

IMPACT REPORT 2026



Parkinson's disease: From the gut to the brain



Health and economic impacts, and
policy implications, of probiotics in Parkinson's disease

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Biotechnology and
Biological Sciences
Research Council

INFORM Hub

INVESTIGATING THE ROLE OF FUNCTIONAL FOODS AND BEVERAGES TO IMPROVE HEALTH AND RECOVERY

1. Executive Summary

This Impact Report explores the role of functional foods, specifically ‘biotics’ (probiotics, prebiotics, and synbiotics), in addressing gastrointestinal and nutritional challenges in people living with Parkinson’s disease (PwP). Parkinson’s disease (PD) is a progressive neurodegenerative condition affecting approximately 10 million people worldwide (166,000 in the UK), with both motor and non-motor symptoms adversely impacting quality of life (QoL).

To inform this report, we conducted a systematic review and meta-analysis of randomised controlled trials to critically evaluate the effects of biotic interventions on gastrointestinal symptoms and QoL in PwP. In parallel, public and participant involvement (PPI) activities, including focus groups and research engagement events, were undertaken across the UK and Ireland to capture the lived experiences of PwP and identify the key nutrition-related challenges. A high-level economic model was developed to estimate the health and cost impacts of a probiotic supplementation programme.

Key Findings

Our **meta-analysis findings** suggest that probiotic interventions have benefits in improving constipation. The evidence shows an increase of approximately one additional bowel movement per week, alongside modest improvements in QoL, in response to intervention with probiotics.

Insights from our **PPI activities** highlight significant unmet nutrition-related needs in PwP, including persistent gastrointestinal issues, very limited access to dietetic services and nutritional care, alongside significant barriers related to food affordability and swallowing difficulties.

Our **Economic modelling** estimated that a probiotic supplementation programme for PwP, costing £1.10 per person per week, could generate meaningful health gains, equating to approximately nine additional days of good-quality health per person annually. The implementation of this nutritional intervention would cost approximately £2,400 per quality-adjusted life year (QALY) gained, and is associated with estimated cost offsets of £2–3 million per year due to reduced laxative use.

Overall, intervention with probiotics offers a promising, low-cost strategy to improve gastrointestinal health and QoL in PwP. There are important implications of this report for clinical practice and health policy, and in informing future research priorities. Of note, although probiotics show beneficial effects, this report identifies a significant research shortfall in the evidence-base to support the benefits of prebiotics (including inulin and lactulose), considering their established health claims.

The Project Team

Ulster University

Dr Shane Gordon, Project Lead

Dr Catherine Hughes

Prof Helene McNulty

Dr Michelle Clements

University of Leeds

Prof Kieran Tuohy

University of Auckland

Dr Fiona Lithander

Dr Aakash Prasad

Industry Partners

Richelle Flanagan (My Moves Matters Ireland)

Willie Wixted (ABC Nutritionals, Ireland)

Dr Filippou Papadopoulos (Health Economist)

Stakeholder Critical Review/ Feedback

Dr Melina Jampolis (MD, Nutrition Specialist)

Prof Sumantra Ray (MD, NNEdPro, Global Institute for Food, Nutrition and Health)

2. Industry Collaboration

Industry–academic partnerships are increasingly important in translating functional food research into real-world interventions. This Impact Report, funded through the BBSRC Diet and Health Open Innovation Research Club (OIRC) INFORM Hub, was developed in collaboration with ABC Nutritionals, the industry partner working with us to co-develop gut-modulating drinks for ongoing Food4PD (RIPEN Hub) and GutFood (INFORM Hub) research projects. This Industry–academic collaboration has proved to be invaluable in bridging scientific evidence and practical implementation. ABC Nutritionals contributed expertise in formulation, taste, and real-world feasibility, while the research team provided up-to-date evidence synthesis on nutrition, biotics, the microbiome, and needs of PwP.

3. Parkinson’s Disease, Nutrition Needs and Biotics

Parkinson’s disease, a progressive neurological condition, is characterised by the loss of dopamine-producing cells in the brain. An estimated 166,000 people are living with Parkinson’s in the UK (1). PD is associated with motor symptoms (including tremor, slowness, stiffness, balance problems) and a wide range of non-motor symptoms that often precede or outweigh the motor problems (2). While motor symptoms are well recognised in PD, the non-motor symptoms which affect 80-90% of PwP can have a greater negative impact on QoL.

Constipation is the most common gastrointestinal symptom, affecting up to 80% of PwP and can precede the onset of motor symptoms by as much as two decades (3). Notably, small intestinal bacterial overgrowth has been reported in up to 46% of individuals with PD (4), and broader alterations in gut microbiome composition compared with healthy controls are well established (5). Gastrointestinal and other non-motor manifestations in PD can impair nutrient absorption, reduce the effectiveness of PD medications, and contribute to malnutrition (2). Recently, increasing attention has focused on the gut–brain axis - a communication system linking the gastrointestinal tract and the brain, and there is emerging evidence indicating that altering the gut microbiome through dietary approaches may help to alleviate gastrointestinal issues (3,6,7). At the forefront of this research are biotics (**Figure 1**), which refer to probiotics, prebiotics, and synbiotics, that can potentially influence the gut in many positive ways.

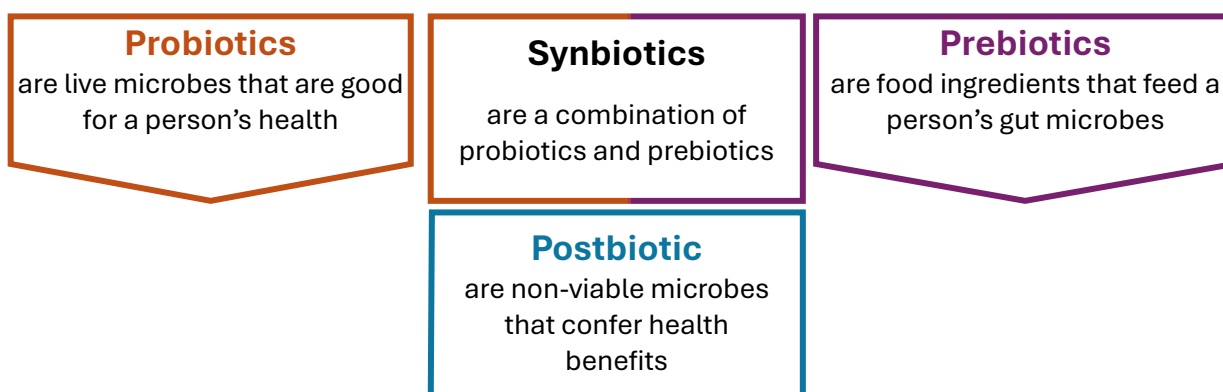


Figure 1. Types of biotics

Beyond biotics, nutrition plays a crucial, but all too often overlooked, role in the management of PD. To better support clinical practice, it is essential for neurologists to have a concise overview of how nutrition intersects with PD pathology (8). These PD-specific issues are central to modern symptom management and should include the most important nutritional considerations as identified by neurologists, ranging from weight regulation to nutrient-drug interactions - (**Figure 2**).

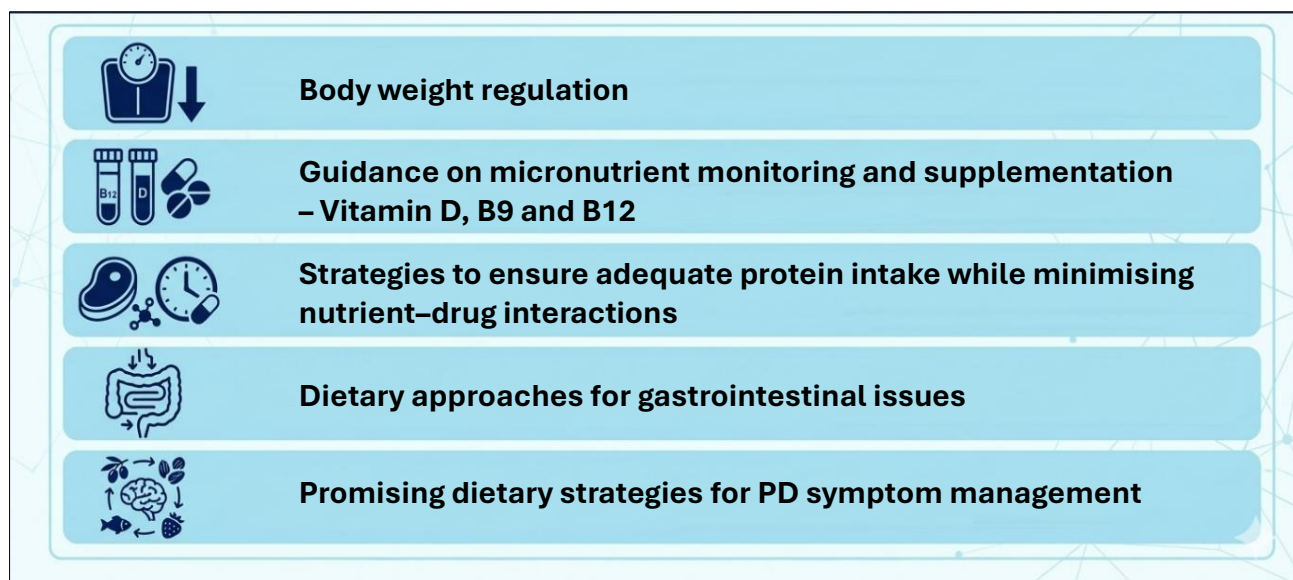


Figure 2. Most Important Nutritional Considerations for Neurologists in PD

Adapted from Shuler *et al.* (2026)

4. Perspectives from PwP

Public and participant involvement (PPI) activities were conducted via focus groups which included PwP and their carers across the UK and Ireland. Participants shared their experiences of living with PD and the food and nutritional challenges that they faced in their daily lives (these concerns are summarised in **Figure 3**).

Participants in these focus groups highlighted unmet needs around food and nutrition, difficulties swallowing and chewing, digestive problems, constipation, and food affordability. They also reported limited access to specialist nutritionist advice, lack of dietetics support, and the impacts on their diet of non-motor symptoms such as fatigue and cognitive issues.

Notably, concerns around constipation and gut health identified in these focus groups were also echoed by people newly diagnosed with Parkinson’s disease at a Parkinson’s UK research event (Section 7), where similar issues were raised during panel discussions. These insights emphasise the vulnerability of PwP, particularly those living alone, and the importance of tailored nutritional guidance and support in managing their condition. Yet, despite the significant nutrition-related complications associated with PD, and the unmet needs highlighted by PwP from our focus groups, approximately 90% of PwP lacked access to basic dietetic services. This

highlights a critical gap, given the broad range of ways a dietitian can support PwP, as highlighted by Flanagan *et al.* 2024 (9) in an article setting out the key role of the dietitian in PD care.

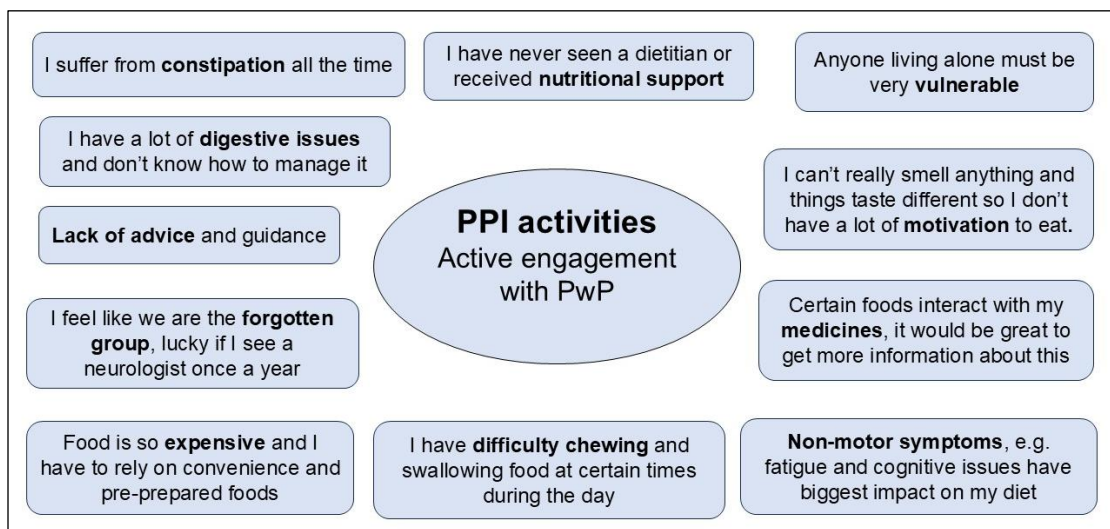


Figure 3. PPI activities capturing challenges and concerns of PwP
PPI, Public and Participant Involvement; PwP, people living with Parkinson’s disease

5. Evidence from Trials of Biotics

A published systematic review from our team members highlighted that clinical trials with probiotics and synbiotics may offer benefits for PwP, particularly in improving bowel movement frequency, stool consistency and reduced laxative use, which are major concerns for many patients (10). We built on this systematic review in the current project by doing an updated literature search. Additionally, we conducted a meta-analysis of randomised controlled trials to evaluate the effects of biotic interventions on gastrointestinal symptoms and QoL in PwP.

The results from the meta-analysis indicated that probiotic interventions helped PwP to have one additional bowel movement per week (**Figure 4**). In addition, patient-reported QoL scores showed a modest but significant overall benefit of biotics. Additional research is needed because there were large differences in the types of supplements, dosages and study designs of the published studies. Whilst a promising area of investigation, more research is needed before recommendations to patients can be made. Importantly, probiotics and synbiotics were generally well tolerated, though occasional mild side-effects were reported.

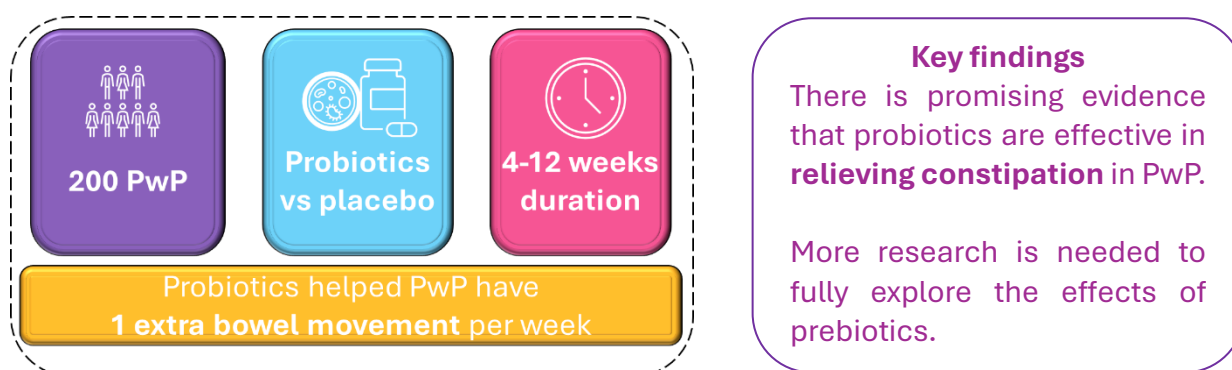


Figure 4. A meta-analysis to examine the effects of probiotics on bowel movement frequency in PwP

Notably, there are no studies of prebiotics as standalone interventions. This is important, given that in non-PD populations, certain prebiotics, particularly inulin-type fructans, have been consistently shown to increase stool frequency and improve bowel function, in a clear dose-response relationship. Indeed, native chicory inulin is currently the only gut-modulating ingredient with an authorised European Food Safety Authority (EFSA) health claim for maintenance of normal defecation, supported by multiple human intervention studies at intakes of ≥ 12 g/day. In addition, lactulose is a well-established, but underexplored prebiotic. At low doses, lactulose promotes beneficial gut bacteria and carries an EFSA health claim for reducing intestinal transit time at 10 g/day, with good tolerability and potential added benefits such as improved mineral absorption. Despite reported benefits, many probiotic health claim applications have failed due to insufficient strain characterisation, formulation heterogeneity, and inconsistent clinical outcomes. Clearly, further research in this area should be prioritised.

6. Economic Impacts and Policy Implications

A high-level economic assessment was conducted to estimate the health benefits and costs associated with offering a daily probiotic supplement to PwP, as summarised in **Table 1**.

Table 1. Modelled Impact of a Nationwide Daily Probiotic Programme for PwP

What we tested	Under a hypothetical 5-year national programme offering a daily probiotic to PwP alongside their usual care. Assuming 50–65% uptake with gradual attrition, the gross annual spend on probiotic supplementation is estimated at £4–6 million. This represents <0.2% of the England Public Health Grant allocated to local authorities annually (approximately £4.1 billion in 2025).
What we found	For about £1.10 a week , each participant gains about 9 extra days of good-quality health each year . Scaled up to 1,000 participants, that’s over 9,000 extra “good-health” days every year. The only effect we assume here is the relief of constipation, a debilitating symptom of PD.
Why this matters	Even very small improvements add up when many people benefit. For PwP, this programme buys extra time in which they feel better—at very low cost.
Good value for money?	Yes, the programme is expected to generate £2–3 million per year in cost offsets from reduced laxative use. After accounting for these savings, the net annual cost is estimated at £2–3 million, indicating a modest budgetary impact alongside strong cost-effectiveness. At ~£2,400 per QALY, this is far below what the NHS typically pays for similar health gains. Put another way, every £1 spent returns ~£8 – £13 of health value by standard NHS measures.*
What it is and isn’t	This does not cure PD nor alter its progression. It is a low-cost supplement that has been shown to improve bowel function and hence reduce constipation, potentially improving everyday life for PwP.

NHS, National Health Service; PD, Parkinson’s disease; PwP, people living with Parkinson’s disease; QALY, quality-adjusted life year

All underlying assumptions, data sources and modelling details are provided in the appendices (**Table 3**). *Assuming a typical NHS willingness-to-pay threshold of £20,000–£30,000 per QALY

7. Stakeholder Engagement Events

Ulster University Satellite Event on Precision Nutrition – 5th November 2025

As part of our stakeholder engagement programme, a dissemination event was hosted at Ulster University (Coleraine), delivered both in-person and virtually, to share emerging findings and gather expert insights. The session brought together academic and nutrition research staff, clinicians, dietitians, PhD students and post-doctoral scientists, together with members from the NNEdPro Global Institute for Food, Nutrition and Health, to discuss the evolving evidence-base for nutritional strategies that support gastrointestinal and overall health in PwP. NNEdPro, an award-winning, interdisciplinary think-tank, significantly extended the event's online reach, ensuring that key insights were shared, not only locally, but also across NNEdPro's international membership network.



Figure 5. Precision Nutrition Satellite Event, Ulster University Coleraine.

Discussions focused on the current research on the prebiotic inulin and its potential role in managing gastrointestinal issues, the critical importance of hydration for PwP, and the need for deeper collaboration between the food and beverage industry and researchers to develop and reformulate functional foods and drinks. Stakeholders also explored how nutritional status, including blood levels of vitamins B6 and B12, may interact with levodopa use (the primary medication used to manage motor symptoms in PD), reinforcing the need for more personalised and evidence-informed dietary guidance.

Parkinson's UK Northern Ireland Research Event – 28th November 2025

This research event brought together researchers, clinicians and most importantly, PwP to share and discuss current research and future priorities. The event provided a platform for meaningful two-way dialogue, enabling PwP to engage directly with researchers, ask questions, and reflect on how research aligns with lived experience.



Figure 6. Parkinson's UK Northern Ireland Research Event, Hilton Templepatrick

8. Five Key Recommendations

Based on the evidence presented in this report, the following five recommendations outline key actions that we conclude are necessary to support the nutritional care and related gastrointestinal health of PwP.

Table 2. Five Key Recommendations for Parkinson's Nutrition and Care

1. Improve regular access to **nutrition support** (e.g. by including dietetic referrals as part of standard PD care).
2. Ensure that **nutrition/dietetic support** is incorporated into Parkinson's research design and reporting.
3. Pilot **real-world** pre- and probiotic interventions to test their feasibility, acceptability, delivery, adherence, and cost-effectiveness.
4. Improve awareness and knowledge of nutrition, and accessibility of **nutrition education** for PwP and carers.
5. Strengthen **PPI** in PD nutrition research.

PD, Parkinson's disease; PPI, public and participant involvement

The programme showcased a broad range of ongoing research across the UK, with a particular emphasis on improving QoL, advancing treatment development, and addressing unmet needs identified by the PD community. By fostering collaboration and knowledge exchange between researchers, healthcare professionals, and PwP, the event helped strengthen partnerships and ensure that future research is informed by patient priorities and real-world impact.

Acknowledgements

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We are deeply grateful to our **PPI contributors**, who generously shared their lived experience of PD through both online and in-person engagements. Their perspectives have been instrumental in shaping the direction, relevance, and quality of this work.

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Appendix

Table 3. Key Economic Modelling Inputs

Variable	Value	Lower – upper range (sensitivity analysis)	Sources	Commentary
Baseline constipation prevalence (SBMs<3) - mild	50%	30 - 60%	Earone et al 2009; Sun et al. 2021	GI domain symptom prevalence by H&Y stage from FRIAMO study; used as baseline constipation probability in untreated patients; Numbers are 'best guess' assumptions based on several literature observations that constipation is very common and frequently reported around 50-70%(this can vary by self-reported vs Rome III defined constipation) and then using the FRIAMO study numbers as anchors for 'baking-in' the increasing prevalence assumption into the model
Baseline constipation prevalence (SBMs<3) – moderate	70%	50 - 85%		
Baseline constipation prevalence (SBMs<3) – severe	75%	50 - 85%		
Change in weekly SBMs with probiotics (effect size) – mild	1.22	0.84 – 1.59	Own meta-analysis (Sun et al 2022, Du et al 2022, Tan et al 2020)	Probiotics-based interventions effect on number of SBMs per week; Assumed only for mild cohort given limited evidence of probiotic effects in later stages
Effect size modifier – moderate	80%	70%- 90%	Assumption	Conservative assumption that greatest impact on early-stage PD; Advanced PD pathophysiology expected to overpower probiotic improvements in later stages
Effect size modifier – severe	50%	30%- 60%	Assumption	
Probiotic price per month	£4.80	£2.40 – £9.60	ABC Nutritionals, HEIGHTS, assumption (for range)	Baseline assumption of volume-discounted net price to the NHS
Laxative costs per week	£2.31	£1.39 – £4.62	BNF; Assumption (NHS discount)	Movicol Ready to Take oral solution 25ml sachets Forum Health Products Ltd - 2 sachets per day in constipated weeks; £9.89 per pack of 30 sachets -> £0.33/sachet so £0.33x2x7 = £4.62/week; Assume 50% discount based on previous work of real NHS spending vs indicative drug spending
Utility – mild	0.70	0.65 – 0.80	Norlin et al 2021	Stage-specific utility estimates
Utility – moderate	0.55	0.52 – 0.66		
Utility – severe	0.32	0.10 – 0.45		
Utility gain with constipation relief	0.05	0.03-0.07	Huang et al 2014; Hatswell et al 2016	EQ-5D utility gains from Linaclotide and Lubiprostone trials/HTA submissions; Utility effect size from constipation relief assumed homogenous across severity stages; Attenuation of possible intervention benefit assumed through reduced likelihood of constipation relief and not in utility change to avoid double-counting effect attenuation
Months to progression mild -> moderate	107	92 – 114	Zhao et al 2010	Direct Kaplan–Meier median H&Y stage transition times from Zhao et al 2010
Months to progression moderate -> severe	24	20 - 30		
Accelerating hazards assumption mild -> moderate (k parameter)	1.3	1.1 – 1.6	Assumption	Zhao et al. report non-parametric medians but model uses a parametric assumption of progression hazards that increase with time-in-stage
Accelerating hazards assumption moderate -> severe (k parameter)	1.5	1.2 – 1.8		
Annual dropout rate	12%	5%-20%	Assumption	Assumption based on general low/zero AE rates in RCTs but high assumed non-adherence with supplementation routine;