

Clinical Evidence and Trials on Probiotic Efficacy for Specific Health Conditions: A Review of Recent Clinical Evidence

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Abstract

Probiotics have gained substantial attention as potential adjunctive interventions for the prevention and management of a wide range of health conditions. Their proposed benefits are associated with modulation of the gut and oral microbiota, enhancement of epithelial barrier integrity, regulation of immune responses, production of bioactive metabolites and interaction with host metabolic and neurological pathways. However, clinical efficacy is not uniform and depends on probiotic strain, dose, formulation, duration, host characteristics and disease-specific factors. This review synthesizes recent systematic reviews, meta-analyses and randomized controlled trials examining probiotic efficacy in selected gastrointestinal, metabolic, periodontal, dermatological and cognitive conditions. Recent evidence suggests that probiotics may improve global symptoms and quality of life in irritable bowel syndrome, support remission and reduce recurrence in selected patients with ulcerative colitis, and improve selected outcomes in constipation and acute diarrhoea. Evidence also suggests potential metabolic benefits in type 2 diabetes and gestational diabetes, although results are heterogeneous. In periodontal disease, probiotics may improve plaque and bleeding-related outcomes when used as an adjunct to conventional therapy. Emerging evidence indicates possible benefits in atopic dermatitis and cognitive function, but these areas require further high-quality trials. Across conditions, the most consistent limitation is heterogeneity in strains, dose, intervention duration, study populations and clinical endpoints. Consequently, probiotic therapy should be considered condition-specific and strain-specific rather than universally applicable. Future research should emphasize standardized strain identification, dose reporting, longer follow-up, personalized microbiome-based approaches and clinically meaningful outcomes.

Keywords: probiotics; clinical trials; randomized controlled trials; systematic review; meta-analysis; gut microbiota; irritable bowel syndrome; ulcerative colitis; metabolic health; periodontal disease; atopic dermatitis; cognitive function

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1. Introduction

Probiotics are live microorganisms that, when administered in adequate amounts, confer a health benefit on the host. Their clinical application has expanded from traditional gastrointestinal applications to areas including metabolic health, oral health, dermatology, pregnancy-related metabolic disorders and neurocognitive health.

The increasing interest in probiotics is largely related to the recognition that the human microbiota influences digestion, epithelial barrier function, immune regulation, inflammation, metabolism and communication along the gut-brain axis. Probiotic organisms may influence these processes through competitive exclusion of pathogens, production of antimicrobial substances, modulation of microbial metabolites, reinforcement of epithelial integrity and regulation of immune responses.

Despite extensive research, clinical findings remain inconsistent. A major reason is that the term “probiotic” represents a diverse group of microorganisms with different biological properties. The effects of one strain cannot necessarily be extrapolated to another strain of the same species. Furthermore, clinical outcomes may depend on dose, duration, delivery vehicle, disease severity, baseline microbiota and concomitant treatment.

Recent systematic reviews and meta-analyses provide increasingly detailed evidence concerning **which probiotic interventions may be useful for specific health conditions**. The present review therefore focuses on clinical evidence rather than solely on mechanistic or laboratory findings.

2. Objectives

The objectives of this review are:

1. To summarize recent clinical evidence regarding probiotic efficacy in specific health conditions.
2. To evaluate findings from randomized controlled trials and systematic reviews/meta-analyses.
3. To identify conditions in which probiotic therapy demonstrates promising clinical effects.
4. To examine the influence of strain, dose, duration and formulation on outcomes.
5. To evaluate the safety and limitations of probiotic interventions.
6. To identify research gaps and future directions for clinical probiotic research.

3. Methodology

3.1 Literature Search Strategy

A structured literature search was undertaken using major biomedical databases, including **PubMed/MEDLINE, Scopus, Web of Science and Cochrane Library**. Literature published predominantly from **2020 to 2026** was considered, while earlier landmark studies were retained where they provided important background or clinical evidence.

Search terms included combinations of:

- “probiotics”
- “probiotic supplementation”
- “randomized controlled trial”
- “clinical trial”
- “systematic review”
- “meta-analysis”
- “irritable bowel syndrome”
- “ulcerative colitis”
- “inflammatory bowel disease”
- “diarrhea”
- “constipation”
- “type 2 diabetes”
- “gestational diabetes”
- “periodontitis”
- “gingivitis”
- “atopic dermatitis”
- “cognitive function”

Boolean operators **AND/OR** were used to combine intervention and disease-specific terms.

3.2 Inclusion Criteria

Studies were considered eligible when they:

- involved human participants;
- investigated probiotic supplementation or probiotic-containing interventions;
- included a clinical health condition or clinically relevant outcome;

- were randomized controlled trials, systematic reviews, meta-analyses or umbrella reviews;
- reported clinical, biochemical, microbiological or patient-reported outcomes;
- were published in peer-reviewed journals.

3.3 Exclusion Criteria

Studies were excluded when they:

- were exclusively animal or in-vitro studies;
- lacked clinically relevant outcomes;
- were non-peer-reviewed sources;
- did not provide sufficient information regarding the intervention;
- investigated unrelated microbial interventions without a probiotic component.

3.4 Evidence Synthesis

Because probiotic interventions differ substantially in microbial strains, formulations, doses and clinical populations, findings were synthesized narratively rather than assuming that all probiotic preparations were therapeutically equivalent.

Important methodological note: The present manuscript is a structured review based on published systematic reviews/meta-analyses and selected clinical evidence. If it is submitted as a formal **systematic review**, the authors should conduct and document a complete database search and report actual PRISMA screening numbers rather than inserting estimated numbers.

4. Biological Basis of Probiotic Action

Several mechanisms may contribute to probiotic effects.

4.1 Modulation of intestinal microbiota

Probiotics may alter microbial community composition and microbial metabolic activity, potentially supporting restoration of microbial balance.

4.2 Enhancement of epithelial barrier function

Certain probiotic strains may influence tight-junction proteins and epithelial integrity, potentially reducing abnormal intestinal permeability.

4.3 Immunomodulation

Probiotics may affect innate and adaptive immune responses and modify inflammatory cytokine production.

4.4 Competitive exclusion

Probiotics can compete with pathogenic microorganisms for nutrients and attachment sites and may produce antimicrobial substances.

4.5 Metabolite production

Probiotic-associated microbial metabolism can contribute to production or modulation of short-chain fatty acids and other bioactive metabolites.

4.6 Gut–brain communication

Microbiota-related metabolites and immune signaling may influence the gut–brain axis, providing a biological rationale for investigating probiotics in cognitive and psychological outcomes.

These mechanisms provide biological plausibility but do not automatically establish clinical effectiveness. Clinical benefit must be demonstrated in appropriately designed human trials.

5. Clinical Evidence in Irritable Bowel Syndrome

Irritable bowel syndrome (IBS) is a chronic gastrointestinal disorder characterized by abdominal pain, bloating and altered bowel habits. Dysbiosis, intestinal barrier alterations, visceral hypersensitivity and gut–brain interactions have contributed to interest in probiotics as adjunctive therapy.

A 2024 systematic review and meta-analysis by **Yang et al.** included **20 studies involving 3,011 patients**. Compared with placebo, probiotics significantly improved the global IBS symptom improvement rate and quality of life. Subgroup analyses suggested potential benefits from higher probiotic doses and multi-strain preparations for abdominal pain. However, substantial heterogeneity was observed among studies. No significant difference in adverse-event frequency was found between probiotics and placebo.

Another 2024 systematic review/meta-analysis reported significant improvements in stool habits and quality of life, particularly among patients with diarrhoea-predominant IBS, but again noted substantial heterogeneity.

A 2024 network meta-analysis comparing probiotics, prebiotics, synbiotics and FMT reported that probiotics improved IBS symptoms, with particularly favorable evidence involving **Bifidobacterium** and **Lactobacillus** strains.

Interpretation

The evidence supports probiotics as a potentially useful **adjunct for IBS symptom management**, but there is insufficient evidence to recommend a single universal probiotic formulation for all IBS patients.

6. Probiotics in Inflammatory Bowel Disease

Inflammatory bowel disease (IBD) includes ulcerative colitis (UC) and Crohn's disease (CD). Abnormal microbiota composition and immune dysregulation are important components of IBD pathophysiology.

A 2024 systematic review and meta-analysis evaluating probiotics in UC reported that probiotics may be useful in reducing recurrence among patients in clinical remission. The evidence for inducing remission in active disease was less conclusive.

Importantly, the analysis did not demonstrate a significant increase in general adverse events.

An updated evidence synthesis of IBD randomized controlled trials further demonstrated that the effects of probiotics differ between UC and Crohn's disease. The evidence has been more favorable for selected outcomes in UC than for Crohn's disease.

A 2025 systematic review and meta-analysis published in *Nutrition Reviews* further evaluated probiotic supplementation and fecal microbiota outcomes in IBD, demonstrating the continuing development of microbiome-directed clinical research.

Interpretation

Probiotics may have a role as an **adjunct to conventional treatment in selected UC populations**, but the evidence does not support replacing established pharmacological treatment with probiotics.

7. Ulcerative Colitis

Among gastrointestinal inflammatory disorders, UC is one of the most extensively studied conditions for probiotic intervention.

A 2024 meta-analysis involving **13 randomized controlled trials and 930 patients** suggested that probiotic-assisted therapy may reduce UC recurrence among patients who have achieved clinical remission. Evidence concerning active UC was less definitive.

A network meta-analysis examining probiotics, prebiotics and synbiotics in mild-to-moderate UC also suggested that selected combinations containing **Lactobacillus**, **Bifidobacterium** and **Streptococcus** may improve clinical remission when used as adjunctive interventions.

These findings support the concept that **specific probiotic combinations may have therapeutic value in selected UC populations**, but heterogeneity and low certainty of evidence remain important limitations.

8. Probiotics for Constipation

Functional constipation is another gastrointestinal condition in which probiotics have been evaluated.

A 2024 systematic review and meta-analysis involving **1,243 patients across 10 studies** reported statistically significant effects favoring probiotics for constipation management, although substantial heterogeneity was observed.

Potential benefits may include:

- improved stool frequency;
- improved stool consistency;
- reduced gastrointestinal discomfort;
- modulation of intestinal microbial activity.

However, because the probiotic preparations and intervention protocols differ considerably, additional

well-designed RCTs are required to determine which strains and doses are most effective.

9. Probiotics for Acute and Persistent Diarrhoea

Probiotics have been investigated particularly extensively in infectious and acute diarrhoeal disorders.

A 2024 systematic review and meta-analysis evaluated probiotic treatment for acute or persistent diarrhoea in children from birth to 10 years. Such evidence is clinically relevant because diarrhoeal disease remains an important cause of morbidity in childhood.

The therapeutic effects of probiotics in diarrhoea may involve competitive inhibition of pathogens, restoration of microbial balance, enhancement of intestinal barrier function and modulation of immune responses.

However, probiotic efficacy can vary according to the causative organism, patient age, nutritional status, strain, dose and geographical setting.

10. Probiotics and Type 2 Diabetes

Metabolic disorders represent an expanding area of probiotic research.

A 2025 systematic review evaluated probiotics, prebiotics, synbiotics and FMT in adults with type 2 diabetes and related dysglycaemia. The review used PubMed/MEDLINE, Scopus and Web of Science and assessed clinical and mechanistic outcomes associated with microbiome-directed interventions.

A separate 2024 meta-analysis evaluated probiotic supplementation at different intervention durations in patients with type 2 diabetes and reported effects on glycaemic control.

Potential mechanisms include:

- modulation of gut microbial composition;
- improvement of intestinal barrier function;
- alteration of short-chain fatty acid production;
- reduction of low-grade inflammation;
- potential improvement in insulin sensitivity.

However, probiotics should currently be considered **adjunctive nutritional interventions rather than substitutes for diabetes management**.

11. Probiotics and Gestational Diabetes Mellitus

Gestational diabetes mellitus (GDM) is an important clinical condition in which probiotic interventions have generated both positive and conflicting findings. A 2024 meta-analysis of **14 RCTs involving 3,527 pregnant women** reported a significant reduction in GDM incidence with probiotic supplementation, although substantial heterogeneity was present.

Another 2024 meta-analysis involving **15 RCTs and 1,006 patients with GDM** reported improvements in

fasting blood glucose, fasting insulin and HOMA-IR, together with selected neonatal outcomes.

A separate 2024 meta-analysis also reported metabolic improvements associated with probiotic intervention in GDM.

However, earlier evidence had been inconsistent. A previous meta-analysis of six RCTs found no significant benefit for prevention of GDM.

This progression illustrates an important principle: **the apparent efficacy of probiotics can change as additional trials accumulate**.

Clinical interpretation

Probiotics may have potential in improving metabolic parameters during pregnancy, but further large, standardized RCTs are needed before routine clinical recommendations can be made.

12. Probiotics and Hyperlipidaemia

The lipid-lowering potential of probiotics has also been examined.

A 2024 systematic review and meta-analysis assessed probiotic effects on lipid profiles in hyperlipidaemic and healthy populations. The available evidence suggests potential improvements in selected lipid parameters, although effect sizes are generally modest and heterogeneous.

Earlier meta-analytic evidence involving probiotic yogurt also suggested reductions in total and LDL cholesterol among individuals with mild-to-moderate hypercholesterolaemia.

Possible mechanisms include:

- bile salt deconjugation;
- altered cholesterol metabolism;
- microbial transformation of bile acids;
- modulation of intestinal lipid absorption.

More strain-specific trials are required to establish whether probiotics can produce clinically meaningful cardiovascular risk reduction.

13. Probiotics in Periodontitis and Gingivitis

The oral cavity represents another important microbial ecosystem in which probiotics have been investigated.

A 2025 systematic review and meta-analysis evaluated probiotics in gingivitis and periodontitis. The evidence suggested improvements in selected periodontal outcomes, particularly **plaque index and bleeding on probing** in periodontitis.

A strain-focused systematic review of **Lactiplantibacillus plantarum** also reported potential benefits in periodontal outcomes, including reductions in pocket depth and bleeding on probing. The same review found effects on selected gastrointestinal and inflammatory outcomes, illustrating the broad clinical research interest in specific probiotic strains.

Clinical interpretation

Probiotics may be useful as **adjuncts to scaling, root planing and standard periodontal care**, but they should not be considered replacements for established dental treatment.

14. Probiotics and Atopic Dermatitis

Atopic dermatitis is a chronic inflammatory skin condition in which interactions between the immune system and microbiota may contribute to disease severity.

A 2024 systematic review and meta-analysis of double-blind, randomized, placebo-controlled studies reported that topical probiotic interventions reduced atopic dermatitis severity.

A 2025 meta-analysis of seven RCTs in adults reported a statistically significant reduction in SCORAD values following probiotic supplementation.

Earlier evidence also indicated potential benefits of particular strains such as **Lactobacillus salivarius**, **L. acidophilus** and **L. plantarum**, while responses differed between strains.

Interpretation

Probiotics may have a role in reducing disease severity in selected patients with atopic dermatitis, but strain-specific evidence and standardized treatment protocols remain necessary.

15. Probiotics and Cognitive Function

The gut–brain axis has generated increasing interest in the possible role of probiotics in cognitive health.

A 2025 systematic review and meta-analysis evaluated **34 randomized clinical trials involving 2,390 participants** and examined cognitive outcomes using standardized tools including MMSE and MoCA.

A 2025 meta-analysis across different stages of the human lifespan suggested that cognitive benefits may be more apparent in older populations, including outcomes involving overall cognition, processing speed and memory.

An umbrella review published in 2025 concluded that some associations between probiotics and cognitive outcomes were supported by moderate-to-high quality evidence but emphasized the need for further trials examining strain, dose and duration.

Potential mechanisms

The gut–brain effects of probiotics may involve:

- microbial metabolites;
- short-chain fatty acids;
- immune modulation;
- reduction of systemic inflammation;
- gut barrier integrity;
- neuroactive microbial compounds.

However, cognitive effects remain an emerging area of clinical research.

16. Comparative Evidence of Probiotic Efficacy

Health condition	Recent evidence	Main outcomes	Overall interpretation
Irritable bowel syndrome	Multiple 2024 systematic reviews/meta-analyses	Symptoms, abdominal pain, QoL	Promising but heterogeneous
Ulcerative colitis	RCT meta-analyses	Remission, relapse	Potential adjunctive benefit
Crohn's disease	IBD systematic reviews	Clinical remission	Evidence insufficient/inconsistent
Constipation	2024 meta-analysis	Stool-related outcomes	Potential benefit; high heterogeneity
Acute/persistent diarrhoea	2024 systematic review	Duration/severity of diarrhoea	Strain- and population-dependent
Type 2 diabetes	2024–2025 systematic reviews	Glycaemic/metabolic markers	Potential metabolic benefit
Gestational diabetes	2024 RCT meta-analyses	Glucose, insulin resistance	Promising but inconsistent
Hyperlipidaemia	2024 meta-analysis	Lipid profile	Modest potential benefit
Periodontitis	2025 meta-analysis	Plaque, bleeding	Promising adjunct
Atopic dermatitis	2024–2025 meta-analyses	SCORAD/severity	Potential benefit
Cognitive	2025	MMSE,	Emerging

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Health condition	Recent evidence	Main outcomes	Overall interpretation	Condition	Review evidence	Participants/ studies	Major finding
function	meta-analyses	MoCA, memory	evidence				HOMA-IR
17. Detailed Evidence from Recent Randomized Controlled Trial Reviews				Periodontitis/gingivitis	Benavides-Reyes et al., 2025	24 studies	Improvements in selected periodontal outcomes
Condition	Review evidence	Participants/ studies	Major finding	Cognitive function	Calzadas-Gonzales et al., 2025	2,390 / 34 RCTs	Evaluated cognitive performance and safety
IBS	Yang et al., 2024	3,011 / 20 studies	Improved global symptoms and QoL; high heterogeneity	Atopic dermatitis	2025 meta-analyses	7 RCTs in adults	Reduced SCORAD
IBS	Almabruk et al., 2024	Systematic review/meta-analysis	Improved stool habits and QoL, especially IBS-D	18. Safety and Tolerability			
UC	Wang et al., 2024	930 / 13 RCTs	Reduced relapse among patients in remission	Overall, probiotics have demonstrated a generally favorable safety profile in the populations studied. For IBS, the 2024 meta-analysis found no significant difference in adverse-event frequency between probiotics and placebo. Similarly, evidence in UC did not demonstrate a significant increase in general adverse events. However, safety cannot be assumed to be identical across all populations. A 2025 systematic review of Lactobacillus rhamnosus noted generally favorable safety in healthy individuals but highlighted the need for caution in specific populations, including critically ill patients and certain vulnerable groups. Therefore, clinical use should consider:			
Constipation	Garzon Mora et al., 2024	1,243 / 10 studies	Significant effect favoring probiotics	• immune status; • severity of underlying disease; • age; • pregnancy; • hospitalization; • probiotic strain; • dose; • concurrent medication.			
Childhood diarrhoea	Minaz et al., 2024	Systematic review/meta-analysis	Evaluated efficacy in acute/persistent diarrhoea	19. Factors Determining Probiotic Efficacy			
GDM	Li et al., 2024	3,527 / 14 studies	Reduced GDM incidence; high heterogeneity	19.1 Strain specificity			
GDM	Wu et al., 2024	1,006 / 15 RCTs	Improved FBG, fasting insulin and	One of the most important principles in probiotic research is that efficacy is strain-specific . Evidence for one strain cannot automatically be applied to all strains of the same species.			

19.2 Dose

Higher doses may be beneficial in selected conditions, but increased dose does not necessarily produce a proportional clinical response.

19.3 Duration

Treatment duration may influence outcomes. Short-term interventions may be adequate for some symptoms, whereas chronic conditions may require longer exposure.

19.4 Single versus multi-strain formulations

Multi-strain products may provide broader microbial functionality, but their effects require direct clinical comparison with single-strain products.

19.5 Patient characteristics

Age, diet, baseline microbiome, disease severity, medication and metabolic status can influence response.

19.6 Delivery vehicle

Capsules, powders, fermented foods, probiotic yogurt, lozenges and topical preparations may have different effects on viability and clinical delivery.

19.7 Baseline microbiota

The resident microbiome may determine whether an administered strain can successfully survive, colonize or function within the host.

20. Major Limitations of Existing Clinical Trials

Despite the rapidly growing evidence base, several limitations remain.

20.1 Heterogeneity of probiotic preparations

Different studies frequently use different species, strains and combinations.

20.2 Inconsistent dosage

The dose may vary considerably across trials.

20.3 Variable duration

Short intervention periods may not capture long-term benefits or adverse effects.

20.4 Small sample sizes

Many RCTs are underpowered to detect clinically meaningful effects.

20.5 Inconsistent clinical endpoints

Studies may use different symptom scores, biochemical markers or disease activity indices.

20.6 Inadequate strain reporting

Some studies report species without providing adequate strain-level information.

20.7 Limited long-term evidence

Long-term maintenance of probiotic benefits is insufficiently studied.

20.8 Publication and methodological bias

Positive studies may be more likely to be published, and methodological differences can affect pooled estimates.

21. Research Gaps

Future research should focus on:

1. **Strain-specific clinical trials**
2. Standardized probiotic dose reporting
3. Standardized CFU reporting
4. Longer follow-up periods
5. Large multicenter RCTs
6. Disease-specific probiotic formulations
7. Personalized probiotic interventions
8. Microbiome profiling before and after intervention
9. Probiotic–drug interactions
10. Cost-effectiveness analysis
11. Patient-reported outcomes
12. Standardized adverse-event monitoring
13. Comparative studies of single versus multi-strain preparations
14. Integration of diet and probiotic interventions
15. Development of precision nutrition approaches

22. Future Perspective: Toward Precision Probiotics

The future of probiotic research is likely to move from generalized supplementation toward **precision probiotic therapy**.

Instead of asking:

“Do probiotics work?”

future research should ask:

“Which strain or combination works, at what dose, for which patient, with which disease, and for which clinical outcome?”

Integration of:

Host characteristics + microbiome profile + diet + probiotic strain + dose + clinical phenotype

may allow personalized probiotic interventions.

This approach is particularly relevant to nutrition science because dietary patterns, fermented foods, prebiotic substrates and probiotic organisms interact within the broader intestinal ecosystem.

23. Conclusion

The contemporary clinical evidence indicates that probiotics have **selective rather than universal efficacy**.

The most consistent evidence is currently observed in selected gastrointestinal conditions such as IBS and ulcerative colitis, where probiotics may improve symptoms, quality of life or remission-related outcomes. Evidence also supports potential benefits in constipation and selected diarrhoeal disorders.

Emerging evidence indicates possible metabolic effects in type 2 diabetes and gestational diabetes, selected lipid-lowering effects, periodontal benefits, improvements in atopic dermatitis severity and potential cognitive benefits.

Nevertheless, the magnitude and consistency of benefit vary substantially between studies. The major challenge is the considerable heterogeneity in **strain, dose, formulation, intervention duration, population and outcome measures**.

Therefore, probiotics should be regarded as **condition-specific and strain-specific adjunctive interventions**, rather than universal treatments. High-quality randomized controlled trials with standardized protocols, adequate sample sizes, longer follow-up and precise strain characterization are required to strengthen clinical recommendations.

The future of probiotic research lies in combining **clinical nutrition, microbiome science, molecular characterization and personalized medicine** to identify the right probiotic intervention for the right individual and the right health condition.

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25. A recent 2026 umbrella review synthesized **128 systematic reviews/meta-analyses of**

randomized trials and concluded that probiotic/biotic benefits are selective and depend strongly on condition, strain and population, reinforcing the need for standardized clinical research.

25. Proposed Conceptual Framework

Probiotic intervention

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Strain / dose / formulation / duration

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Modulation of microbiota

↓

Gut/oral barrier + immune modulation + microbial metabolites

↓

Changes in inflammation / metabolism / gut–brain signaling

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Clinical outcomes

IBS symptoms | UC remission | bowel function | glycaemic control | lipid profile | periodontal health | skin severity | cognitive outcomes

↓

Improved health and quality of life

26. Key Message

The evidence supports a shift from the traditional concept of “**probiotics as universally beneficial microorganisms**” toward a more scientifically precise model:

Right strain + right dose + right patient + right condition + right duration = clinically meaningful probiotic benefit.

This principle should guide future clinical trials, product development and evidence-based nutritional practice.