**Supplement material**

**Table S1.** PRISMA 2020 checklist.

**Table S2.** Risk of bias assessment with ROBINS-I tool.

**Table S3.** The PD-related genetic variants used for the MR analyses.

**Figure S1.** Sensitivity analysis of Meta-analysis.

**Figure S2.** Funnel plot of meta-analysis.

**Figure S3**. Scatter plot (A), forest plot (B), leave-one-out plot (C), and funnel plot (D) of the causal effect of PD on prostate cancer risk.

**Table S1. PRISMA 2020 checklist.**

| **Section and Topic**  | **Item #** | **Checklist item**  | **Location where item is reported**  |
| --- | --- | --- | --- |
| **TITLE**  |  |
| Title  | 1 | Identify the report as a systematic review. | Page 1 |
| **ABSTRACT**  |  |
| Abstract  | 2 | See the PRISMA 2020 for Abstracts checklist. | Page 1 |
| **INTRODUCTION**  |  |
| Rationale  | 3 | Describe the rationale for the review in the context of existing knowledge. | Page 2 |
| Objectives  | 4 | Provide an explicit statement of the objective(s) or question(s) the review addresses. | Page 2 |
| **METHODS**  |  |
| Eligibility criteria  | 5 | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. | Page 2 |
| Information sources  | 6 | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. | Page 2 |
| Search strategy | 7 | Present the full search strategies for all databases, registers and websites, including any filters and limits used. | Page 2 |
| Selection process | 8 | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. | Page 2 |
| Data collection process  | 9 | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. | Page 2, Figure 2 |
| Data items  | 10a | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. | Page 2-3 |
| 10b | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. | Table 2 |
| Study risk of bias assessment | 11 | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. | Table S2 |
| Effect measures  | 12 | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. | Page 3 |
| Synthesis methods | 13a | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). | Page 2-3Page 3 |
| 13b | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions. | Page 3 |
| 13c | Describe any methods used to tabulate or visually display results of individual studies and syntheses. | Page 3 |
| 13d | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. | Page 3 |
| 13e | Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression). | Page 3 |
| 13f | Describe any sensitivity analyses conducted to assess robustness of the synthesized results. | Page 3 |
| Reporting bias assessment | 14 | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). | Page 3 |
| Certainty assessment | 15 | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. | Page 3 |
| **RESULTS**  |  |
| Study selection  | 16a | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. | Page 4 |
| 16b | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | Table 2 |
| Study characteristics  | 17 | Cite each included study and present its characteristics. | Table 2 |
| Risk of bias in studies  | 18 | Present assessments of risk of bias for each included study. | Table S2, Figure S2 |
| Results of individual studies  | 19 | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect Estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. | Page 4 |
| Results of syntheses | 20a | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. | Page 4 |
| 20b | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | Page 4 |
| 20c | Present results of all investigations of possible causes of heterogeneity among study results. | Page 4 |
| 20d | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. | Page 4 |
| Reporting biases | 21 | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. | Page 4 |
| Certainty of evidence  | 22 | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. | Page 4 |
| **DISCUSSION**  |  |
| Discussion  | 23a | Provide a general interpretation of the results in the context of other evidence. | Page 5-6 |
| 23b | Discuss any limitations of the evidence included in the review. | Page 5-6 |
| 23c | Discuss any limitations of the review processes used. | Page 5-6 |
| 23d | Discuss implications of the results for practice, policy, and future research. | Page 5-6 |
| **OTHER INFORMATION** |  |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. | Page 1 |
| 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. | Page 1 |
| 24c | Describe and explain any amendments to information provided at registration or in the protocol. | Page 1 |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. | Page 8 |
| Competing interests | 26 | Declare any competing interests of review authors. | Page 8 |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. | Page 8 |

**Table S2. Risk of bias assessment with ROBINS-I tool.**

|  |  |  |  |
| --- | --- | --- | --- |
| Author, Year of Publication | Study Design | Domains | References |
| **Pre-intervention** | **At intervention** | **Post-intervention** | **Overall risk of bias judgement** |
| **Bias due to confounding** | **Bias in selection of participants into the study** | **Bias in classification of interventions** | **Bias due to deviations from intended interventions** | **Bias due to missing data** | **Bias in measurement of outcomes** | **Bias in selection of the reported result** |
| Driver, 2007 | Cohort | Low | Low | Moderate | Low | Low | Low | Moderate | Moderate | (1) |
| Fois, 2010 | Cohort | Low | Low | Low | Low | Low | Low | Low | Low | (2) |
| Becker, 2010 | Cohort | Low | Low | Low | Low | Low | Low | Moderate | Moderate | (3) |
| Lo, 2010 | Case-control | Low | Low | Low | Low | Low | Low | Low | Low | (4) |
| Rugbjerg, 2012 | Cohort | Low | Low | Low | Low | Low | Low | Low | Low | (5) |
| Wirdefeldt, 2013 | Cohort | Low | Low | Low | Low | Low | Low | Low | Low | (6) |
| Ong, 2014 | Cohort | Low | Low | Low | Low | Low | Low | Low | Low | (7) |
| Lin, 2015 | Cohort | Low | Low | Low | Low | Moderate | Low | Low | Moderate | (8) |
| Park, 2019 | Cohort | Low | Low | Low | Low | Low | Low | Low | Low | (9) |

***NA* not available**

**Table S4 The genetic variants used for the MR analyses**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | **Exposure：Parkinson’s Disease** | **Outcome：Prostate cancer** | **steiger\_dir** | **steiger\_pval** | **R2** | **F** |
| **SNP** | **CHR** | **A1** | **A2** | **Beta** | **SE** | **pval** | **Beta** | **SE** | **pval** |  |  |  |  |
| rs10513789 | 3 | G | T | -0.1596 | 0.0219 | 3.18E-13 | 3.00E-04 | 0.01 | 0.9791 | TRUE | 0.000600543 | 0.007603809 | 3698.695489 |
| rs10847864 | 12 | T | G | 0.1274 | 0.0179 | 9.81E-13 | 0.006 | 0.01 | 0.5447 | TRUE | 0.00438852 | 0.007501654 | 3648.629376 |
| rs12934900 | 16 | T | A | 0.1215 | 0.0184 | 4.33E-11 | 0.0075 | 0.0084 | 0.3724 | TRUE | 0.018919852 | 0.006652448 | 3232.829261 |
| rs144814361 | 10 | T | C | 0.4411 | 0.068 | 9.07E-11 | 0.0181 | 0.0365 | 0.6205 | TRUE | 0.008259615 | 0.006653193 | 3233.193592 |
| rs329647 | 11 | C | G | -0.1133 | 0.0178 | 1.94E-10 | -0.0193 | 0.0089 | 0.0310899 | TRUE | 0.266475964 | 0.005709273 | 2771.850973 |
| rs34311866 | 4 | C | T | 0.2272 | 0.0231 | 7.97E-23 | 0.0228 | 0.011 | 0.0378103 | TRUE | 0.004482659 | 0.016256364 | 7977.080233 |
| rs356203 | 4 | T | C | -0.2398 | 0.0178 | 3.01E-41 | 0.0012 | 0.0083 | 0.8828 | TRUE | 3.74E-10 | 0.027180364 | 13487.31305 |
| rs35749011 | 1 | A | G | 0.7508 | 0.0659 | 5.02E-30 | -0.052 | 0.0319 | 0.1028 | TRUE | 7.17E-05 | 0.021122077 | 10416.2305 |
| rs4488803 | 3 | A | G | -0.1136 | 0.0199 | 1.08E-08 | -0.0099 | 0.0084 | 0.2362 | TRUE | 0.094702738 | 0.006046615 | 2936.626959 |
| rs4588066 | 18 | A | G | 0.1046 | 0.0178 | 4.45E-09 | -0.0024 | 0.0087 | 0.7813 | TRUE | 0.010916493 | 0.004808071 | 2332.203841 |
| rs4613239 | 2 | G | C | 0.1784 | 0.0248 | 6.21E-13 | -0.0079 | 0.0127 | 0.5328 | TRUE | 0.004162793 | 0.007321206 | 3560.216294 |
| rs4698412 | 4 | A | G | 0.1258 | 0.0168 | 7.05E-14 | 0.002 | 0.0082 | 0.8049 | TRUE | 0.000843321 | 0.007823912 | 3806.603708 |
| rs4774417 | 15 | A | G | 0.1052 | 0.0192 | 4.63E-08 | 0.0061 | 0.0092 | 0.505 | TRUE | 0.043793206 | 0.004261782 | 2066.086862 |
| rs58879558 | 17 | C | T | -0.2383 | 0.025 | 1.36E-21 | -0.0187 | 0.0097 | 0.0552904 | TRUE | 0.004719402 | 0.019672749 | 9687.16 |
| rs620490 | 8 | G | T | -0.1174 | 0.019 | 6.46E-10 | -0.0187 | 0.009 | 0.0370698 | TRUE | 0.270134349 | 0.005510721 | 2674.92018 |
| rs6741007 | 2 | G | T | -0.1233 | 0.0175 | 2.09E-12 | -3.00E-04 | 0.0088 | 0.9757 | TRUE | 0.000923106 | 0.007527544 | 3661.317012 |
| rs75505347 | 12 | T | C | 0.3917 | 0.0674 | 6.12E-09 | -0.0027 | 0.0365 | 0.9415 | TRUE | 0.007095758 | 0.005867044 | 2848.901063 |
| rs75646569 | 5 | G | T | 0.1916 | 0.0266 | 5.62E-13 | -0.0051 | 0.0134 | 0.7032 | TRUE | 0.002052129 | 0.007285072 | 3542.515653 |
| rs7695720 | 4 | C | A | -0.1255 | 0.0208 | 1.53E-09 | -0.009 | 0.01 | 0.372 | TRUE | 0.038399566 | 0.005209464 | 2527.923348 |
| rs823106 | 1 | C | G | -0.1492 | 0.0239 | 4.10E-10 | 0.0022 | 0.0117 | 0.8475 | TRUE | 0.00516667 | 0.005713797 | 2774.060198 |
| rs858295 | 7 | G | A | -0.1039 | 0.0176 | 3.83E-09 | 0.0082 | 0.0083 | 0.325 | TRUE | 0.05344011 | 0.005158208 | 2502.922258 |

SNP: single nucleotide polymorphism, CHR: chromosome, A1: effect allele, A2: other allele, BETA: beta-coefficient (in standard deviation units), SE: standard error

**Supplementary Figures**

**Figure S1.** Sensitivity analysis of Meta-analysis.



**Figure S2**. Funnel plot of meta-analysis.



**Figure S3**. Scatter plot (A), forest plot (B), leave-one-out plot (C), and funnel plot (D) of the causal effect of PD on prostate cancer risk.



**Reference**

1. Driver JA, Logroscino G, Buring JE, Gaziano JM, Kurth T. A prospective cohort study of cancer incidence following the diagnosis of Parkinson's disease. Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology. 2007;16(6):1260-5.

2. Fois AF, Wotton CJ, Yeates D, Turner MR, Goldacre MJ. Cancer in patients with motor neuron disease, multiple sclerosis and Parkinson's disease: record linkage studies. Journal of neurology, neurosurgery, and psychiatry. 2010;81(2):215-21.

3. Becker C, Brobert GP, Johansson S, Jick SS, Meier CR. Cancer risk in association with Parkinson disease: a population-based study. Parkinsonism & related disorders. 2010;16(3):186-90.

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5. Rugbjerg K, Friis S, Lassen CF, Ritz B, Olsen JH. Malignant melanoma, breast cancer and other cancers in patients with Parkinson's disease. International journal of cancer. 2012;131(8):1904-11.

6. Wirdefeldt K, Weibull CE, Chen H, Kamel F, Lundholm C, Fang F, et al. Parkinson's disease and cancer: A register-based family study. American journal of epidemiology. 2014;179(1):85-94.

7. Ong EL, Goldacre R, Goldacre M. Differential risks of cancer types in people with Parkinson's disease: a national record-linkage study. European journal of cancer (Oxford, England : 1990). 2014;50(14):2456-62.

8. Lin PY, Chang SN, Hsiao TH, Huang BT, Lin CH, Yang PC. Association Between Parkinson Disease and Risk of Cancer in Taiwan. JAMA oncology. 2015;1(5):633-40.

9. Park JH, Kim DH, Park YG, Kwon DY, Choi M, Jung JH, et al. Cancer risk in patients with Parkinson's disease in South Korea: A nationwide, population-based cohort study. European journal of cancer (Oxford, England : 1990). 2019;117:5-13.