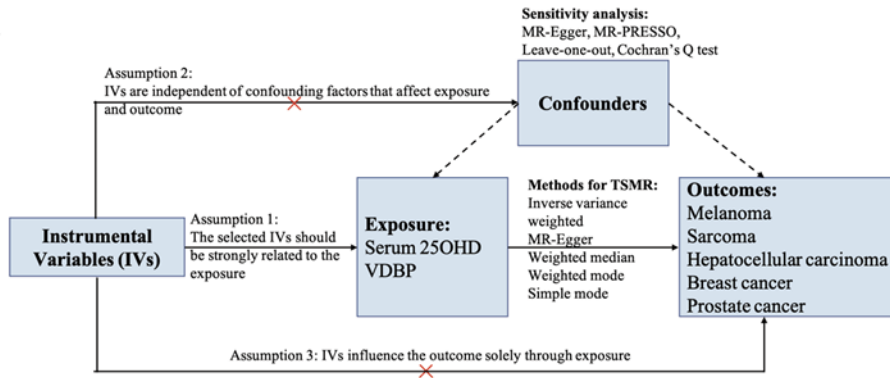
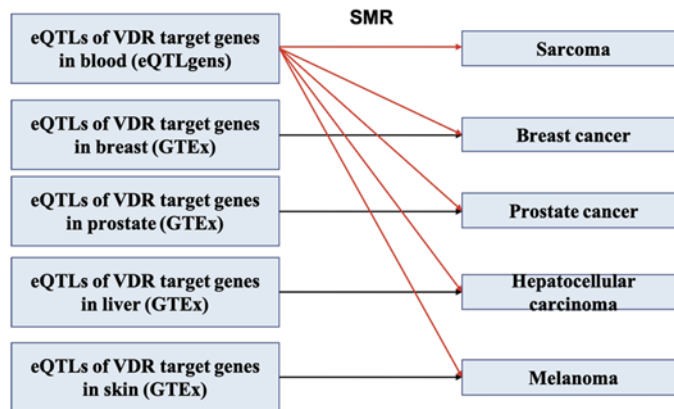


Supplementary Figure S1

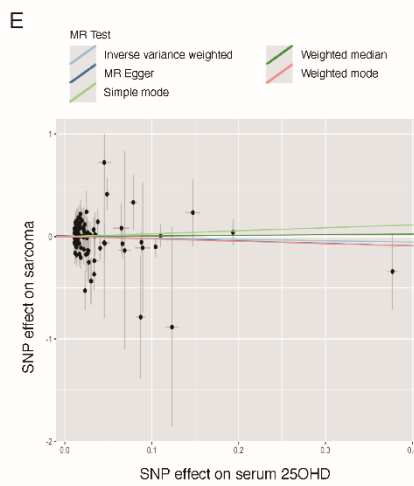
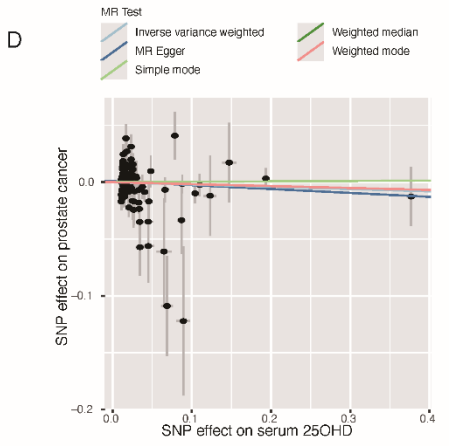
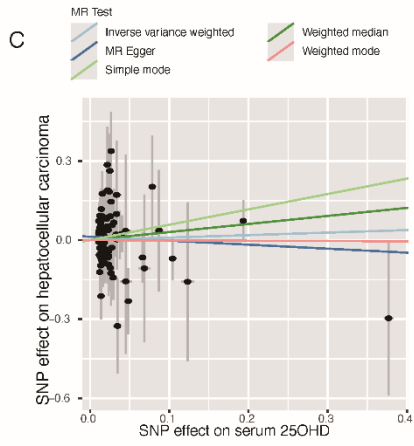
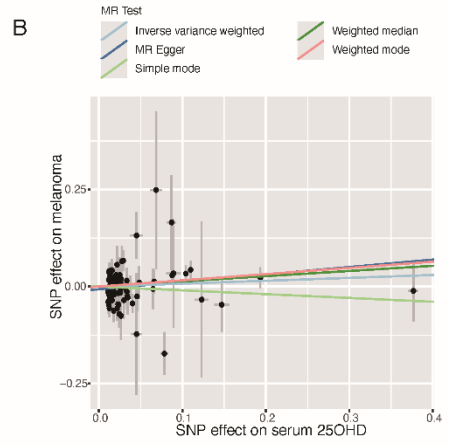
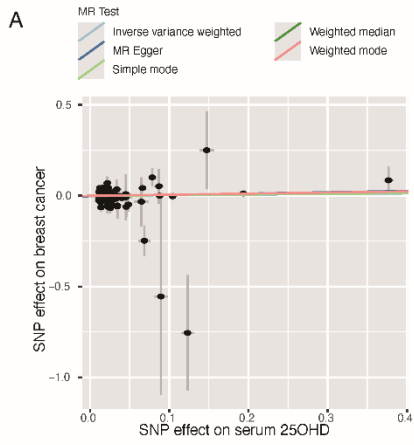
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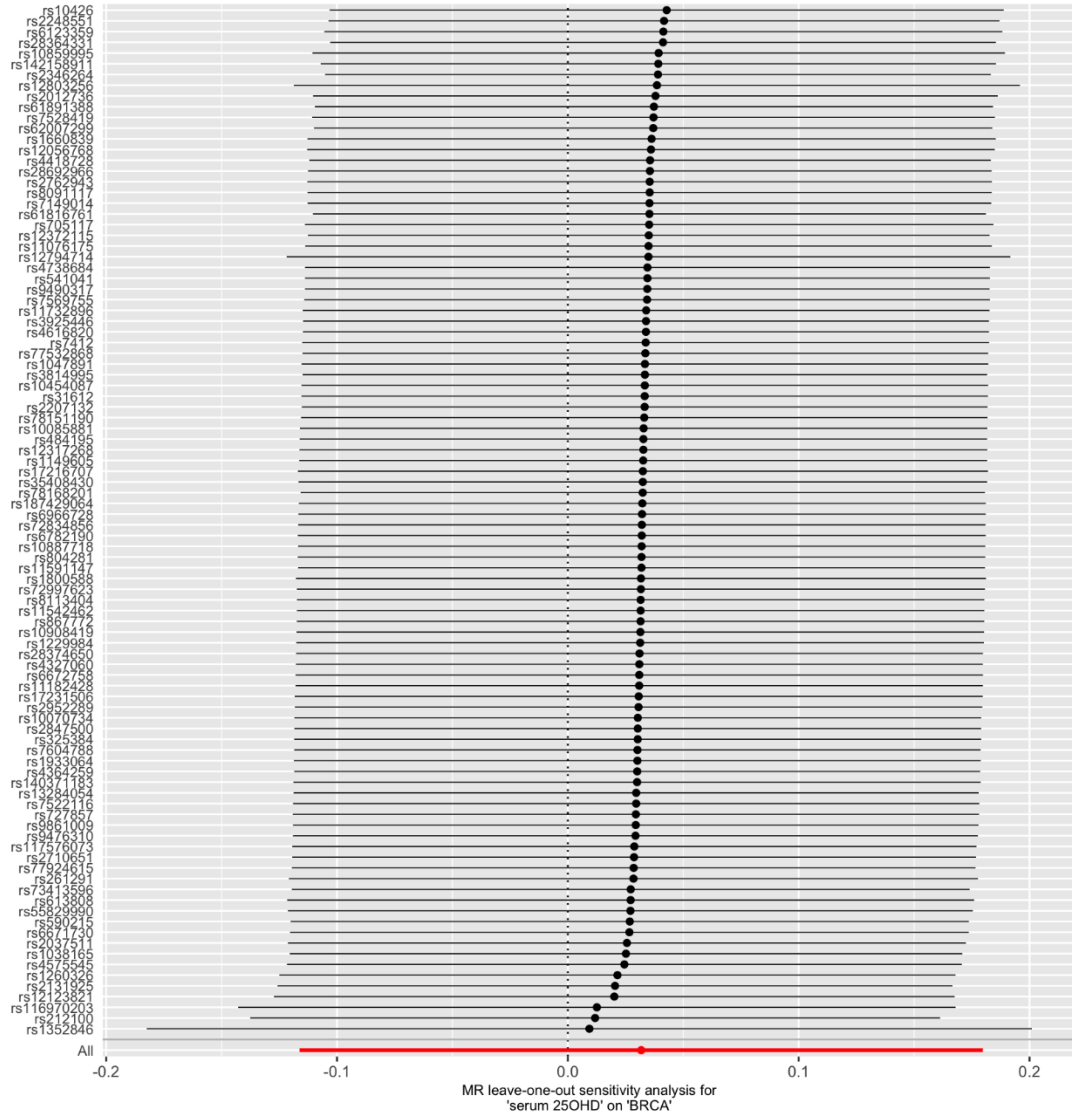
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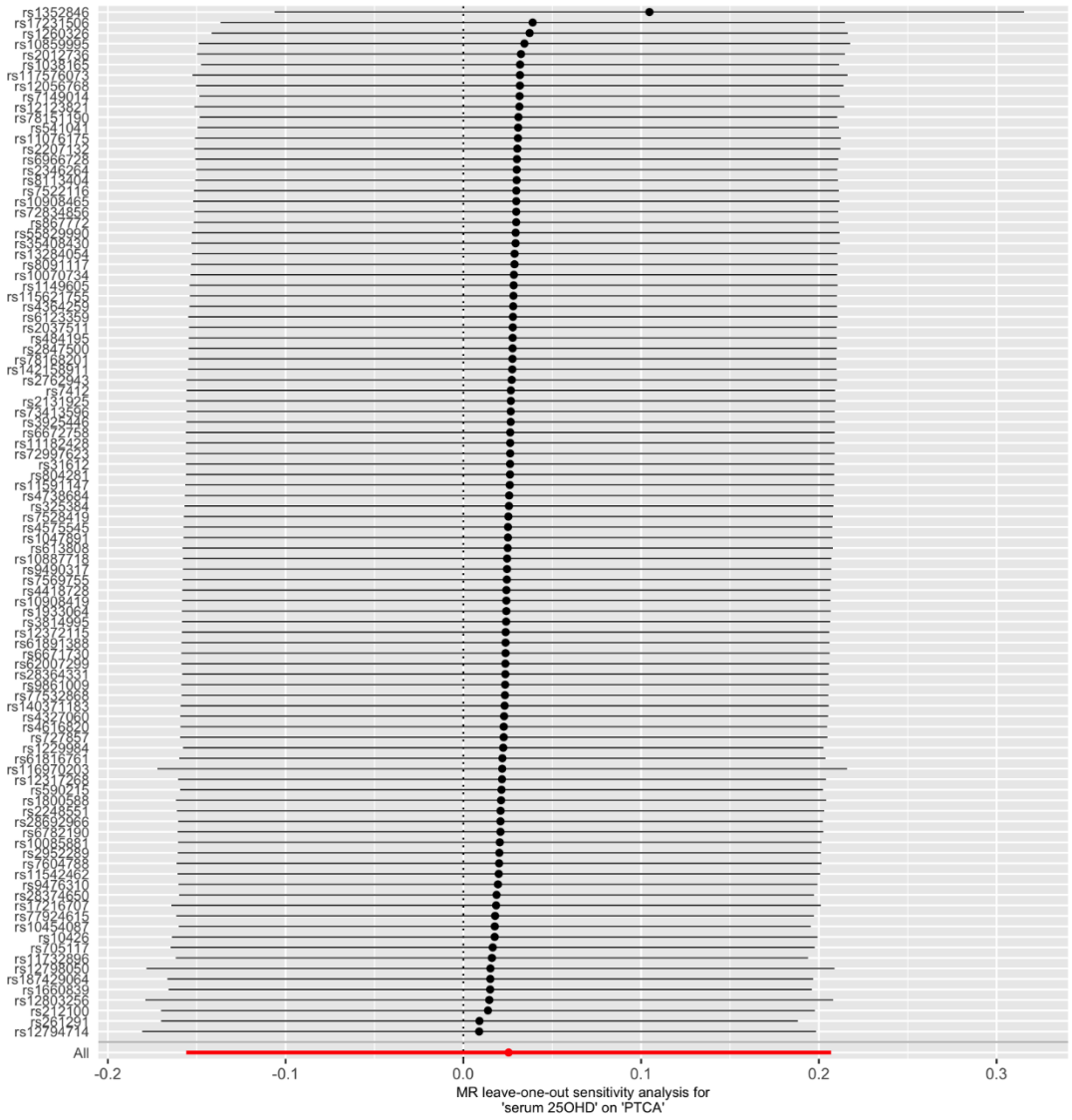
Supplementary Figure S2



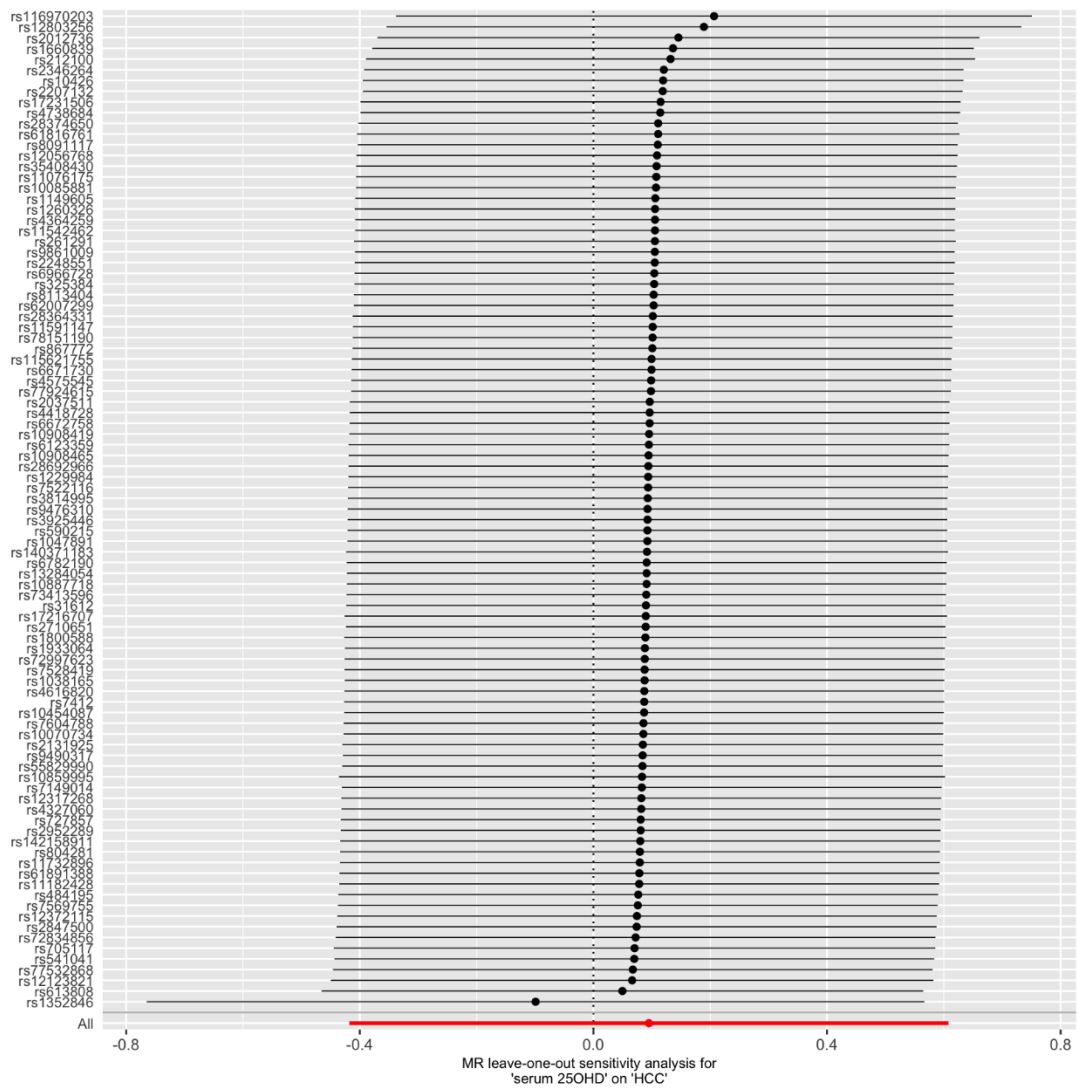
Supplementary Figure S3



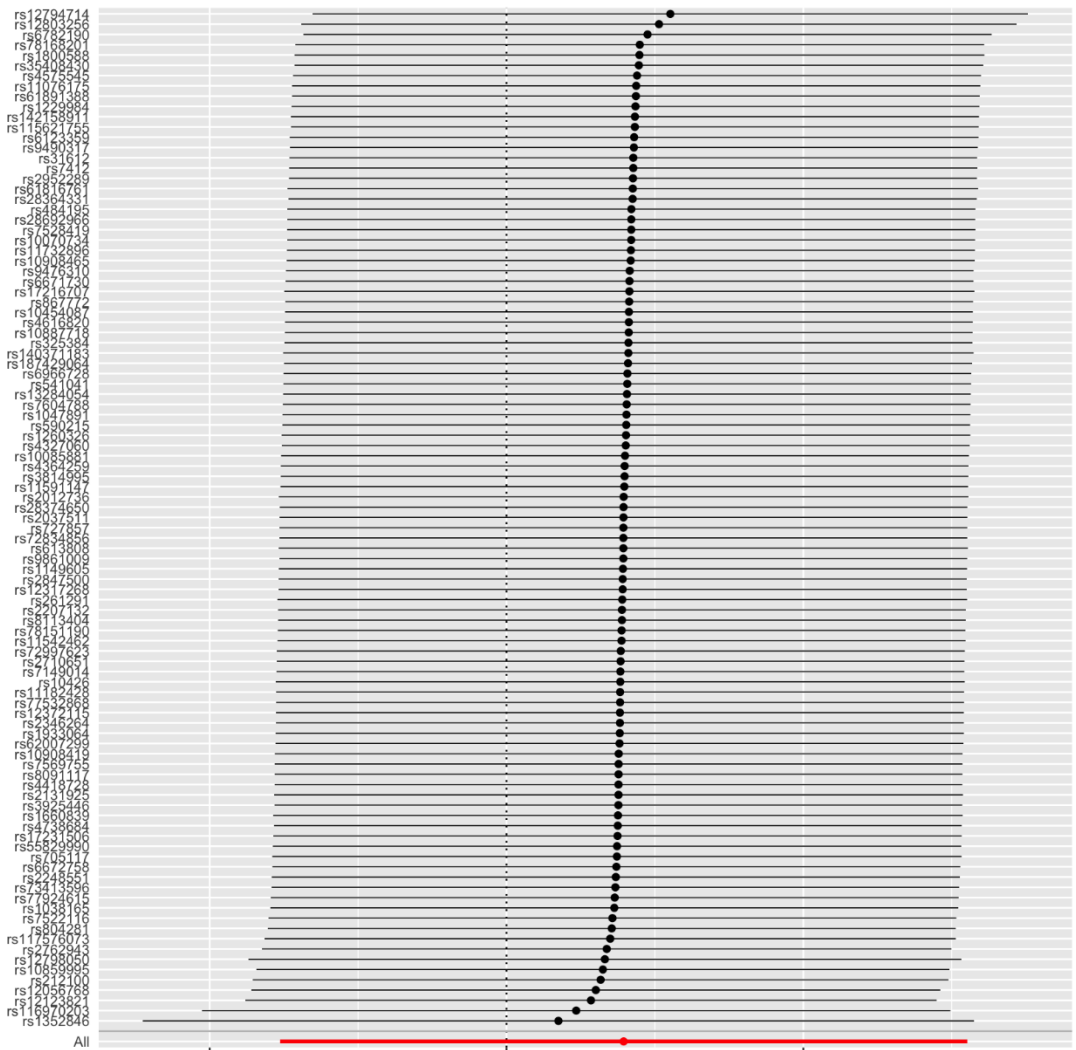
Supplementary Figure S4



Supplementary Figure S5

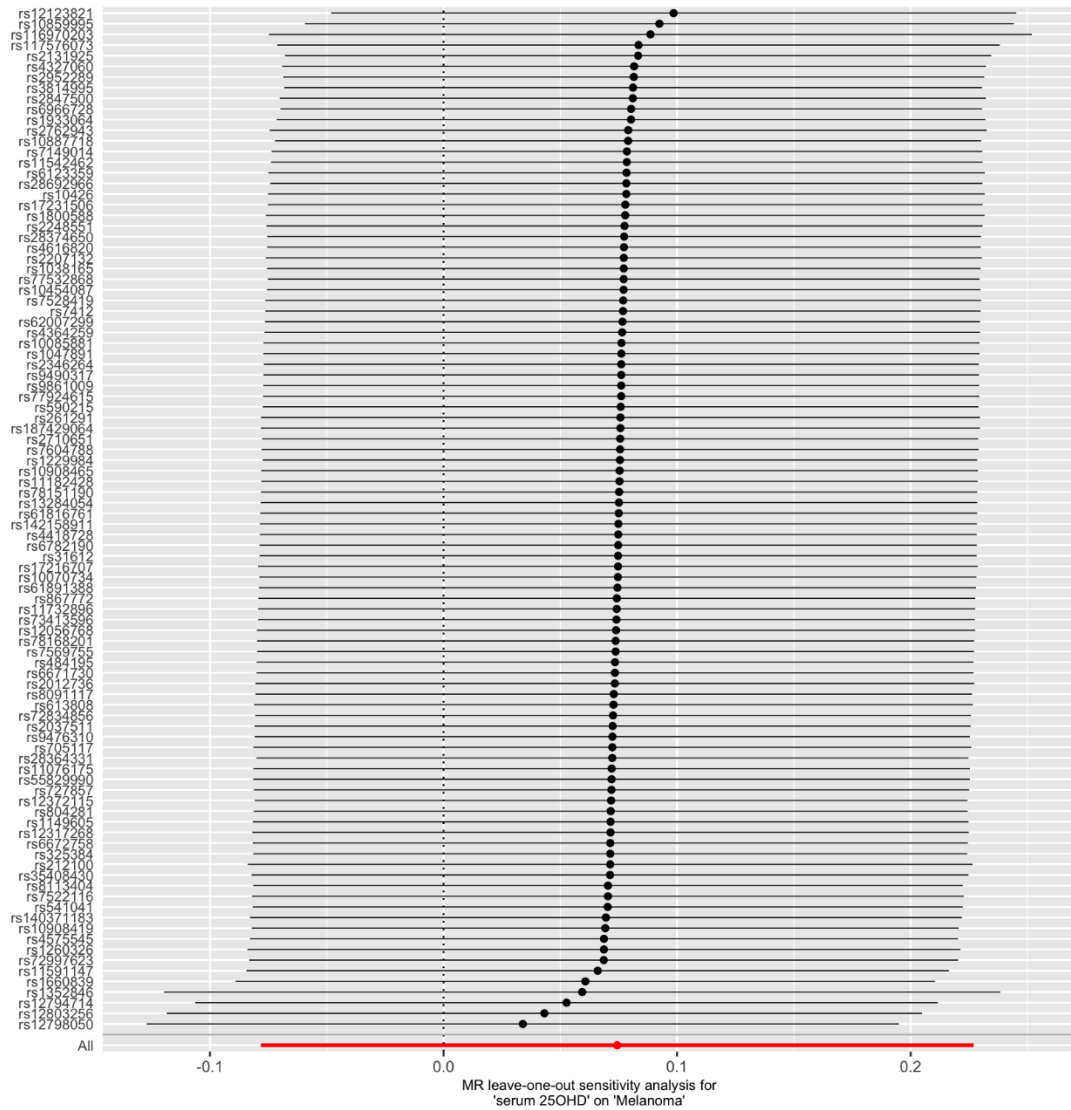


Supplementary Figure S6

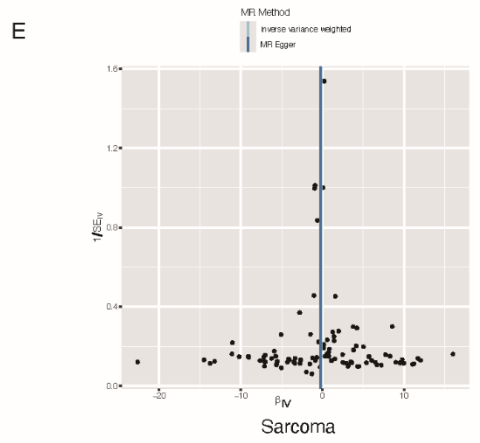
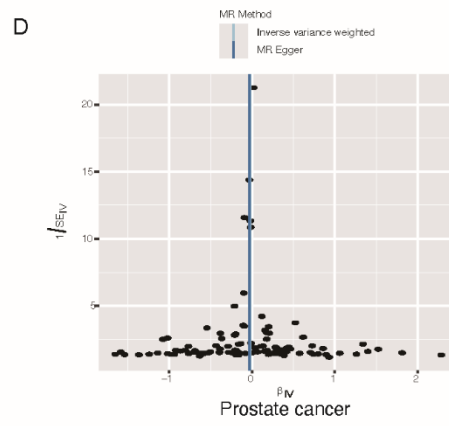
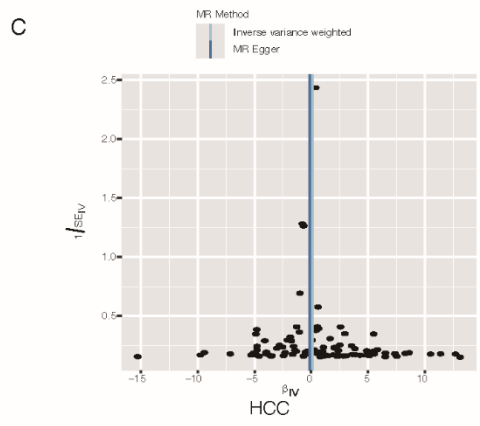
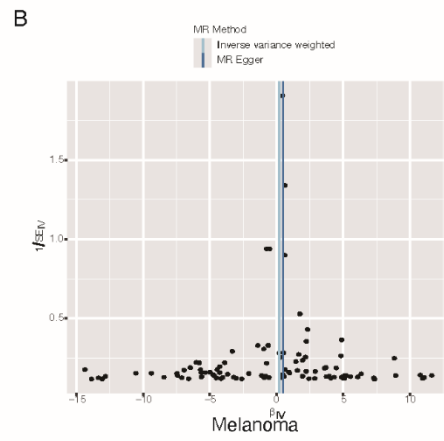
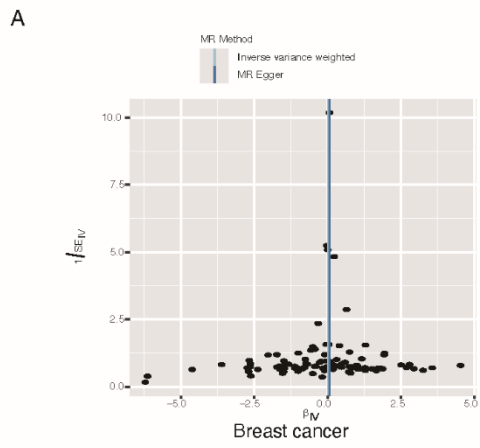


MR leave-one-out sensitivity analysis for 'serum 25OHD' on 'Sarcoma'

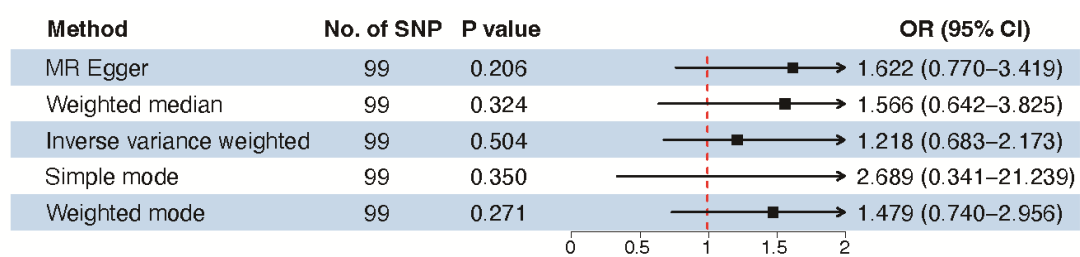
Supplementary Figure S7



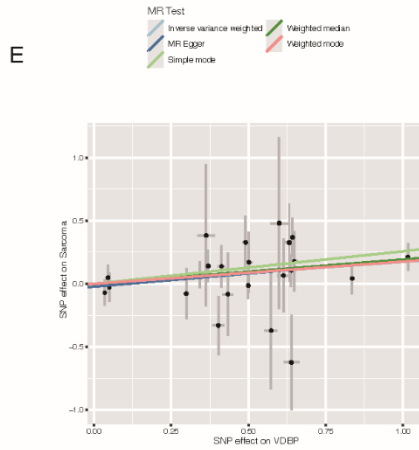
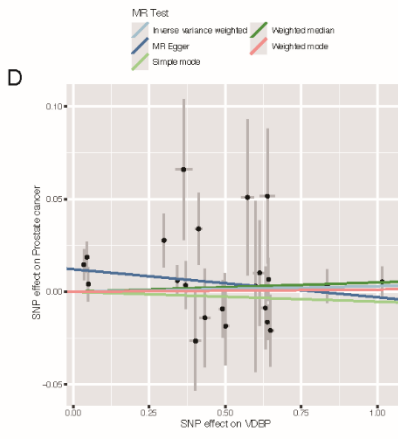
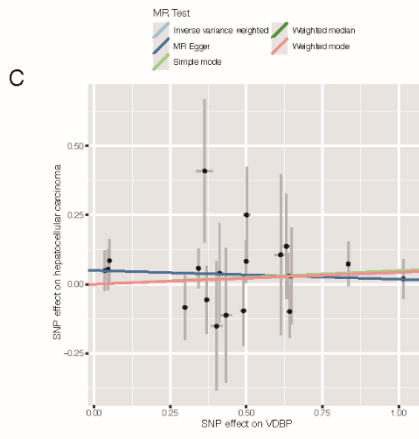
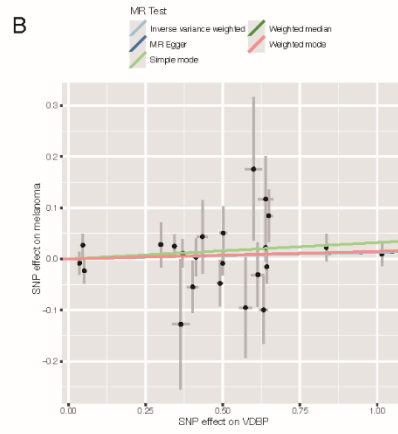
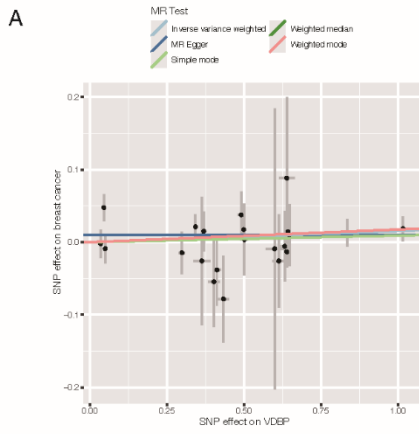
Supplementary Figure S8



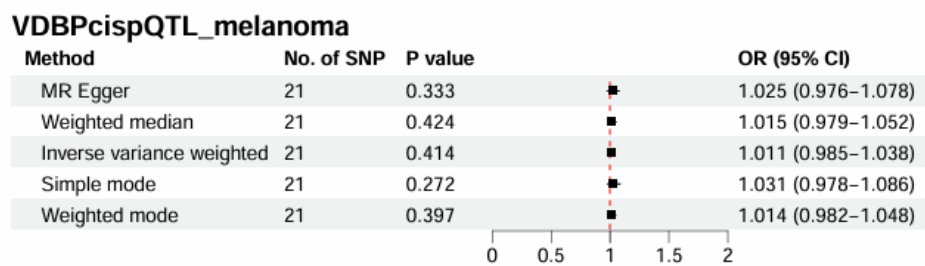
Supplementary Figure S9



Supplementary Figure S10

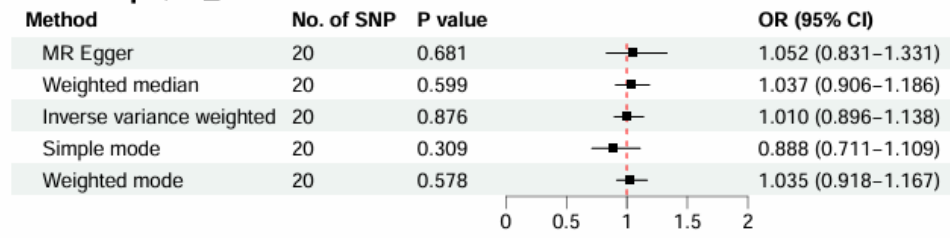


Supplementary Figure S11

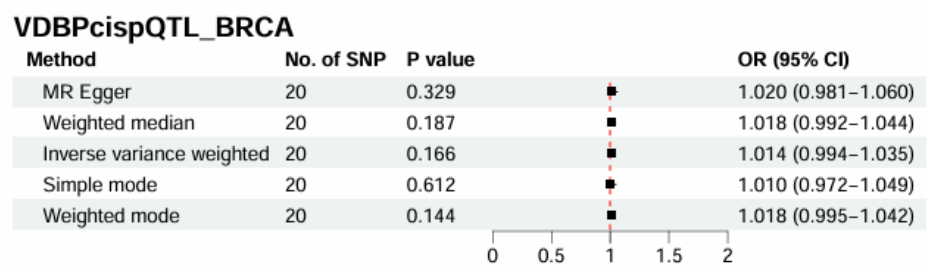


Supplementary Figure S12

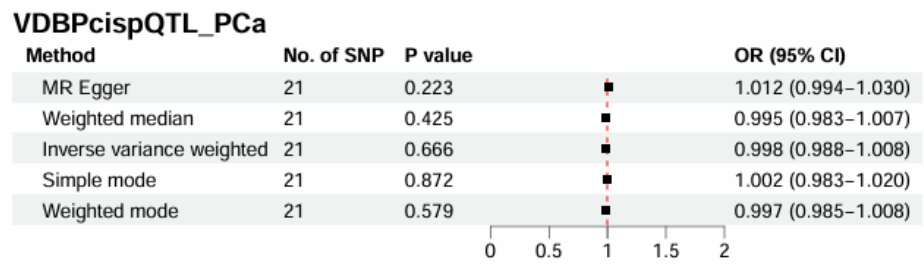
VDBPcisQTL_Sarcoma



Supplementary Figure S13

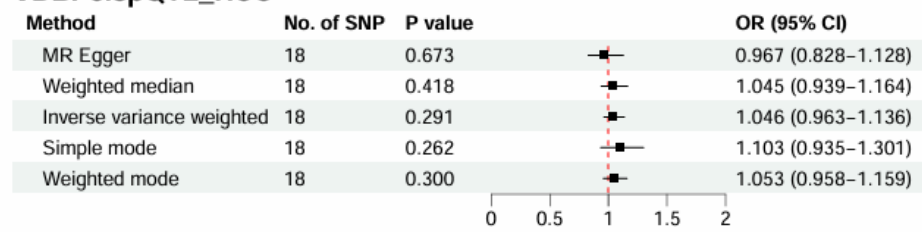


Supplementary Figure S14

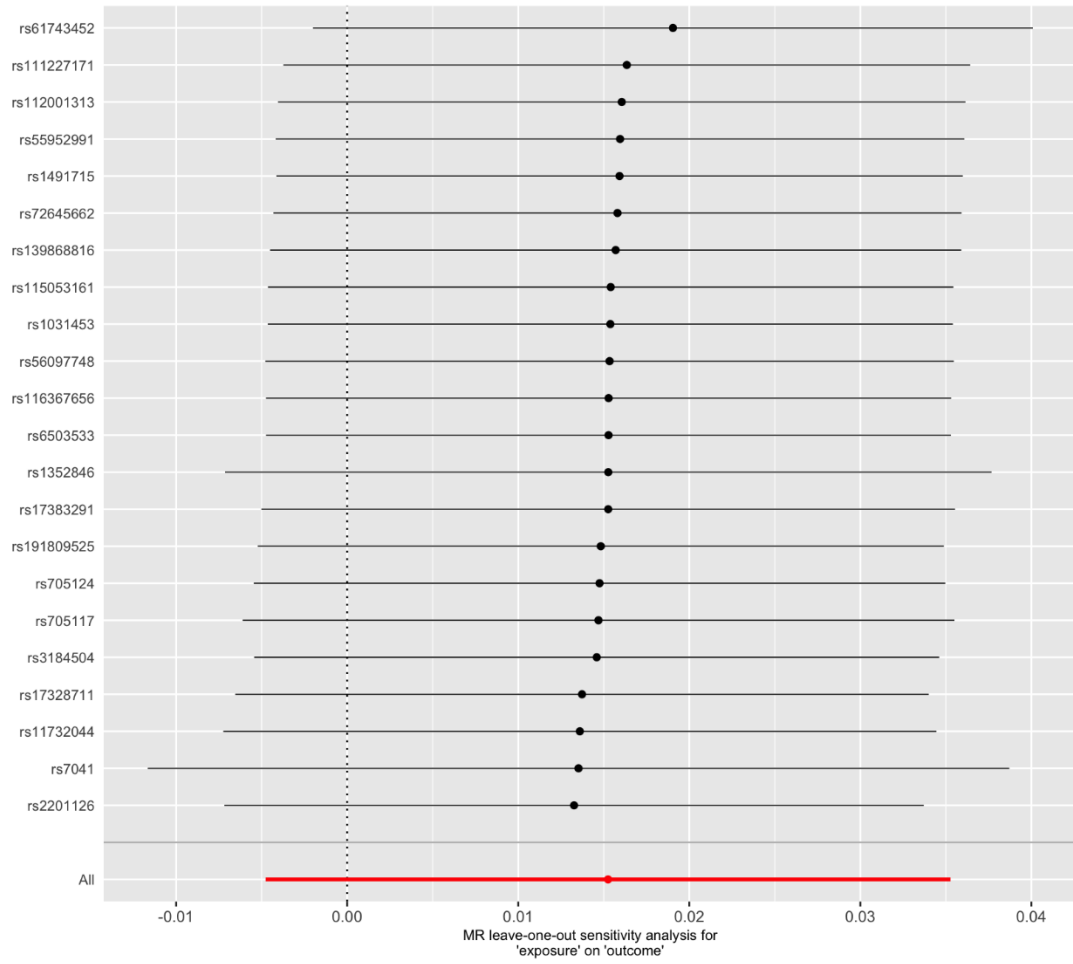


Supplementary Figure S15

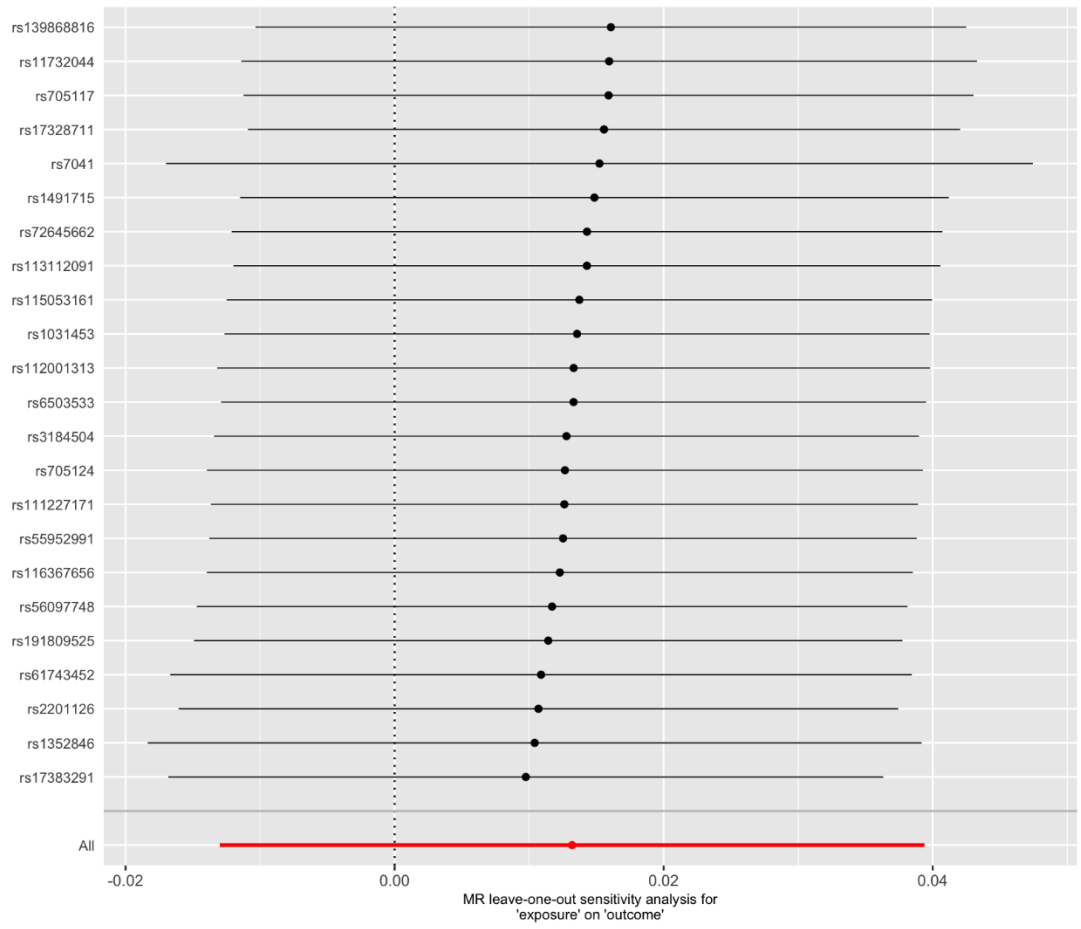
VDBPcispQTL_HCC



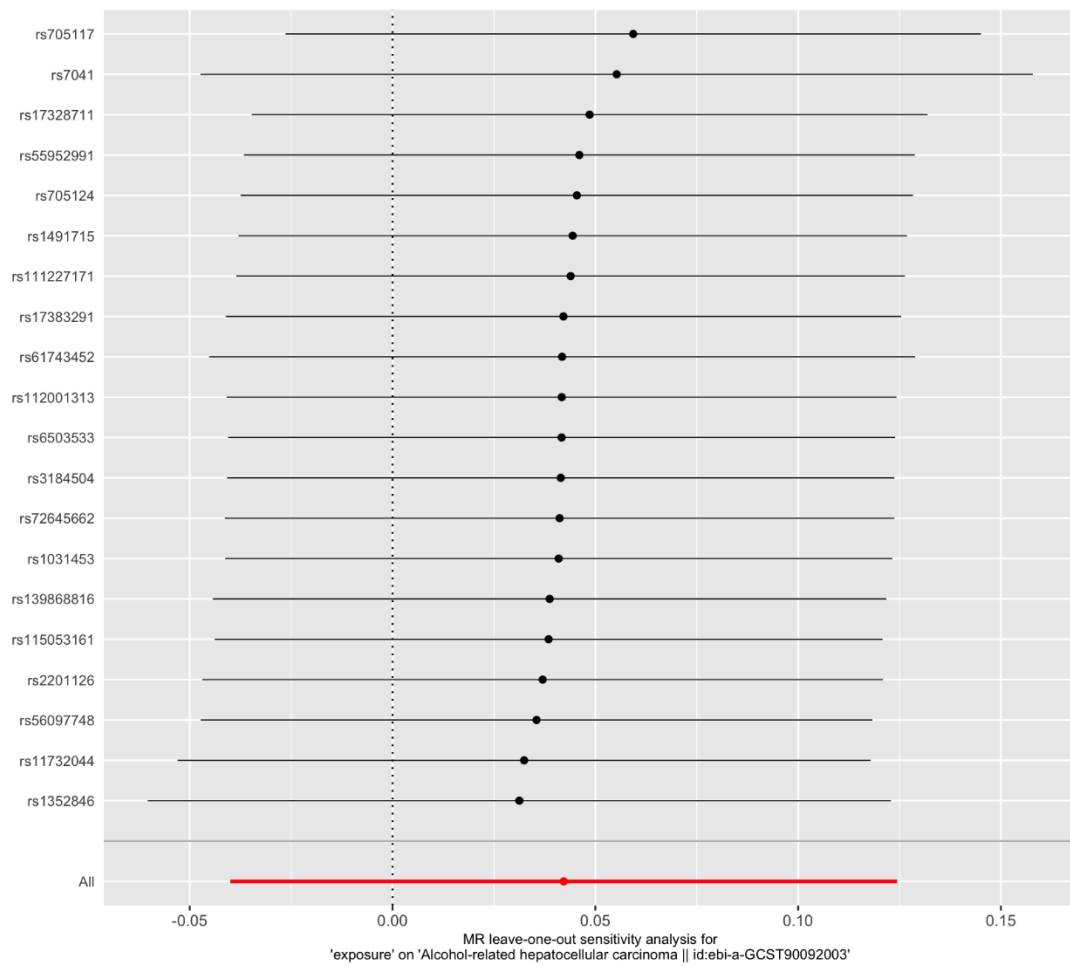
Supplementary Figure S16



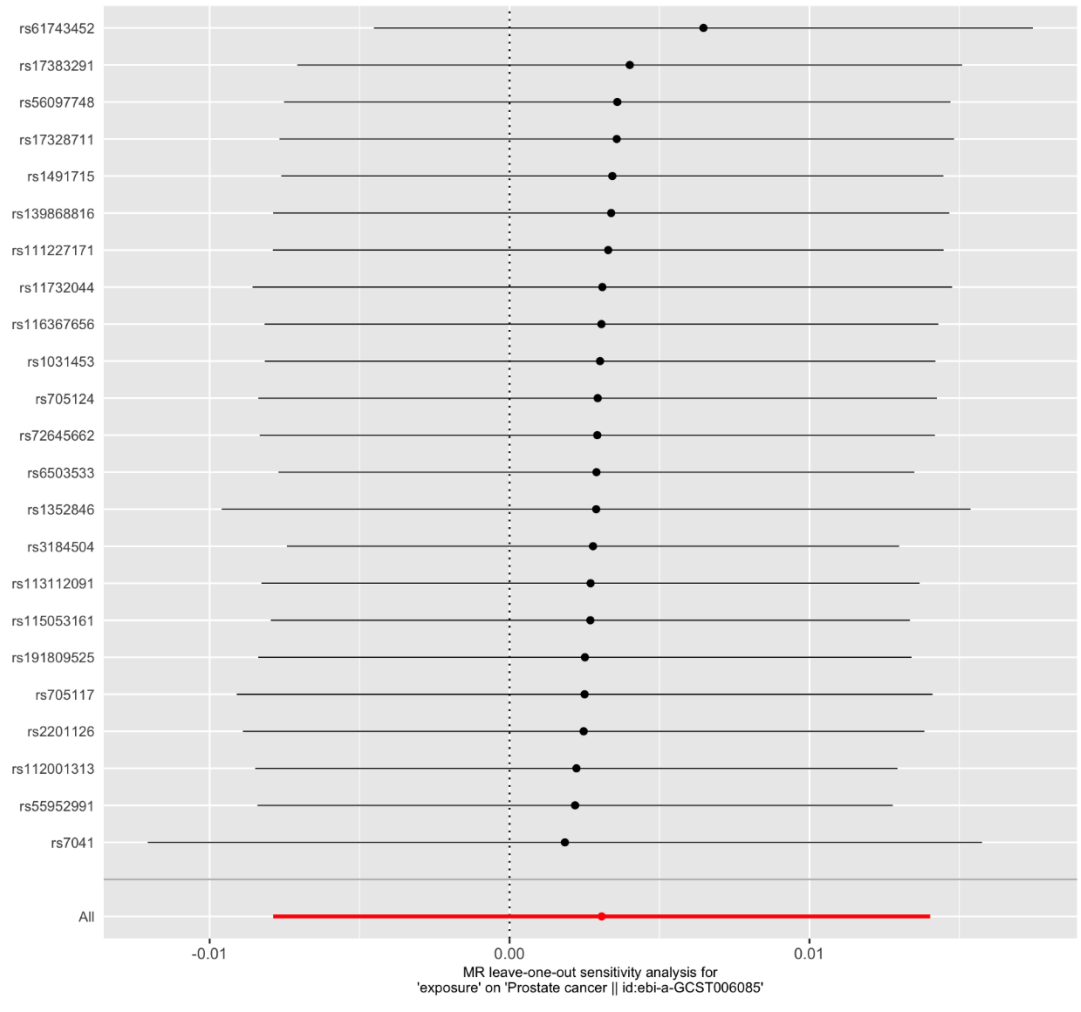
Supplementary Figure S17



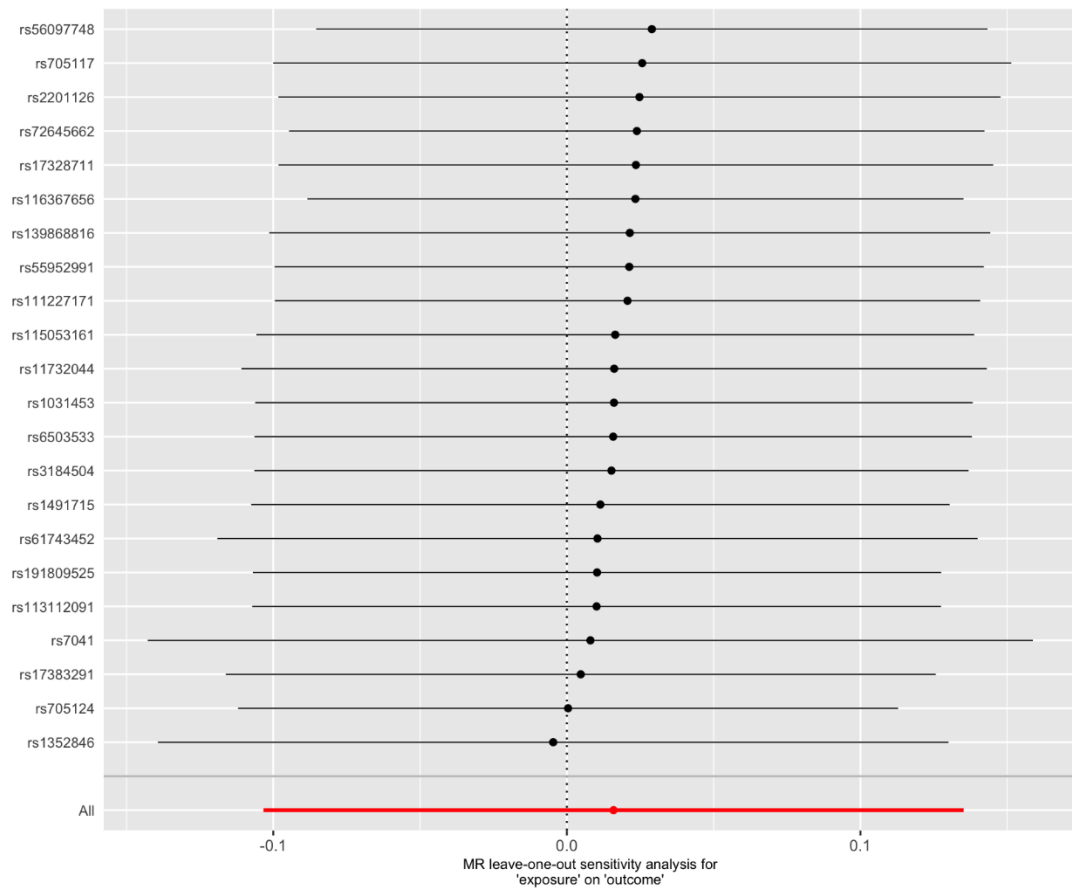
Supplementary Figure S18



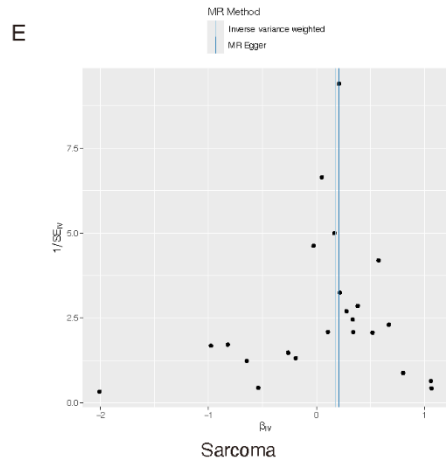
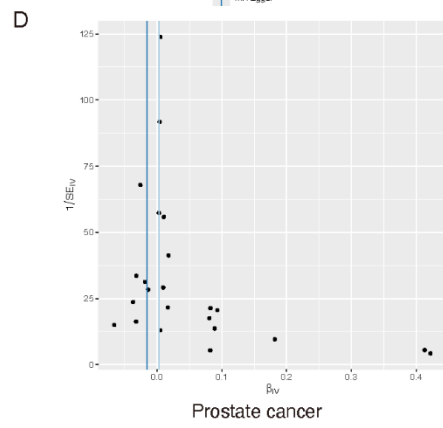
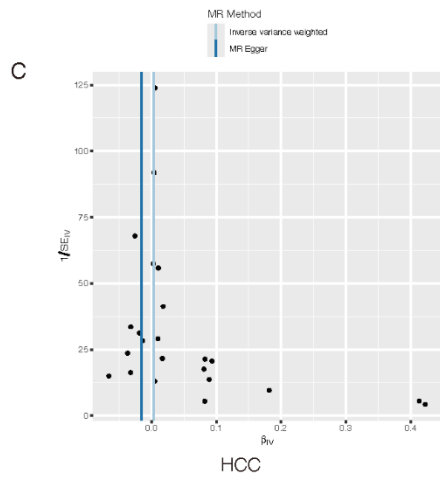
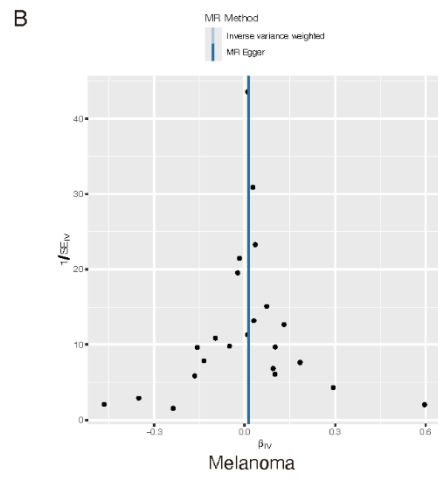
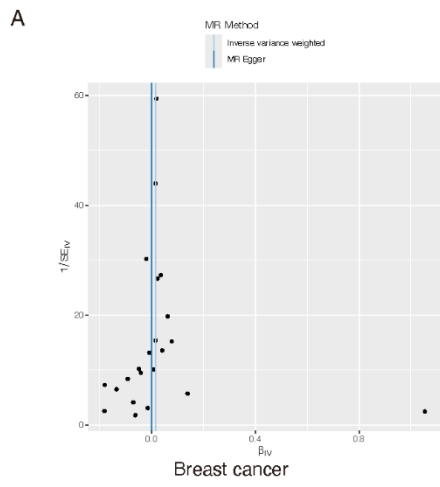
Supplementary Figure S19



Supplementary Figure S20



Supplementary Figure S21



Supplementary Figure S22

DNA repair & epigenetics	<ul style="list-style-type: none">• Activate DNA damage repair proteins (e.g., p53, BRCA1, ATM, 53BP1, PCNA);• Regulate histone acetylation/methylation; microRNAs (e.g., miR-125b, miR-145);
Oxidative stress defense	<ul style="list-style-type: none">• Upregulate antioxidant enzymes (e.g., SOD1/2, G6PD, TXNRD1, NRF2);• Reduce ROS and oxidative DNA damage markers (e.g., 8-OHdG);
Proliferation/differentiation/apoptosis	<ul style="list-style-type: none">• Upregulate IGFBP3, P21, P27, GOS2, FADD, TGFβ and its receptors;• Inhibit Wnt/β-catenin signaling pathway;• Activate FOXO3/4;• Induces apoptosis through Bax upregulation, Bcl-2 downregulation, caspase activation;• Inhibit PI3K-Akt signaling pathway through PTEN upregulation;
Immune modulation & tumor microenvironment	<ul style="list-style-type: none">• Enhances anti-tumor immunity (\uparrow cytotoxic T cells, NK cell function);• Microbiome-dependent cancer immunity (e.g., <i>B. fragilis</i> promotes tumor resistance in a VitD-dependent manner)• Suppresses chronic inflammation (\downarrow IL-6, TNF-α, NF-κB signaling, p38-MAPK signaling);