**References**

1. Ou, Z. *et al.* Global Trends in the Incidence, Prevalence, and Years Lived With Disability of Parkinson’s Disease in 204 Countries/Territories From 1990 to 2019. *Front. Public Health* **9**, 776847 (2021).

2. Poewe, W. *et al.* Parkinson disease. *Nat. Rev. Dis. Primer* **3**, 17013 (2017).

3. Schapira, A. H. V., Chaudhuri, K. R. & Jenner, P. Non-motor features of Parkinson disease. *Nat. Rev. Neurosci.* **18**, 435–450 (2017).

4. Yu, Q.-J. *et al.* Parkinson disease with constipation: clinical features and relevant factors. *Sci. Rep.* **8**, 567 (2018).

5. Abbott, R. D. *et al.* Frequency of bowel movements and the future risk of Parkinson’s disease. *Neurology* **57**, 456–462 (2001).

6. Braak, H. *et al.* Staging of brain pathology related to sporadic Parkinson’s disease. *Neurobiol. Aging* **24**, 197–211 (2003).

7. Shannon, K. M. *et al.* Alpha‐synuclein in colonic submucosa in early untreated Parkinson’s disease. *Mov. Disord.* **27**, 709–715 (2012).

8. Sampson, T. R. *et al.* Gut Microbiota Regulate Motor Deficits and Neuroinflammation in a Model of Parkinson’s Disease. *Cell* **167**, 1469-1480.e12 (2016).

9. Romano, S. *et al.* Meta-analysis of the Parkinson’s disease gut microbiome suggests alterations linked to intestinal inflammation. *Npj Park. Dis.* **7**, 27 (2021).

10. Dalile, B., Van Oudenhove, L., Vervliet, B. & Verbeke, K. The role of short-chain fatty acids in microbiota–gut–brain communication. *Nat. Rev. Gastroenterol. Hepatol.* **16**, 461–478 (2019).

11. Houser, M. C. & Tansey, M. G. The gut-brain axis: is intestinal inflammation a silent driver of Parkinson’s disease pathogenesis? *Npj Park. Dis.* **3**, 3 (2017).

12. Wallen, Z. D. *et al.* Metagenomics of Parkinson’s disease implicates the gut microbiome in multiple disease mechanisms. *Nat. Commun.* **13**, 6958 (2022).

13. Fu, S.-C. *et al.* Exploring the Causal Effect of Constipation on Parkinson’s Disease Through Mediation Analysis of Microbial Data. *Front. Cell. Infect. Microbiol.* **12**, 871710 (2022).

14. Kenna, J. E. *et al.* Changes in the Gut Microbiome and Predicted Functional Metabolic Effects in an Australian Parkinson’s Disease Cohort. *Front. Neurosci.* **15**, 756951 (2021).

15. Debelius, J. *et al.* Tiny microbes, enormous impacts: what matters in gut microbiome studies? *Genome Biol.* **17**, 217 (2016).

16. Mertsalmi, T. H. *et al.* More than constipation – bowel symptoms in Parkinson’s disease and their connection to gut microbiota. *Eur. J. Neurol.* **24**, 1375–1383 (2017).

17. Baldini, F. *et al.* Parkinson’s disease-associated alterations of the gut microbiome predict disease-relevant changes in metabolic functions. *BMC Biol.* **18**, 62 (2020).

18. Khedr, E. M. *et al.* Gut microbiota in Parkinson’s disease patients: hospital-based study. *Egypt. J. Neurol. Psychiatry Neurosurg.* **57**, 153 (2021).