

**Table S1 .** Brief description of the genome-wide association study data used in this study.

| Expourse/Outcome | GWAS-id            | Population | ncase  | Sample size | Number of SNPs |
|------------------|--------------------|------------|--------|-------------|----------------|
| PM2.5            | ukb-b-10817        | European   | NA     | 423,796     | 9,851,867      |
| BMI              | ieu-a-835          | European   | NA     | 322,154     | 2,554,668      |
| Smoking          | ukb-a-39           | European   | 88,601 | 289,727     | 10,894,596     |
| GDM              | finn-b-O15_PREG_DM | European   | 6,033  | 123,000     | 16,379,684     |

BMI, body mass index; GDM, gestational diabetes mellitus; SNP, single nucleotide polymorphism.

**Table S2 .** Removed SNPs were associated with the possible mechanistic pathways of GDM.

| Chr | SNP        | EA | OA | PM2.5  |       |          | GDM    |       |       |
|-----|------------|----|----|--------|-------|----------|--------|-------|-------|
|     |            |    |    | BETA   | SE    | P        | BETA   | SE    | P     |
| 10  | rs10786736 | C  | G  | 0.016  | 0.004 | 9.50E-06 | -0.038 | 0.035 | 0.265 |
| 15  | rs11855821 | A  | G  | -0.013 | 0.002 | 2.10E-07 | 0.029  | 0.025 | 0.234 |
| 1   | rs12133063 | A  | C  | 0.010  | 0.002 | 4.00E-06 | 0.012  | 0.020 | 0.563 |
| 2   | rs13429081 | T  | A  | 0.014  | 0.003 | 8.90E-07 | 0.026  | 0.024 | 0.282 |
| 9   | rs1537371  | A  | C  | 0.012  | 0.002 | 8.50E-09 | -0.006 | 0.020 | 0.759 |
| 10  | rs4933236  | C  | T  | 0.010  | 0.002 | 5.50E-06 | -0.023 | 0.021 | 0.257 |
| 6   | rs56068671 | T  | G  | -0.018 | 0.004 | 3.60E-06 | -0.001 | 0.027 | 0.965 |
| 3   | rs75738250 | A  | T  | 0.013  | 0.003 | 5.70E-06 | 0.009  | 0.024 | 0.718 |
| 8   | rs77205736 | T  | C  | 0.014  | 0.002 | 2.10E-08 | -0.042 | 0.030 | 0.160 |
| 8   | rs800507   | T  | G  | 0.011  | 0.003 | 9.80E-06 | 0.033  | 0.023 | 0.145 |
| 17  | rs8614     | A  | C  | 0.013  | 0.003 | 2.80E-06 | -0.036 | 0.028 | 0.200 |
| 6   | rs9260734  | A  | G  | 0.014  | 0.003 | 3.10E-06 | -0.073 | 0.028 | 0.009 |
| 3   | rs987204   | A  | G  | 0.010  | 0.002 | 2.00E-06 | 0.042  | 0.021 | 0.040 |

SNP, single nucleotide polymorphism; CHR, chromosome; EA, effect allele; OA, other allele; SE, standard error.

**Table S3.** Characteristics of SNPs used in the MR analysis in the summary statistics reported in the GWAS on PM2.5 and GDM.

| Chr | SNP         | EA | OA | PM2.5  |       |          | GDM    |       |       | F     |
|-----|-------------|----|----|--------|-------|----------|--------|-------|-------|-------|
|     |             |    |    | BETA   | SE    | P        | BETA   | SE    | P     |       |
| 2   | rs10203969  | T  | G  | -0.010 | 0.002 | 5.50E-06 | -0.013 | 0.023 | 0.570 | 20.64 |
| 9   | rs10961167  | A  | G  | -0.019 | 0.004 | 2.00E-06 | -0.071 | 0.047 | 0.134 | 22.63 |
| 16  | rs11075636  | G  | A  | -0.013 | 0.003 | 8.90E-06 | -0.028 | 0.028 | 0.317 | 19.74 |
| 1   | rs11209977  | G  | A  | 0.014  | 0.003 | 8.90E-06 | 0.007  | 0.024 | 0.762 | 19.74 |
| 6   | rs114708313 | T  | A  | 0.025  | 0.004 | 4.20E-08 | 0.091  | 0.037 | 0.013 | 30.08 |
| 12  | rs11610713  | T  | A  | 0.038  | 0.008 | 2.50E-06 | 0.021  | 0.070 | 0.769 | 22.16 |
| 13  | rs11616726  | G  | T  | -0.018 | 0.004 | 9.00E-06 | 0.027  | 0.048 | 0.582 | 19.72 |
| 4   | rs116259394 | G  | A  | -0.035 | 0.008 | 8.50E-06 | -0.020 | 0.050 | 0.683 | 19.83 |
| 8   | rs116925111 | G  | T  | 0.053  | 0.011 | 9.10E-07 | 0.102  | 0.076 | 0.177 | 24.10 |
| 10  | rs1172955   | A  | T  | 0.011  | 0.002 | 5.80E-06 | -0.012 | 0.023 | 0.601 | 20.55 |
| 22  | rs117366154 | T  | C  | -0.019 | 0.004 | 6.30E-06 | -0.070 | 0.043 | 0.097 | 20.40 |
| 22  | rs117878224 | G  | A  | -0.048 | 0.010 | 1.80E-06 | 0.133  | 0.353 | 0.706 | 22.78 |
| 7   | rs1182891   | T  | G  | 0.013  | 0.003 | 4.40E-06 | -0.003 | 0.028 | 0.927 | 21.10 |
| 8   | rs1217106   | G  | A  | 0.013  | 0.003 | 1.20E-06 | 0.027  | 0.026 | 0.300 | 23.58 |
| 6   | rs12203592  | T  | C  | 0.022  | 0.003 | 6.20E-17 | -0.062 | 0.061 | 0.306 | 69.92 |
| 2   | rs13035717  | T  | A  | -0.013 | 0.003 | 4.60E-06 | 0.018  | 0.022 | 0.419 | 20.99 |
| 4   | rs1318845   | C  | T  | -0.014 | 0.003 | 2.30E-07 | -0.006 | 0.024 | 0.818 | 26.78 |
| 9   | rs1340247   | A  | G  | -0.010 | 0.002 | 7.00E-06 | -0.006 | 0.020 | 0.755 | 20.20 |
| 5   | rs1372504   | A  | G  | 0.012  | 0.002 | 3.10E-08 | 0.049  | 0.021 | 0.020 | 30.67 |
| 20  | rs138685951 | T  | C  | -0.031 | 0.007 | 5.60E-06 | 0.028  | 0.058 | 0.628 | 20.62 |
| 12  | rs140500108 | G  | C  | -0.022 | 0.005 | 5.30E-06 | -0.051 | 0.050 | 0.306 | 20.71 |
| 12  | rs144470316 | C  | G  | -0.051 | 0.011 | 9.00E-06 | -0.029 | 0.148 | 0.842 | 19.71 |
| 9   | rs145151841 | A  | G  | 0.063  | 0.014 | 5.20E-06 | 0.036  | 0.084 | 0.669 | 20.77 |
| 18  | rs146171855 | C  | A  | 0.092  | 0.021 | 8.00E-06 | 0.078  | 0.073 | 0.290 | 19.95 |
| 17  | rs146999536 | A  | C  | 0.055  | 0.012 | 9.40E-06 | 0.099  | 0.248 | 0.690 | 19.63 |
| 17  | rs147392452 | T  | C  | -0.028 | 0.006 | 8.50E-06 | 0.006  | 0.042 | 0.884 | 19.82 |
| 15  | rs151323121 | A  | G  | -0.042 | 0.009 | 6.10E-06 | 0.145  | 0.135 | 0.282 | 20.44 |
| 16  | rs16957755  | C  | T  | 0.022  | 0.004 | 7.60E-07 | 0.004  | 0.050 | 0.935 | 24.46 |
| 8   | rs17070492  | G  | C  | 0.017  | 0.004 | 3.00E-06 | -0.015 | 0.034 | 0.657 | 21.80 |
| 14  | rs17103928  | A  | C  | -0.014 | 0.003 | 3.70E-06 | 0.014  | 0.030 | 0.642 | 21.42 |
| 18  | rs17183854  | G  | T  | -0.043 | 0.009 | 4.00E-06 | 0.012  | 0.056 | 0.834 | 21.25 |
| 7   | rs17657881  | C  | T  | -0.037 | 0.008 | 4.00E-06 | -0.019 | 0.080 | 0.817 | 21.27 |
| 6   | rs1933805   | A  | G  | 0.010  | 0.002 | 9.40E-06 | -0.003 | 0.020 | 0.887 | 19.63 |

|    |            |   |   |        |       |          |        |       |       |       |
|----|------------|---|---|--------|-------|----------|--------|-------|-------|-------|
| 7  | rs2091322  | C | T | -0.010 | 0.002 | 8.80E-06 | -0.014 | 0.022 | 0.535 | 19.75 |
| 7  | rs2141531  | G | T | -0.011 | 0.002 | 1.30E-06 | -0.031 | 0.023 | 0.174 | 23.47 |
| 18 | rs2278801  | G | A | 0.010  | 0.002 | 6.30E-06 | 0.026  | 0.021 | 0.216 | 20.39 |
| 16 | rs2292156  | T | G | 0.015  | 0.003 | 3.40E-07 | 0.008  | 0.026 | 0.765 | 26.03 |
| 6  | rs2324898  | T | C | 0.010  | 0.002 | 7.50E-06 | 0.004  | 0.021 | 0.845 | 20.07 |
| 5  | rs27152    | T | C | -0.011 | 0.002 | 3.20E-06 | -0.033 | 0.021 | 0.121 | 21.66 |
| 11 | rs35703574 | A | G | -0.025 | 0.005 | 3.90E-06 | 0.088  | 0.055 | 0.112 | 21.31 |
| 4  | rs45485691 | A | G | -0.011 | 0.002 | 7.20E-06 | -0.018 | 0.021 | 0.386 | 20.15 |
| 2  | rs4854523  | G | A | 0.013  | 0.003 | 3.40E-06 | 0.032  | 0.026 | 0.213 | 21.60 |
| 1  | rs487230   | G | A | -0.012 | 0.003 | 3.60E-06 | 0.009  | 0.024 | 0.699 | 21.45 |
| 19 | rs4926311  | T | C | -0.010 | 0.002 | 8.20E-06 | -0.040 | 0.021 | 0.060 | 19.88 |
| 2  | rs56181709 | T | C | -0.012 | 0.003 | 7.10E-06 | -0.003 | 0.022 | 0.877 | 20.18 |
| 5  | rs58824859 | C | A | 0.012  | 0.002 | 1.90E-07 | 0.021  | 0.021 | 0.304 | 27.14 |
| 20 | rs6024877  | C | T | 0.024  | 0.006 | 9.70E-06 | 0.045  | 0.038 | 0.243 | 19.58 |
| 20 | rs6134106  | A | C | 0.054  | 0.012 | 4.80E-06 | 0.062  | 0.048 | 0.198 | 20.93 |
| 19 | rs62119705 | T | C | 0.011  | 0.002 | 8.90E-07 | 0.034  | 0.021 | 0.096 | 24.16 |
| 2  | rs62180462 | A | G | -0.035 | 0.008 | 4.20E-06 | 0.069  | 0.113 | 0.544 | 21.19 |
| 5  | rs62368672 | C | T | -0.018 | 0.004 | 4.00E-06 | -0.035 | 0.051 | 0.498 | 21.26 |
| 7  | rs62484669 | A | G | 0.018  | 0.004 | 8.60E-07 | 0.047  | 0.039 | 0.230 | 24.21 |
| 11 | rs628913   | T | C | -0.010 | 0.002 | 5.40E-06 | 0.009  | 0.020 | 0.640 | 20.71 |
| 2  | rs6432776  | C | T | 0.011  | 0.002 | 1.60E-06 | -0.015 | 0.022 | 0.492 | 22.97 |
| 2  | rs6547952  | G | T | -0.011 | 0.002 | 1.20E-06 | 0.023  | 0.021 | 0.262 | 23.58 |
| 15 | rs656813   | C | T | -0.014 | 0.003 | 8.90E-06 | -0.015 | 0.039 | 0.707 | 19.74 |
| 3  | rs66501886 | G | C | -0.010 | 0.002 | 9.50E-06 | 0.031  | 0.022 | 0.162 | 19.60 |
| 2  | rs6749467  | A | G | -0.012 | 0.002 | 1.40E-08 | -0.016 | 0.021 | 0.447 | 32.23 |
| 6  | rs6937315  | C | T | 0.010  | 0.002 | 6.20E-06 | -0.004 | 0.022 | 0.865 | 20.43 |
| 7  | rs6960011  | G | A | -0.011 | 0.002 | 3.70E-06 | -0.004 | 0.021 | 0.857 | 21.40 |
| 14 | rs718059   | A | G | -0.014 | 0.003 | 4.40E-06 | -0.002 | 0.026 | 0.941 | 21.08 |
| 18 | rs72642437 | T | C | 0.113  | 0.019 | 3.10E-09 | 0.015  | 0.041 | 0.713 | 35.12 |
| 13 | rs72655898 | G | A | -0.011 | 0.002 | 2.40E-06 | -0.018 | 0.022 | 0.399 | 22.27 |
| 14 | rs72700006 | C | T | 0.020  | 0.004 | 2.40E-06 | -0.045 | 0.034 | 0.183 | 22.26 |
| 2  | rs72805044 | C | T | -0.037 | 0.008 | 7.60E-06 | -0.123 | 0.095 | 0.192 | 20.03 |
| 5  | rs72808024 | C | A | -0.016 | 0.003 | 9.90E-08 | -0.002 | 0.029 | 0.934 | 28.39 |
| 1  | rs7514956  | C | A | -0.013 | 0.003 | 2.60E-06 | 0.016  | 0.025 | 0.516 | 22.12 |
| 6  | rs75730485 | C | T | -0.027 | 0.006 | 9.80E-06 | 0.002  | 0.052 | 0.965 | 19.56 |
| 2  | rs7573056  | C | A | -0.011 | 0.002 | 1.50E-07 | -0.017 | 0.020 | 0.417 | 27.64 |
| 15 | rs76230173 | A | G | -0.021 | 0.005 | 7.60E-06 | 0.078  | 0.048 | 0.104 | 20.04 |
| 12 | rs77147615 | C | T | 0.025  | 0.006 | 8.20E-06 | -0.035 | 0.080 | 0.659 | 19.88 |
| 6  | rs77255816 | T | C | 0.031  | 0.006 | 4.20E-08 | -0.134 | 0.105 | 0.201 | 30.04 |
| 6  | rs7750418  | G | T | 0.010  | 0.002 | 6.80E-06 | -0.009 | 0.021 | 0.659 | 20.24 |

|    |            |   |   |        |       |          |        |       |       |       |
|----|------------|---|---|--------|-------|----------|--------|-------|-------|-------|
| 6  | rs7776279  | A | G | 0.011  | 0.002 | 4.40E-06 | 0.021  | 0.023 | 0.378 | 21.06 |
| 15 | rs77962859 | C | T | -0.016 | 0.004 | 7.30E-06 | -0.036 | 0.033 | 0.263 | 20.10 |
| 8  | rs78230389 | G | A | -0.047 | 0.009 | 8.10E-07 | -0.016 | 0.246 | 0.949 | 24.34 |
| 14 | rs78467598 | G | C | -0.038 | 0.008 | 7.60E-07 | -0.057 | 0.086 | 0.508 | 24.45 |
| 12 | rs78539764 | C | T | -0.034 | 0.007 | 3.70E-07 | 0.045  | 0.084 | 0.595 | 25.87 |
| 20 | rs79004040 | G | C | -0.032 | 0.007 | 8.90E-06 | -0.229 | 0.077 | 0.003 | 19.74 |
| 10 | rs7910200  | T | C | -0.010 | 0.002 | 6.30E-06 | -0.009 | 0.021 | 0.679 | 20.40 |
| 3  | rs79229868 | A | G | 0.045  | 0.010 | 7.50E-06 | 0.019  | 0.042 | 0.645 | 20.06 |
| 3  | rs80123875 | T | G | -0.019 | 0.004 | 1.30E-06 | -0.017 | 0.037 | 0.648 | 23.48 |
| 17 | rs80347400 | G | A | 0.014  | 0.003 | 6.10E-06 | 0.009  | 0.026 | 0.735 | 20.46 |
| 11 | rs875982   | T | C | -0.010 | 0.002 | 5.70E-06 | -0.016 | 0.020 | 0.439 | 20.57 |
| 8  | rs9644485  | C | T | 0.010  | 0.002 | 4.90E-06 | -0.008 | 0.020 | 0.702 | 20.88 |

SNP, single nucleotide polymorphism; CHR, chromosome; EA, effect allele; OA, other allele; SE, standard error; F, F-statistic .

**Table S4.** Causal estimates of PM2.5 on GDM in multivariable MR.

| Method               | Beta  | SE    | OR                 | P         |
|----------------------|-------|-------|--------------------|-----------|
| Adjusted for BMI     | 0.861 | 0.358 | 2.366(1.664-3.067) | 1.607e-02 |
| Adjusted for smoking | 0.611 | 0.182 | 1.842(1.486-2.199) | 8.099e-04 |
| Adjusted for all     | 0.867 | 0.360 | 2.380(1.674-3.085) | 1.589e-02 |

MVMR, multivariable mendelian randomization; BMI, body mass index; SE, standard error; OR, odds ratio;