 0.01 |
| | | Weighted median | 0.60 | 0.39 | 0.12 |
| | | Weighted mode | 0.60 | 0.39 | 0.13 |
| | | MR-PRESSO | 0.76 | 0.28 | 0.02 |
| Phenylalanine | Female | Inverse variance weighted | −0.66 | 0.60 | 0.27 |
| | | Weighted median | −0.43 | 0.46 | 0.35 |
| | | Weighted mode | −0.39 | 0.46 | 0.40 |
| | | MR-PRESSO | −0.36 | 0.48 | 0.48 |
| Tyrosine | Overall | Inverse variance weighted | −0.60 | 0.28 | 0.03 |
| | | Weighted median | −0.14 | 0.29 | 0.62 |
| | | Weighted mode | −0.15 | 0.28 | 0.59 |
| | | MR-PRESSO | −0.41 | 0.25 | 0.10 |
| Tyrosine | Male | Inverse variance weighted | −0.69 | 0.32 | 0.03 |
| | | Weighted median | −0.47 | 0.34 | 0.16 |
| | | Weighted mode | −0.26 | 0.35 | 0.47 |
| | | MR-PRESSO | −0.69 | 0.32 | 0.04 |
| Tyrosine | Female | Inverse variance weighted | −0.68 | 0.30 | 0.03 |
| | | Weighted median | −0.16 | 0.36 | 0.66 |
| | | Weighted mode | −0.21 | 0.33 | 0.53 |
| | | MR-PRESSO | −0.68 | 0.30 | 0.03 |

For phenylalanine, rs34121855 was excluded in the overall analysis, due to its potential pleiotropic effect concerning alcohol intake frequency. For tyrosine, the following SNPs were excluded due to their potential pleiotropic effects: in the overall analysis, rs6754311 and rs7909960 were excluded due to their associations with age completed full time education. Additionally, rs13107325, rs4665972, rs62062797, rs62466318, and rs9972653 were excluded because of their potential effects on alcohol intake frequency. Within the female subgroup, rs7902343 was excluded for its pleiotropic effect with the age of completing full-time education, and rs4665972 was also excluded due to its impact on alcohol intake frequency. In the male subgroup, rs13107325 was removed from the analysis for its pleiotropic effect on alcohol intake frequency.

**Supplementary Table 11. Sensitivity analysis on the association of genetically predicted phenylalanine and tyrosine with life years using genetic instruments from a GWAS without UK Biobank participants.**

| Exposure | Sex | Method | #SNPs | Beta (95% CI) | *p*-value | outlier |
|---|---|---|---|---|---|---|
| Phenylalanine | Overall | Inverse variance weighted | 9 | 0.35 (−0.74, 1.44) | 0.53 | |
| | | Weighted median | 9 | −0.10 (−1.04, 0.85) | 0.84 | |
| | | Weighted mode | 9 | −0.12 (−1.14, 0.90) | 0.82 | |
| | | MR-PRESSO | 8 | −0.02 (−1.23, 1.20) | 0.97 | rs28365897 |
| | Male | Inverse variance weighted | 9 | 1.05 (0.03, 2.08) | 0.04 | |
| | | Weighted median | 9 | 1.00 (0.05, 1.95) | 0.04 | |
| | | Weighted mode | 9 | 0.94 (−0.06, 1.93) | 0.07 | |
| | | MR-PRESSO | 9 | 1.05 (−0.15, 2.26) | 0.08 | |
| | Female | Inverse variance weighted | 9 | −0.12 (−1.55, 1.32) | 0.88 | |
| | | Weighted median | 9 | −0.19 (−1.31, 0.94) | 0.74 | |
| | | Weighted mode | 9 | −0.39 (−1.60, 0.82) | 0.53 | |
| | | MR-PRESSO | 7 | −0.19 (−1.09, 0.71) | 0.63 | rs1047891, rs28365897 |
| Tyrosine | Overall | Inverse variance weighted | 19 | −0.21 (−2.16, 1.73) | 0.83 | |
| | | Weighted median | 19 | −0.31 (−0.90, 0.28) | 0.30 | |
| | | Weighted mode | 19 | −0.36 (−0.89, 0.17) | 0.19 | |
| | | MR-PRESSO | 17 | −0.67 (−1.24, −0.09) | 0.03 | rs4149083, rs429358 |
| | Male | Inverse variance weighted | 19 | −0.52 (−2.03, 0.99) | 0.50 | |
| | | Weighted median | 19 | −0.47 (−1.13, 0.19) | 0.16 | |
| | | Weighted mode | 19 | −0.47 (−1.09, 0.15) | 0.13 | |
| | | MR-PRESSO | 17 | −0.82 (−1.67, 0.03) | 0.06 | rs1021956, rs117866491 |
| | Female | Inverse variance weighted | 19 | 0.09 (−2.20, 2.38) | 0.94 | |
| | | Weighted median | 19 | −0.14 (−0.88, 0.59) | 0.70 | |
| | | Weighted mode | 19 | −0.18 (−0.86, 0.50) | 0.61 | |
| | | MR-PRESSO | 17 | −0.58 (−1.18, 0.02) | 0.06 | rs1021956, rs117866491 |

**Supplementary Table 12. Power calculation in the MR analysis on lifespan.**

| Exposure | Sex | $r^2$ | Case | Control | Sample size | Effect size detected (odds ratio) | Effect size detected (life years) |
|---|---|---|---|---|---|---|---|
| Phenylalanine | Overall | 0.01 | 208,118 | 181,048 | 389,166 | 1.09 | −1.72 |
| | Men | | 317,652 | 97,659 | 415,311 | 1.10 | −2.18 |
| | Women | | 246,941 | 165,996 | 412,937 | 1.09 | −2.23 |
| Tyrosine | Overall | 0.03 | 208,118 | 181,048 | 389,166 | 1.06 | −1.17 |
| | Men | | 317,652 | 97,659 | 415,311 | 1.06 | −1.33 |
| | Women | | 246,941 | 165,996 | 412,937 | 1.06 | −1.51 |

The calculation of $r^2$ was based on $beta^2 \times 2 \times (EAF) \times (1\text{-}EAF)$. The number of cases and controls are from the GWAS of parental lifespan we used in the MR analysis (Pilling LC et al., Aging (Albany NY). 2017; 9:2504–20). The power calculations for the MR analysis were performed using the online tool available at https://sb452.shinyapps.io/power/.

**Supplementary Table 13. Associations of genetic instruments for phenylalanine with potential confounders in UK Biobank.**

| SNP | *p*-value with potential confounders | | | | | |
|---|---|---|---|---|---|---|
| | Townsend deprivation index at recruitment | Age completed full time education | Current tobacco smoking | Alcohol intake frequency | Time spent doing moderate physical activity | Time spent doing vigorous physical activity |
| ***Overall*** | | | | | | |
| rs1009062 | 4.08E-01 | 1.48E-01 | 7.22E-01 | 3.80E-01 | 9.17E-01 | 6.08E-01 |
| rs1043011 | 2.76E-01 | 2.26E-01 | 3.28E-01 | 3.60E-02 | 1.99E-01 | 3.57E-01 |
| rs1047891 | 7.47E-01 | 5.65E-01 | 7.13E-01 | 6.55E-01 | 6.43E-01 | 5.96E-01 |
| rs10750864 | 8.60E-01 | 7.38E-01 | 1.92E-01 | 5.31E-01 | 2.82E-01 | 8.53E-01 |
| rs10826337 | 8.67E-01 | 2.28E-01 | 3.65E-01 | 8.92E-01 | 9.91E-01 | 6.33E-01 |
| rs117040573 | 6.06E-01 | 3.96E-01 | 3.23E-01 | 7.11E-01 | 9.31E-01 | 8.96E-01 |
| rs12830698 | 1.07E-01 | 7.87E-01 | 5.99E-01 | 2.05E-01 | 3.95E-01 | 9.10E-01 |
| rs13254494 | 3.63E-02 | 9.43E-01 | 2.52E-01 | 2.56E-01 | 3.23E-01 | 5.61E-01 |
| rs1522298 | 9.87E-01 | 2.09E-01 | 9.15E-01 | 5.10E-01 | 2.26E-01 | 5.16E-01 |
| rs17253619 | 2.55E-01 | 7.67E-01 | 7.82E-01 | 3.43E-01 | 8.67E-01 | 7.11E-02 |
| rs1800759 | 9.50E-02 | 1.58E-01 | 1.07E-02 | 6.18E-02 | 9.67E-01 | 4.28E-01 |
| rs2239328 | 1.78E-01 | 4.65E-02 | 4.32E-01 | 2.89E-01 | 3.50E-01 | 5.83E-01 |
| rs34121855 | 9.48E-01 | 1.34E-01 | 4.78E-01 | 1.45E-09 | 3.96E-01 | 7.49E-01 |
| rs3757132 | 6.20E-02 | 1.97E-01 | 9.95E-01 | 2.89E-01 | 8.80E-01 | 1.35E-01 |
| rs61935426 | 2.01E-01 | 6.92E-01 | 1.86E-01 | 5.99E-01 | 9.95E-01 | 9.35E-01 |
| rs73063122 | 9.59E-01 | 3.35E-01 | 7.93E-01 | 6.59E-03 | 3.12E-01 | 3.17E-01 |
| rs75017413 | 6.30E-01 | 4.46E-01 | 2.50E-01 | 4.75E-01 | 7.10E-01 | 6.04E-02 |
| rs870072 | 6.17E-01 | 5.12E-01 | 6.58E-02 | 7.36E-01 | 3.44E-01 | 1.80E-01 |
| rs932316 | 4.21E-02 | 6.04E-01 | 7.37E-01 | 4.04E-02 | 5.17E-01 | 8.98E-01 |
| rs99780 | 5.22E-03 | 2.17E-01 | 1.33E-01 | 2.42E-01 | 2.80E-01 | 3.63E-01 |
| ***Male*** | | | | | | |
| rs1009062 | 6.84E-01 | 3.99E-02 | 2.48E-01 | 2.78E-01 | 7.57E-01 | 5.05E-01 |
| rs10750864 | 9.38E-01 | 2.97E-01 | 7.82E-01 | 9.46E-01 | 2.74E-01 | 2.26E-01 |
| rs12367892 | 7.20E-01 | 7.03E-01 | 7.30E-01 | 8.41E-01 | 6.71E-03 | 6.59E-01 |
| rs1321250 | 1.42E-01 | 9.64E-01 | 3.54E-01 | 3.01E-01 | 6.76E-01 | 1.55E-01 |
| rs1498691 | 6.95E-01 | 9.02E-01 | 2.29E-01 | 8.08E-01 | 6.10E-01 | 7.84E-01 |
| rs1718292 | 1.53E-01 | 7.76E-01 | 6.69E-01 | 3.65E-01 | 9.39E-01 | 3.96E-02 |
| rs17253619 | 7.90E-02 | 6.80E-01 | 7.19E-01 | 2.55E-01 | 2.90E-01 | 6.11E-02 |
| rs2229742 | 8.04E-01 | 7.03E-01 | 3.07E-01 | 3.47E-02 | 4.54E-02 | 7.23E-01 |
| rs2239327 | 1.82E-01 | 3.12E-02 | 8.02E-01 | 6.36E-03 | 1.03E-01 | 9.26E-01 |
| rs3757132 | 2.21E-01 | 7.37E-01 | 5.54E-02 | 4.99E-01 | 5.85E-01 | 4.30E-01 |
| rs75918019 | 5.99E-01 | 8.97E-01 | 1.45E-01 | 5.11E-01 | 3.82E-01 | 1.69E-02 |
| rs76169231 | 6.03E-01 | 2.98E-01 | 6.38E-01 | 6.11E-01 | 4.32E-01 | 2.08E-01 |
| ***Female*** | | | | | | |
| rs1047891 | 5.59E-01 | 7.24E-01 | 6.97E-01 | 8.12E-01 | 4.00E-01 | 4.00E-01 |
| rs10750864 | 9.58E-01 | 3.27E-01 | 4.78E-01 | 3.22E-01 | 1.93E-01 | 1.93E-01 |
| rs12830698 | 7.16E-02 | 5.36E-01 | 8.82E-01 | 2.82E-01 | 7.36E-02 | 7.36E-02 |
| rs1408268 | 8.21E-01 | 3.74E-01 | 1.10E-01 | 6.44E-02 | 9.39E-02 | 9.39E-02 |
| rs1498694 | 8.27E-01 | 6.17E-01 | 3.80E-02 | 2.02E-01 | 7.24E-01 | 7.24E-01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| rs17253619 | 4.36E-01 | 6.12E-01 | 3.71E-01 | 2.35E-01 | 5.94E-01 | 5.94E-01 |
| rs2239328 | 9.82E-01 | 8.96E-01 | 9.93E-01 | 4.51E-01 | 9.77E-01 | 9.77E-01 |
| rs2694917 | 3.31E-01 | 4.91E-01 | 3.02E-01 | 1.50E-01 | 6.98E-01 | 6.98E-01 |
| rs4149058 | 8.92E-01 | 2.97E-01 | 4.81E-01 | 5.96E-01 | 8.76E-01 | 8.76E-01 |
| rs9804734 | 6.82E-01 | 9.49E-02 | 8.91E-02 | 6.57E-01 | 2.65E-01 | 2.65E-01 |

A significant association was observed between rs34121855 and alcohol intake frequency in the overall analysis.

**Supplementary Table 14. Associations of genetic instruments for tyrosine with potential confounders in UK Biobank.**

| SNP | *p*-value with potential confounders | | | | | |
|---|---|---|---|---|---|---|
| | Townsend deprivation index at recruitment | Age completed full time education | Current tobacco smoking | Alcohol intake frequency | Time spent doing moderate physical activity | Time spent doing vigorous physical activity |
| ***Overall*** | | | | | | |
| rs10027275 | 4.22E-01 | 2.30E-02 | 5.63E-01 | 8.65E-01 | 7.62E-01 | 8.64E-01 |
| rs10164853 | 5.43E-03 | 1.33E-01 | 4.75E-01 | 7.63E-01 | 3.17E-01 | 3.54E-01 |
| rs10217762 | 1.98E-02 | 3.76E-03 | 2.82E-01 | 1.34E-01 | 6.48E-01 | 3.39E-01 |
| rs1043011 | 2.76E-01 | 2.26E-01 | 3.28E-01 | 3.60E-02 | 1.99E-01 | 3.57E-01 |
| rs10750864 | 8.60E-01 | 7.38E-01 | 1.92E-01 | 5.31E-01 | 2.82E-01 | 8.53E-01 |
| rs11263465 | 9.19E-01 | 2.89E-01 | 6.34E-01 | 1.77E-01 | 6.03E-01 | 9.25E-02 |
| rs11614623 | 7.33E-01 | 9.79E-01 | 1.47E-01 | 1.55E-01 | 5.68E-01 | 1.91E-01 |
| rs11643623 | 7.83E-01 | 5.02E-01 | 3.52E-01 | 1.53E-01 | 2.93E-01 | 9.28E-01 |
| rs11706810 | 2.01E-02 | 2.29E-02 | 3.01E-01 | 1.15E-04 | 3.83E-01 | 2.37E-01 |
| rs12212085 | 6.01E-02 | 2.20E-02 | 1.25E-02 | 6.70E-01 | 7.28E-01 | 3.05E-01 |
| rs123698 | 4.82E-02 | 8.98E-01 | 6.81E-01 | 7.04E-01 | 4.14E-01 | 4.17E-01 |
| rs12596084 | 8.09E-01 | 8.16E-01 | 6.93E-01 | 3.84E-01 | 4.11E-01 | 3.00E-01 |
| rs12811045 | 5.26E-01 | 6.75E-02 | 4.21E-01 | 6.74E-01 | 4.82E-01 | 6.15E-01 |
| rs12824518 | 2.92E-01 | 8.89E-02 | 7.39E-01 | 8.43E-01 | 4.06E-02 | 6.61E-02 |
| rs13107325 | 1.13E-01 | 6.86E-04 | 5.26E-05 | 6.90E-15 | 7.56E-02 | 6.82E-02 |
| rs13142887 | 3.37E-01 | 1.24E-01 | 1.41E-01 | 8.19E-01 | 3.70E-02 | 9.90E-01 |
| rs13281892 | 3.58E-01 | 9.48E-01 | 2.48E-01 | 8.42E-01 | 3.79E-01 | 4.60E-01 |
| rs1345901 | 5.22E-01 | 5.33E-01 | 4.90E-01 | 1.19E-01 | 9.58E-01 | 5.72E-01 |
| rs1433210 | 1.73E-01 | 5.45E-01 | 1.10E-01 | 4.10E-02 | 7.25E-01 | 7.86E-01 |
| rs150851429 | 1.31E-01 | 5.11E-04 | 4.15E-01 | 3.92E-01 | 8.74E-01 | 8.21E-01 |
| rs151175127 | 7.05E-01 | 4.91E-02 | 4.26E-01 | 2.07E-01 | 1.45E-01 | 1.39E-01 |
| rs1531022 | 7.35E-01 | 9.55E-01 | 3.23E-01 | 1.98E-01 | 6.48E-01 | 6.56E-01 |
| rs17050272 | 3.54E-01 | 9.43E-01 | 9.45E-02 | 8.25E-01 | 3.47E-02 | 2.13E-01 |
| rs174537 | 1.53E-02 | 1.87E-01 | 1.74E-01 | 1.45E-01 | 4.00E-01 | 4.30E-01 |
| rs1800961 | 2.23E-01 | 5.28E-01 | 3.89E-01 | 7.53E-01 | 8.20E-01 | 4.26E-01 |
| rs183657985 | 5.15E-03 | 1.46E-04 | 4.42E-01 | 4.37E-04 | 7.74E-01 | 9.44E-01 |
| rs1883711 | 5.45E-02 | 1.29E-01 | 3.08E-01 | 2.49E-02 | 9.61E-01 | 4.84E-01 |
| rs194742 | 6.59E-01 | 5.53E-01 | 6.49E-01 | 6.10E-01 | 5.21E-01 | 7.71E-01 |
| rs204926 | 5.16E-01 | 8.86E-01 | 7.45E-02 | 3.28E-01 | 8.67E-01 | 8.46E-01 |
| rs2126263 | 3.92E-01 | 8.37E-01 | 9.10E-03 | 4.80E-03 | 7.82E-01 | 9.72E-01 |
| rs2189966 | 5.23E-01 | 9.57E-01 | 2.26E-01 | 6.22E-02 | 1.06E-01 | 8.13E-01 |
| rs2393775 | 4.72E-01 | 5.63E-01 | 5.15E-01 | 2.70E-02 | 7.19E-01 | 1.17E-01 |
| rs28601761 | 1.47E-01 | 5.07E-02 | 9.22E-01 | 3.64E-05 | 3.42E-01 | 5.10E-01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| rs34396849 | 5.75E-05 | 7.95E-02 | 6.57E-04 | 3.44E-01 | 9.10E-01 | 1.08E-01 |
| rs35048664 | 1.00E+00 | 2.07E-01 | 9.25E-01 | 4.98E-01 | 2.25E-01 | 5.17E-01 |
| rs35757209 | 9.56E-01 | 3.71E-01 | 8.82E-01 | 6.63E-01 | 8.48E-01 | 3.00E-02 |
| rs41289886 | 1.80E-01 | 1.57E-01 | 5.29E-01 | 6.71E-01 | 2.04E-01 | 6.73E-01 |
| rs4493565 | 1.80E-02 | 1.37E-01 | 4.81E-02 | 3.12E-02 | 7.66E-01 | 7.26E-01 |
| rs4665972 | 3.83E-01 | 3.05E-01 | 1.74E-01 | 3.10E-55 | 3.41E-01 | 9.50E-01 |
| rs4722551 | 7.84E-01 | 7.26E-01 | 3.27E-01 | 1.79E-02 | 8.01E-01 | 9.23E-02 |
| rs4921914 | 9.65E-01 | 1.65E-04 | 5.17E-01 | 2.00E-01 | 9.49E-01 | 5.61E-01 |
| rs511154 | 9.79E-01 | 2.48E-01 | 7.19E-01 | 2.46E-01 | 4.72E-01 | 7.69E-01 |
| rs56058728 | 1.33E-01 | 4.31E-01 | 2.80E-01 | 2.33E-01 | 9.39E-01 | 6.63E-01 |
| rs56337219 | 1.69E-01 | 3.95E-01 | 2.02E-01 | 3.05E-02 | 2.93E-01 | 1.53E-01 |
| rs56401710 | 7.95E-01 | 7.13E-01 | 1.00E-01 | 1.26E-04 | 2.44E-01 | 9.62E-01 |
| rs61676179 | 2.82E-01 | 6.06E-01 | 5.49E-01 | 6.93E-01 | 1.15E-01 | 5.39E-01 |
| rs62062797 | 9.63E-01 | 2.27E-01 | 1.94E-02 | 3.09E-11 | 1.54E-01 | 3.53E-03 |
| rs62466318 | 9.36E-01 | 2.10E-02 | 2.30E-01 | 1.44E-11 | 7.15E-01 | 8.15E-01 |
| rs6575900 | 1.56E-01 | 4.02E-01 | 3.67E-01 | 4.12E-01 | 1.03E-03 | 3.14E-01 |
| rs6754311 | 2.02E-01 | 2.11E-10 | 5.81E-01 | 7.68E-02 | 2.42E-01 | 1.30E-01 |
| rs6831352 | 5.83E-02 | 9.62E-02 | 7.61E-04 | 8.25E-04 | 7.86E-01 | 5.56E-01 |
| rs6906327 | 2.03E-01 | 8.49E-01 | 7.99E-01 | 7.48E-01 | 3.71E-01 | 9.83E-01 |
| rs715 | 6.32E-01 | 6.41E-01 | 6.19E-01 | 6.64E-01 | 7.13E-01 | 7.73E-01 |
| rs73079476 | 9.36E-01 | 3.13E-01 | 6.90E-01 | 1.80E-03 | 3.06E-01 | 2.31E-01 |
| rs73158176 | 7.99E-03 | 8.07E-01 | 9.87E-01 | 4.71E-01 | 7.11E-01 | 7.25E-01 |
| rs738408 | 7.65E-03 | 3.17E-01 | 6.52E-01 | 1.63E-02 | 4.29E-01 | 9.96E-01 |
| rs7404381 | 4.49E-03 | 2.11E-02 | 5.01E-04 | 3.45E-01 | 1.56E-01 | 6.48E-01 |
| rs7537281 | 2.43E-01 | 7.68E-02 | 3.64E-01 | 6.54E-03 | 2.69E-01 | 2.60E-01 |
| rs77042499 | 1.92E-02 | 7.94E-02 | 5.66E-03 | 6.52E-01 | 3.56E-01 | 9.88E-01 |
| rs78424108 | 9.02E-02 | 6.01E-01 | 4.25E-01 | 4.56E-01 | 1.57E-01 | 6.24E-01 |
| rs78802502 | 6.19E-01 | 4.46E-01 | 2.39E-01 | 4.61E-01 | 7.62E-01 | 6.27E-02 |
| rs7909960 | 2.69E-01 | 3.71E-11 | 1.34E-05 | 1.80E-01 | 5.50E-01 | 2.47E-01 |
| rs79687284 | 4.32E-02 | 5.59E-01 | 1.74E-01 | 4.12E-01 | 2.23E-01 | 7.56E-02 |
| rs8021303 | 1.93E-01 | 8.29E-01 | 1.59E-01 | 8.30E-01 | 2.03E-01 | 1.09E-01 |
| rs8122094 | 4.36E-01 | 9.08E-01 | 9.73E-01 | 1.64E-04 | 9.24E-01 | 7.71E-01 |
| rs9972653 | 5.78E-01 | 1.33E-01 | 5.42E-01 | 1.83E-09 | 9.07E-01 | 7.24E-01 |
| ***Male*** | | | | | | |
| rs10020631 | 3.37E-01 | 6.33E-01 | 2.86E-01 | 9.27E-01 | 9.18E-01 | 5.90E-01 |
| rs10027275 | 6.33E-01 | 7.72E-01 | 2.10E-01 | 5.41E-02 | 7.83E-01 | 5.70E-01 |
| rs10221244 | 8.65E-01 | 6.50E-01 | 2.53E-01 | 7.39E-01 | 3.85E-01 | 1.86E-01 |
| rs1043011 | 2.09E-01 | 5.84E-01 | 5.85E-01 | 3.60E-01 | 1.53E-01 | 4.58E-01 |
| rs1051952 | 4.67E-01 | 9.91E-01 | 1.05E-02 | 8.31E-01 | 1.08E-01 | 4.11E-01 |
| rs10761756 | 1.37E-01 | 5.50E-03 | 9.17E-02 | 2.71E-01 | 3.41E-01 | 2.41E-01 |
| rs116862171 | 9.54E-01 | 1.86E-01 | 2.23E-01 | 1.72E-02 | 3.13E-01 | 7.77E-02 |
| rs116992380 | 7.85E-01 | 2.00E-01 | 6.55E-01 | 6.78E-01 | 5.73E-01 | 9.88E-01 |
| rs12206654 | 1.08E-02 | 6.04E-01 | 1.46E-04 | 6.69E-01 | 8.37E-01 | 6.78E-01 |
| rs123698 | 6.77E-01 | 7.31E-01 | 7.08E-01 | 2.12E-01 | 7.47E-01 | 7.23E-01 |
| rs12614487 | 1.39E-01 | 4.70E-01 | 9.49E-01 | 4.17E-01 | 3.60E-01 | 1.29E-01 |
| rs12632030 | 1.39E-01 | 5.51E-02 | 5.16E-02 | 1.23E-03 | 7.97E-01 | 2.88E-01 |
| rs12811045 | 7.47E-01 | 6.10E-02 | 4.41E-01 | 2.17E-01 | 2.18E-01 | 7.27E-01 |
| rs13107325 | 1.68E-01 | 3.25E-03 | 4.93E-02 | 5.49E-12 | 7.76E-01 | 4.58E-02 |

| | | | | | | |
|---|---|---|---|---|---|---|
| rs1531022 | 6.14E-01 | 9.52E-01 | 9.80E-01 | 2.29E-01 | 6.26E-01 | 7.28E-01 |
| rs17050272 | 9.63E-01 | 1.29E-01 | 2.29E-01 | 5.13E-01 | 4.13E-01 | 7.76E-01 |
| rs174537 | 3.09E-02 | 6.32E-02 | 2.29E-01 | 1.62E-01 | 3.31E-01 | 4.46E-01 |
| rs17717962 | 8.91E-01 | 1.69E-01 | 3.42E-01 | 7.57E-01 | 7.63E-02 | 8.59E-01 |
| rs1800759 | 2.33E-01 | 2.35E-02 | 3.49E-03 | 2.71E-01 | 2.18E-01 | 3.56E-01 |
| rs1800961 | 1.49E-01 | 6.07E-01 | 4.53E-01 | 2.29E-01 | 3.94E-01 | 9.91E-01 |
| rs1871395 | 3.06E-01 | 3.74E-01 | 3.22E-01 | 1.24E-01 | 6.88E-01 | 6.84E-01 |
| rs1883711 | 4.79E-01 | 9.51E-01 | 8.20E-01 | 5.26E-03 | 9.49E-01 | 7.16E-01 |
| rs2297644 | 3.71E-01 | 1.88E-01 | 4.44E-01 | 5.80E-01 | 1.45E-01 | 9.89E-01 |
| rs2464190 | 7.12E-02 | 5.88E-01 | 8.99E-01 | 3.72E-01 | 8.19E-01 | 7.08E-01 |
| rs2980888 | 3.53E-01 | 4.77E-01 | 1.13E-01 | 2.46E-02 | 1.79E-01 | 8.17E-01 |
| rs35614968 | 9.48E-01 | 9.16E-01 | 8.74E-02 | 6.75E-01 | 8.01E-01 | 7.76E-01 |
| rs3783642 | 7.39E-01 | 8.06E-01 | 1.69E-02 | 1.91E-01 | 1.90E-01 | 7.80E-02 |
| rs4719841 | 7.44E-01 | 9.17E-01 | 7.96E-01 | 1.51E-01 | 9.87E-01 | 7.10E-02 |
| rs4760099 | 4.16E-01 | 1.29E-01 | 8.34E-01 | 6.45E-01 | 4.76E-01 | 7.44E-02 |
| rs4766214 | 8.23E-02 | 4.26E-01 | 6.95E-01 | 1.99E-01 | 6.21E-01 | 5.22E-02 |
| rs511154 | 1.02E-01 | 2.72E-01 | 3.15E-01 | 2.24E-01 | 6.74E-01 | 3.41E-01 |
| rs58542926 | 5.20E-01 | 1.85E-03 | 5.12E-01 | 3.45E-01 | 2.19E-01 | 8.95E-01 |
| rs62646255 | 3.53E-01 | 7.26E-01 | 5.09E-01 | 6.42E-04 | 6.09E-01 | 2.12E-01 |
| rs6575900 | 4.22E-01 | 2.10E-01 | 3.69E-01 | 3.43E-01 | 2.32E-04 | 1.68E-01 |
| rs72839445 | 3.77E-03 | 5.10E-01 | 8.81E-05 | 9.95E-01 | 6.33E-01 | 8.53E-01 |
| rs73091233 | 4.76E-01 | 1.37E-01 | 4.59E-01 | 2.39E-01 | 6.13E-01 | 4.65E-01 |
| rs738408 | 4.06E-02 | 6.35E-01 | 1.10E-01 | 3.69E-01 | 8.91E-02 | 1.40E-01 |
| rs78424108 | 2.31E-03 | 9.21E-01 | 3.82E-01 | 2.43E-01 | 6.69E-01 | 5.03E-01 |
| rs79295634 | 4.18E-01 | 7.96E-01 | 1.29E-01 | 9.06E-01 | 7.53E-02 | 1.96E-03 |
| rs8047723 | 7.49E-01 | 1.66E-01 | 1.35E-01 | 8.25E-01 | 8.57E-01 | 2.34E-01 |
| rs9987289 | 9.13E-01 | 6.10E-02 | 2.62E-02 | 7.12E-01 | 1.41E-01 | 8.95E-01 |
| ***Female*** | | | | | | |
| rs1047891 | 5.59E-01 | 7.24E-01 | 6.97E-01 | 8.12E-01 | 4.00E-01 | 4.00E-01 |
| rs1135688 | 4.84E-01 | 4.03E-01 | 6.07E-01 | 3.80E-01 | 9.52E-01 | 9.52E-01 |
| rs11640725 | 2.40E-02 | 1.90E-03 | 1.66E-01 | 4.00E-01 | 8.47E-01 | 8.47E-01 |
| rs12206654 | 7.67E-01 | 3.85E-01 | 4.97E-01 | 3.03E-01 | 4.35E-01 | 4.35E-01 |
| rs146133919 | 9.49E-01 | 3.07E-01 | 6.54E-01 | 2.73E-01 | 2.37E-01 | 2.37E-01 |
| rs150851429 | 9.94E-01 | 2.08E-03 | 8.76E-01 | 1.73E-01 | 6.60E-01 | 6.60E-01 |
| rs1595261 | 4.71E-01 | 7.72E-01 | 9.28E-01 | 6.24E-01 | 9.97E-01 | 9.97E-01 |
| rs174555 | 5.08E-03 | 7.43E-01 | 5.62E-01 | 5.13E-01 | 2.75E-01 | 2.75E-01 |
| rs1800961 | 8.75E-01 | 9.62E-01 | 3.47E-01 | 7.43E-01 | 4.93E-01 | 4.93E-01 |
| rs2189966 | 1.11E-01 | 6.17E-01 | 8.64E-01 | 6.47E-01 | 7.46E-01 | 7.46E-01 |
| rs2393775 | 1.24E-01 | 8.55E-01 | 5.90E-02 | 2.07E-01 | 1.59E-02 | 1.59E-02 |
| rs2657879 | 2.39E-01 | 1.53E-01 | 5.06E-01 | 1.94E-01 | 3.68E-01 | 3.68E-01 |
| rs28601761 | 1.90E-01 | 5.31E-02 | 1.72E-01 | 2.04E-03 | 3.65E-01 | 3.65E-01 |
| rs330093 | 7.26E-01 | 3.04E-03 | 9.60E-01 | 2.46E-01 | 1.45E-01 | 1.45E-01 |
| rs34346326 | 3.56E-01 | 8.05E-01 | 3.10E-01 | 1.33E-05 | 9.21E-01 | 9.21E-01 |
| rs35261542 | 3.39E-01 | 4.68E-01 | 3.70E-01 | 1.09E-01 | 1.19E-01 | 1.19E-01 |
| rs35491981 | 4.99E-01 | 8.94E-01 | 2.43E-01 | 5.44E-01 | 5.20E-01 | 5.20E-01 |
| rs35614968 | 4.62E-01 | 1.11E-01 | 4.70E-01 | 9.63E-01 | 2.42E-01 | 2.42E-01 |
| rs372273603 | 6.15E-01 | 1.19E-01 | 2.54E-01 | 3.27E-01 | 7.76E-01 | 7.76E-01 |
| rs4149059 | 9.03E-01 | 3.09E-01 | 5.11E-01 | 6.02E-01 | 8.72E-01 | 8.72E-01 |

| | | | | | | |
|---|---|---|---|---|---|---|
| rs4665972 | 7.50E-01 | 6.57E-01 | 3.71E-02 | 8.95E-21 | 7.45E-01 | 7.45E-01 |
| rs56236906 | 5.05E-02 | 3.78E-01 | 1.28E-01 | 6.92E-01 | 8.54E-01 | 8.54E-01 |
| rs6575900 | 7.37E-01 | 8.57E-01 | 7.02E-01 | 1.89E-01 | 4.91E-01 | 4.91E-01 |
| rs75661418 | 9.41E-01 | 6.46E-01 | 2.00E-01 | 2.40E-01 | 4.78E-01 | 4.78E-01 |
| rs76943648 | 9.59E-01 | 6.52E-01 | 4.48E-01 | 4.42E-01 | 7.13E-01 | 7.13E-01 |
| rs7697204 | 3.62E-01 | 2.76E-01 | 3.39E-01 | 5.81E-01 | 4.35E-01 | 4.35E-01 |
| rs7902343 | 2.70E-02 | 3.23E-09 | 2.27E-02 | 1.50E-01 | 9.07E-01 | 9.07E-01 |
| rs895893 | 3.90E-01 | 9.92E-01 | 5.84E-01 | 3.69E-01 | 3.92E-01 | 3.92E-01 |