

Probiotics and Disease: A Comprehensive Summary—Part 5, Respiratory Conditions of the Ears, Nose, and Throat

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Abstract

This article series provides a literature review of the disease-specific probiotic strains studied in published clinical trials in humans and animals. The goal of the series is to provide clinically useful tools. The table design allows for quick access to supportive data and will be helpful as a guide for both researchers and clinicians. The first article (part 1) focused on mental health and neurological conditions and the second article (part 2) explored cultured and fermented foods that are commonly available in the United States. The third article (part 3) explored the relationship between bacterial strains and 2 of the most prevalent diseases we have in modern society, cardiometabolic disease and

fatigue syndromes. The fourth article (part 4) elucidated the role of the microbiome in infectious diseases, and this fifth article (part 5) investigates probiotic strains on respiratory conditions that affect the ears, nose, and throat. Future articles will review conditions related to autoimmunity and dermatological conditions; the influence of the microbiome on cancer development and prognosis; gastrointestinal and genitourinary diseases associated with dysbiosis conditions; followed by an article focused on probiotic supplements. This literature review is specific to disease condition, probiotic classification, and individual strain.

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We investigated disease-specific probiotic strains associated with infectious conditions of the respiratory tract and those of the ears, nose, and throat. This is not an exhaustive review. Considerable research exists on the gut microbiome and role of probiotics; however, this research has not been clearly connected with clinical practice. The authors undertook a review of current literature to explore which specific probiotics and probiotic strains have been used in clinical and laboratory studies. To make this clinically valuable, product names of probiotics and fermented foods have been included. Finished products may vary between

manufacturers; therefore, the researchers included brand listings to provide transparency and to facilitate a functional probiotics guide for clinicians. Exclusions of products meeting our criteria do not imply that these products are not effective—we simply were not aware of them.

Methodology

This literature review originated from a group project that was part of the requirements for a course in the doctoral program in functional and clinical nutrition at Maryland University of Integrative Health (Laurel, MD, USA). The student researchers had approximately 2 months to review the literature and synthesize the paper. The authors agreed on format, templates, and execution. Each author researched and wrote sections reviewing probiotics in relation to various health conditions with literature searches conducted in PubMed, Biomed Central, EBSCO Research Premier, PloS One, Cochrane reviews, and topic-specific open-source journals.

The review of specific probiotic products in the professional marketplace and specific probiotics products was performed using Internet searches, primarily Shop Google, in addition to topic-specific databases to search for specific probiotic species including the strains listed in the research. Novel strains were cross-referenced to

determine whether the strain was available only for research purposes. If a probiotic combination was used in the research, formulas that closely matched the combination were included. Formulas that contain all or most of the specific probiotics and strains were also included. The food survey focused on bacterial strains in food and includes foods that are commercially produced and commonly available in the refrigerated sections of grocery stores in the United States. Information was gleaned from commercial Web sites and by visiting grocery stores (primarily in California).

Probiotics in Ears, Nose, and Throat; Oral Health; and Respiratory Tract

The respiratory tract includes the larynx, nasal cavity, bronchi, and trachea and is composed of mucosal tissue consisting of multiple forms of epithelial cells.¹ Probiotics modulate both the innate and adaptive immune systems at the mucosal level and as well as systemically.² Their disease-modulating effects may be strain and location dependent; thus, applications are site specific. Furthermore, the composition of microbiota in the mucosal tissue varies considerably in each location (ie, oral flora differs from vaginal flora), increasing the specificity of intervention.²

Although some strains of probiotics exert action specific mechanisms to the location of the body and specific microbes (ie, *Streptococcus salivarius* MK12 for group A strep in the throat and ears), it appears from our review on probiotic strains that some strains exhibit multiple benefits for different locations such as *Lactobacillus rhamnosus* GG and *Lactobacillus reuteri*. For instance, *L reuteri* reduces plaque and gingival inflammation,³ and when combined with *Lactobacillus* GG (LGG) and *Bifidobacterium breve*, it reduced airway hyper-responsiveness in a murine model of asthma.⁴ *L rhamnosus* was associated with reduced incidence of upper respiratory tract infections in children⁵ and when used with *Lactobacillus casei* helped to decrease colonization and infection from *Pseudomonas aeruginosa* in ventilator-associated pneumonia.⁶ In general, it appears that using a multistrain probiotic would benefit most areas of the oral cavity; ear, nose, and throat; and respiratory tract. However, certain strains such as *L reuteri* and *S salivarius* are not present in many multistrain probiotics and require additional supplementation.

Table 1. Ears, Nose, and Throat; Oral Health; and Respiratory Tract

Ears, Nose, and Throat/ Oral Health/ Respiratory	Strains	Overview	Professional and Commercial Products	Foods
Gingivitis/Periodontitis				
Allaker & Douglas ⁷ (2015)	<i>L rhamnosus</i> CG, <i>L casei</i> , <i>Bifidobacterium</i> DN-173- 0101	<i>L rhamnosus</i> , <i>L casei</i> , <i>Bifidobacterium</i> have been shown to alter coloniza- tion of cariogenic plaque and prevent dental carries.	Probiotic Synergy (Designs for Health) Prodegin Chewable (Klaire Labs; <i>L acidophilus</i> , <i>L rhamnosus</i> , <i>L salivarius</i> , <i>L paracasei</i> , <i>L plantarum</i>) Many combination probiotic products exist on the market with these similar strains such as Flora 50-14 (Innate Response).	<i>L casei</i>: Nancy’s Organic cow’s milk yogurt, all kefirs <i>L rhamnosus</i> GG: Strains in multistrain products are similar to cultures used in many kefirs. Check ingredients lists for specific strains.
Allaker & Ian ³ (2015)	<i>L reuteri</i> DSM17938	<i>L reuteri</i> was shown to reduce plaque levels and gingival inflammation in subjects.	<i>L reuteri</i> (Nature’s Way) Probiotic Synergy (Designs for Health)	Fermented milks Soy milk Zukay Live Foods veggie kvass, fruit kvass Almond Dream nondairy yogurt Amande cultured almond milk Nancy’s Organic cultured soy Dahlicious cow’s milk lassi DanActive Green Valley Organics lactose- free kefir Nancy’s Organic lowfat plain kefir Redwood Hill Farm goat milk kefir

Table 1. (continued)

Ears, Nose, and Throat/ Oral Health/ Respiratory	Strains	Overview	Professional and Commercial Products	Foods
Szkaradkiewicz et al ⁸ (2014)	<i>L reuteri</i> Prodentis ATCCPTA5289	<i>L reuteri</i> Prodentis decreased inflammation and decreased bleeding and probing depth and clinical attachment in periodontitis. Confirmed antimicrobial activity and antiplaque activity.	Isolated for research purposes only.	None
Nissen et al ⁹ (2014)	<i>L salivarius</i> OMZ520 + <i>L gasseri</i> OMZ525	<i>L salivarius</i> and <i>L gasseri</i> strongly attenuated 2 bacterial toxins associated with periodontitis.	<i>L salivarius</i>, <i>L gasseri</i>: Exact strains not verified in products.	None
Comelli et al ¹⁰ (2002)	<i>S thermophiles</i> MCC1561, <i>L lactis</i> NCC2211	<i>S thermophiles</i> MCC1561 and <i>L lactis</i> NCC2211 modulated the growth and prevented colonization of gingival-promoting bacteria.	Isolated for research purposes only.	None
Comelli et al ¹⁰ (2002)	<i>S salivarius</i> M18	<i>S salivarius</i> M18 produces bacteriocins targeting the cariogenic species <i>S mutans</i> , as well as dextranase and urease, which could help reduce dental plaque accumulation and acidification.	FLORASSIST Oral Hygiene (Life Extension; <i>S salivarius</i> M18)	None
Strep Throat/Pharyngitis				
Di Pierro et al ¹¹ (2013)	<i>S salivarius</i> K12	<i>S salivarius</i> K12 with 90-d treatment in adults showed 60% reduction in reported pharyngitis for 6 mo after. Antagonizes. Previously shown to inhibit the growth of <i>S pyrogenes</i> .	<i>S salivarius</i> K12: ENT Biotic Lozenge (Protocols for Life Balance) Florassist Throat Health (Life Extension) Maximum Strength Ultra Probiotics (Nature's Plus) Citrus Oral Care Probiotics (TheraBreath) TrueOC Quick Melt Oral Care Probiotics (NatureCity) PRO-Dental (Hyperbiotics) ProENT (Rightway Nutrition) Blis K12 Throat Guard Daily (BLIS Technologies Ltd) Chewable Chewable Children's oral probiotic-Children's Oral Probiotic7 Strains with BLIS K12 & M18 (Great Oral Health) Clinical Grade Oral Probiotics (PUR Nutraceuticals)	None
Di Pierro et al ¹² (2014)	<i>S salivarius</i> K12	RTC trial among 60 children using <i>S salivarius</i> K12, 31 participants, 1 billion CFU for 90 d, showed significant reduction of strep/pharyngitis episodes in subjects with recurrent infections. Colonizes the oral cavity.	<i>S salivarius</i> K12: ENT Biotic Lozenge (Protocols for Life Balance) Florassist Throat Health (Life Extension) Maximum Strength Ultra Probiotics (Nature's Plus) Citrus Oral Care Probiotics (TheraBreath) True OC Quick Melt Oral Care Probiotics (NatureCity) PRO-Dental (Hyperbiotics) ProENT (Rightway Nutrition) Blis K12 Throat Guard Daily (BLIS Technologies Ltd) Chewable Children's oral probiotic -7 Strains with BLIS K12 & M18 (Great Oral Health)	None

Table 1. (continued)

Ears, Nose, and Throat/ Oral Health/ Respiratory	Strains	Overview	Professional and Commercial Products	Foods
Gregori et al ¹³ (2016)	<i>S salivarius</i> K12	Retrospective observational study on 130 children with recurrent group A beta hemolytic strep, 76 treated for 90 d, 1 billion CFU, showed significant reduction in recurrence, even 9 mo after treatment.	<i>S salivarius</i> K12: ENT Biotic Lozenge (Protocols for Life Balance) Florassist Throat Health (Life Extension) Maximum Strength Ultra Probiotics (Nature's Plus) Citrus Oral Care Probiotics (TheraBreath) True OC Quick Melt Oral Care Probiotics (NatureCity) PRO-Dental (Hyperbiotics) ProENT (Rightway Nutrition) Blis K12 Throat Guard Daily (BLIS Technologies Ltd) Chewable Children's oral probiotic Chewable Children's Oral Probiotics-7 Strains with BLIS K12 & M18 (Great Oral Health)	None
Colds/Influenza				
Allan & Arroll ⁵ (2014)	<i>L casei</i> DN114-001	Prevention of colonization of pathogens, modulation of immune system.	<i>L casei</i> family can be found in many multistrain probiotics but it might not be the exact strain number. Examples include: Ther-biotic Complete Innate Response Flora 14-50 Ultra-Flora Immune Boost (Metagenics)	None
Allan & Arroll ⁵ (2014)	<i>L rhamnosus</i> GG	Study in 42 children admitted to hospital and randomly assigned a fermented drink with <i>L rhamnosus</i> GG had reduced incidence of upper respiratory incidents during their stay.	Available in many multistrain probiotic formulas. Examples include: Ther-biotic Complete Innate Response Flora 14-50	Strains in multistrain products are similar to cultures used in many kefirs. Check ingredients lists for specific strains.
Davidson et al ¹⁴ (2011)	<i>L rhamnosus</i> GG	Children at day care centers had reduced incidence and duration of upper respiratory infections.	Probiotic <i>Lactobacillus</i> GG (Walgreens)	Strains in multistrain products are similar to cultures used in many kefirs. Check ingredients lists for specific strains.
Davidson et al ¹⁴ (2011)	<i>L casei</i>	In RCT, older adults given this strain had higher influenza-specific titers increased after vaccination.	Available in multistrain probiotics.	<i>L casei</i>: Nancy's Organic cow's milk yogurt, all kefirs
Davidson et al ¹⁴ (2011)	<i>L fermentum</i> CECT5716	In healthy adult, <i>L fermentum</i> improved influenza vaccine immunogenicity.	Isolated for research purposes only.	Unknown
de Vrese et al ¹⁵ (2005)	<i>L gasseri</i> PA16/8 + <i>B longum</i> SP07/3m + <i>B bifidum</i> MG20/5	RCT showed these strains taken for 3 mo significantly shortened common cold episodes by 2 d and reduced severity of symptoms.	Isolated for research purposes only.	Unknown
Leyer et al ¹⁶ (2009)	<i>L acidophilus</i> + <i>B animalis</i> subsp <i>lactis</i>	Reduced incidence of respiratory infections, antibiotic use, fever, coughs, days of missed school, reduction of days of hospitalization.	Pharmax HLC Baby B	Unknown
Reksuppaphol et al ¹⁷ (2012)	General probiotic supplementation	There are a limited number of studies on using probiotics in colds and influenza. They are thought to provide immunomodulatory effects and prevent colonization of pathogens so may serve in a preventive capacity.	Multiple brands and multistrain blends.	Commonly found in fermented foods and beverages.

Table 1. (continued)

Ears, Nose, and Throat/ Oral Health/ Respiratory	Strains	Overview	Professional and Commercial Products	Foods
Waki et al ¹⁸ (2014)	<i>L brevis</i> KB290	6 billion CFU given daily to elementary school aged children and showed significant reduction in incidence of influenza, especially in unvaccinated children.	Isolated for research purposes only.	Probiotic drink containing <i>L brevis</i> KB290 (KB290), isolated from a traditional Japanese pickle, <i>suguki</i> .
Asthma				
Drago et al ¹⁹ (2015)	<i>L salivarius</i> LSO1 + <i>B brevis</i> BR03	In vitro on saliva of asthmatic subject, a combination of these strains was able to downregulate proinflammatory cytokines by peripheral blood monocytes, which may lead to rebalancing of T _h 1/T _h 2 ratio and improvement of symptoms.	B brevis BR03: <i>Bifidus</i> Balance + FOS (Jarrow Formulas)	None
Mortaz et al ²⁰ (2013)	<i>E faecalis</i> FK-23	<i>E faecalis</i> shown to suppress asthmatic response.	Isolated for research purposes only.	None
Mortaz et al ²⁰ (2013)	<i>L reuteri</i> + LGG + <i>B brevis</i>	In a murine model of asthma, <i>L reuteri</i> + <i>B brevis</i> decreased airway hyper-responsiveness, number of inflammatory cells in bronchoalveolar fluid and inflammation of lung tissue.	<i>L reuteri</i> (Nature's Way) <i>L reuteri</i> Plus with <i>L rhamnosus</i> , <i>L acidophilus</i> & FOS (Swanson) <i>L rhamnosus</i> GG (Culturelle) Probiotic <i>L rhamnosus</i> GG (Walgreens) Advanced Multi-Billion Dophilus (Solgar; <i>L rhamnosus</i> GG) Most multistrain probiotic blends.	B brevis: None L reuteri: None LGG: None
Mortaz et al ²¹ (2015)	<i>B brevis</i>	<i>B brevis</i> + prebiotic suppressed airway inflammation in chronic asthma in murine model. May help explain the link between gut and respiratory system.	<i>B brevis</i> found in many multistrain products.	None
Sagar et al ²² (2014)	<i>B brevis</i> M16 + <i>L rhamnosus</i>	<i>B brevis</i> M16 + <i>L rhamnosus</i> in a mouse model showed strong anti-inflammatory properties comparable to budesonide.	B brevis M-16V: Jarro-Dophilus EPS (Jarrow)	None
van de Pol et al ² (2011)	<i>B brevis</i> M-16V + prebiotic	<i>B brevis</i> M-16V + prebiotic in infants with atopic dermatitis demonstrated less frequent wheezing, less asthma medication use. This combination significantly decreased T _h 2 cytokine production and improved peak expiratory flow in adults with asthma.	B brevis M-16V: Jarro-Dophilus EPS (Jarrow)	None
Wu et al ²³ (2014)	<i>L rhamnosus</i> GG	LGG had an anti-inflammatory effect on OVA-induced airway inflammation in a mouse model.	Probiotic LGG (Walgreens) Advanced Multi-Billion Dophilus (Solgar)	Strains in multistrain products are similar to cultures used in many kefirs. Check ingredients lists for specific strains.
Pneumonia				
Forestier et al ⁶ (2008)	<i>L casei</i> <i>L rhamnosus</i>	In RCT pilot study on 17 subjects, <i>L casei</i> and <i>L rhamnosus</i> significantly delayed occurrence and colonization/infection of ventilator-associated pneumonia by <i>P aeruginosa</i> .	L casei: MegaFlora (MegaFood) PerioBiotic Toothpaste (Designs for Health; <i>L casei</i>) Ther-Biotic Complete (Klaire Labs) NOW Gr8 (Dophilus) Flora (Udo's Choice) Super 5 Lozenge Probiotic	L casei: Nancy's Organic cow's milk yogurt, all kefirs L rhamnosus: Almond Dream nondairy yogurt, Amande cultured almond milk, Trader Joe's cultured coconut milk, Nancy's Organic cultured soy, Nancy's Organic cow's milk yogurt, all kefirs, Kevita kombucha, and sparkling probiotic drinks
Morrow et al ²⁴ (2010)	<i>L rhamnosus</i> GG	In a blinded RCT, prophylactic use of <i>L rhamnosus</i> GG reduced the incidence of ventilator-associated pneumonia and <i>C difficile</i> - associated diarrhea in high-risk ICU population.	Probiotic LGG (Walgreens) Advanced Multi-Billion Dophilus (Solgar)	Strains in multistrain products are similar to cultures used in many kefirs. Check ingredients lists for specific strains.

Table 1. (continued)

Ears, Nose, and Throat/ Oral Health/ Respiratory	Strains	Overview	Professional and Commercial Products	Foods
Mortaz et al ²⁰ (2013)	<i>L rhamnosus</i> CRL1505 (Lr05)	<i>L rhamnosus</i> Lr05 was able to significantly reduce the number of <i>S pneumonia</i> in the lung and prevent dissemination into the blood.	Isolated for research purposes only.	None
Mortaz et al ²⁰ (2013)	<i>L casei</i>	<i>L casei</i> increased rate of clearance of <i>P aeruginosa</i> from the lungs with 2-d prior administration.	<i>L casei</i>: MegaFlora (MegaFood) PerioBiotic Toothpaste (Designs for Health; <i>L casei</i>) Ther-Biotic Complete (Klaire Labs) NOW Gr8 (Dophilus) Flora (Udo's Choice) Super 5 Lozenge Probiotic	<i>L casei</i>: Nancy's Organic cow's milk yogurt, all kefirs.
Wang et al ²⁵ (2014)	<i>L casei</i> , <i>L acidophilus</i> + <i>B subtilis</i> + <i>E faecalis</i>	In a double-blind RCT on 100 full term infants, <i>L casei</i> , <i>L acidophilus</i> , <i>Bacillus subtilis</i> , <i>E faecalis</i> significantly reduced rate of nosocomial pneumonia and multiple organ dysfunction syndrome in critically ill infants.	<i>L casei</i>: MegaFlora (MegaFood) PerioBiotic Toothpaste (Designs for Health; <i>L casei</i>) Ther-Biotic Complete (Klaire Labs) NOW Gr8 (Dophilus) Flora (Udo's Choice) Super 5 Lozenge Probiotic <i>E faecium</i>: Enterogenic Concentrate (Integrative Therapeutics) Ultimate Probiotic (4 billion; Nature's Secret) Health-Bac 100 grams (North American Herb & Spice)	<i>L acidophilus</i>: Lassi, kefir, yogurt <i>L casei</i>: Nancy's Organic cow's milk yogurt, all kefirs
Wong et al ²⁶ (2013)	<i>L rhamnosus</i> GG (LGG)	<i>S pneumonia</i> colonization of nasopharynx occurs prior to pneumococcal infections including pneumonia. LGG significantly inhibited the adherence of <i>S pneumonia</i> and was more effective when a higher dose was used.	Probiotic LGG (Walgreens) Advanced Multi-Billion Dophilus (Solgar)	Strains in multistrain products are similar to cultures used in many kefirs. Check ingredients lists for specific strains.
Chronic Obstructive Pulmonary Disease				
Mortaz et al ²⁰ (2013)	<i>L casei</i> Shirota	<i>L casei</i> Shirota increases NK cells in smokers.	<i>L casei</i> Shirota: Unavailable	<i>L casei</i> Shirota: Yakult
Mortaz et al ²⁰ (2013)	<i>L plantarum</i>	<i>L plantarum</i> decreases CVD in smokers.	<i>L plantarum</i>: Dr Formulated Probiotics (Garden of Life) Adult's Probiotic (Flora) Jarro-Dophilus Plus FOS (Jarrow Formulas) Maximum Strength Ultra Probiotics (Nature's Plus)	<i>L plantarum</i>: Fermented vegetables, Kevita probiotic drinks, olives (green)
Mortaz et al ²⁰ (2013)	<i>L rhamnosus</i> + <i>B breve</i>	<i>L rhamnosus</i> + <i>B breve</i> decreased release of proinflammatory mediators in macrophages when exposed to smoke.	<i>L rhamnosus</i> + <i>B breve</i>: Jarro-Dophilus EPS (Jarrow Formulas) Probiotic All-Flora (New Chapter) Ultimate Flora Critical Care (50 billion; Renew Life) Primal Defense Ultra (Garden of Life) iFlora (Sedona Labs) Nexabiotic (Bioprosper Labs)	<i>L rhamnosus</i>: Almond Dream nondairy yogurt, Amande cultured almond milk, Trader Joe's cultured coconut milk, Nancy's Organic cultured soy, Nancy's Organic cow's milk yogurt, all kefirs, Kevita kombucha, and sparkling probiotic drinks
Cystic Fibrosis				
Bruzzese et al ²⁷ (2014)	<i>Lactobacillus</i> GG	In an RCT of 22 children with CF, LGG restored gut microbiota. This supports the efficacy that probiotics reduce gut inflammation and pulmonary exacerbations.	<i>Lactobacillus</i> GG): Probiotic LGG (Walgreens) Advanced Multi-Billion Dophilus (Solgar) iHealth (Culturelle)	Strains in multistrain products are similar to cultures used in many kefirs. Check ingredients lists for specific strains.
Di Nardo et al ²⁸ (2014)	<i>L reuteri</i>	<i>L reuteri</i> when given to CF patients for 6 mo had significantly fewer pulmonary exacerbations and respiratory infections such as otitis.	<i>L reuteri</i> (Nature's Way) <i>L reuteri</i> Plus with <i>L rhamnosus</i> , <i>L acidophilus</i> , & FOS (Swanson)	None

Table 1. (continued)

Ears, Nose, and Throat/ Oral Health/ Respiratory	Strains	Overview	Professional and Commercial Products	Foods
Jafari et al ²⁹ (2013)	Multistrain product: <i>L casei</i> , <i>L rhamnosus</i> , <i>S thermophilus</i> , <i>B breve</i> , <i>L acidophilus</i> , <i>B infantis</i> , <i>L bulgaricus</i>	In a prospective RCT on 37 patients with CF, 20 patients took probiotic supplement for 1 mo containing <i>L casei</i> , <i>L rhamnosus</i> , <i>S thermophilus</i> , <i>B breve</i> , <i>L acidophilus</i> , <i>B infantis</i> , and <i>L bulgaricus</i> . The probiotic group developed significantly fewer pulmonary exacerbations during the next 3 mo and even after.	All strains except <i>L bulgaricus</i>, <i>L reuteri</i>, and <i>L rhamnosus</i> GG: Nexabiotic (Bioprosper Labs) <i>B breve</i>: Ther-Biotic Factor 4 (Bifidobacterium Complex; Klaira Labs) <i>L reuteri</i> (Nature's Way) <i>L reuteri</i> Plus with <i>L rhamnosus</i> , <i>L acidophilus</i> , & FOS (Swanson)	<i>Lactobacillus</i> strains in multistrain products are similar to cultures used in many kefir. Check ingredients lists for specific strains.
Otitis Media				
Di Pierro et al ³⁰ (2015)	<i>S salivarius</i> K12 is the main species showing decreased incidence.	Many studies did not find a benefit of taking probiotics on the recurrence of otitis media except for the use of <i>S salivarius</i> K12 (also helpful with strep throat). A nasal spray of <i>S salivarius</i> 24SMB was also shown to be helpful with otitis media.	<i>S salivarius</i> K12: ENT Biotic Lozenge (Protocols for Life Balance) Florassist Throat Health (Life Extension) Maximum Strength Ultra Probiotics (Nature's Plus) Citrus Oral Care Probiotics (TheraBreath) TrueOC Quick Melt Oral Care Probiotics (NatureCity) PRO-Dental (Hyperbiotics) ProENT (Rightway Nutrition)	None
Di Pierro et al ³⁰ (2015)	<i>S salivarius</i> K12	In 21 children, <i>S salivarius</i> K12 showed a reduction in otitis media when given for 90 d.	<i>S salivarius</i> K12: ENT Biotic Lozenge (Protocols for Life Balance) Florassist Throat Health (Life Extension) Maximum Strength Ultra Probiotics (Nature's Plus) Citrus Oral Care Probiotics (TheraBreath) TrueOC Quick Melt Oral Care Probiotics (NatureCity) PRO-Dental (Hyperbiotics) ProENT (Rightway Nutrition)	None
Marchisio et al ³¹ (2015)	<i>S salivarius</i> 24SMB nasal spray	In a prospective RCT on 100 children, 50 children in the treated groups received intranasal spray with <i>S salivarius</i> 24SMB for 5 d of each month for 3 mo. The treated children showed significant decrease in acute otitis media and antibiotic use.	Isolated for research purposes only.	None
Wong et al ²⁶ (2013)	<i>L rhamnosus</i> GG (LGG)	<i>L rhamnosus</i> GG showed a decreased incidence of otitis media in CF patients.	<i>L rhamnosus</i> GG: Probiotic LGG (Walgreens) Advanced Multi-Billion Dophilus (Solgar) iHealth (Culturelle)	Strains in multistrain products are similar to cultures used in many kefir. Check ingredients lists for specific strains.

Abbreviations: CF, cystic fibrosis; CFU, colony-forming unit; CVD, cardiovascular disease; FOS, fructooligosaccharides; ICU, intensive care unit; LGG, *Lactobacillus rhamnosus* GG; NK, natural killer; OVA, ovalbumin; RCT, randomized controlled trial.

Research Overview: Probiotics in Ears, Nose, and Throat; Oral Health; and Respiratory Tract

Probiotics have the potential to beneficially affect the overall health of the oral cavity, ear, nose, throat, and respiratory mucosa. Probiotics improve barrier function, affect both the innate and adaptive immune systems, and have a beneficial effect on a wide variety of inflammatory diseases.⁴

The oral cavity consists of the nasopharynx, larynx, tonsils, sinuses, and ears and has trans-mucosal surfaces through the Eustachian tubes and the gastrointestinal tract.³² The respiratory tract is specific to the larynx, nasal cavity, bronchi, and trachea.¹ Due to interconnectedness and proximity of these systems, bacteria can freely travel along mucosal surfaces. In this way, bacteria from the respiratory system and the oral cavity can ultimately result in wide-spread inflammation and disease.³³

An example of this is periodontitis. Periodontitis is an oral cavity infection of the gums that can alter not only the oral microbiome, but also the intestinal microbiome, thus triggering systemic inflammation and immune activation. Periodontal infections are classically associated with cardiovascular disease.³³ The probiotics reviewed that were particularly beneficial to oral health, primarily by preventing colonization of cariogenic and periodontal bacteria, include *L rhamnosus* GG, *L casei*, and *L reuteri*, although other strains have also shown potential benefit. *L reuteri* Prodentis secretes hydrogen peroxide, which may account for its antimicrobial properties. It also produces reuterin, which blocks bacterial adherence and prevents against pathogen colonization.³⁴ These probiotics exhibit antimicrobial and anti-inflammatory properties and are associated with an inhibition of harmful bacterial growth.

The physiology of the lung and gastrointestinal tract are so similar and the health of one can ultimately affect the other organ. For example, smoking can increase the risk of both chronic obstructive pulmonary disease (COPD) and Crohn's disease.⁴ The cross-talk between the pulmonary and intestinal mucosa in inflammatory diseases has been established, and it is possible that by improving the gastrointestinal microbiota, there may also be a beneficial effect on COPD and overall lung function.⁴

Recurrent otitis media has not consistently shown to benefit from the addition of many probiotic strains and may in fact respond to a specific strain, *S salivarius* K12. *S salivarius* K12 is not commonly found in probiotic preparations. Several studies suggest that *S salivarius* K12 could decrease the recurrence of ear infections along with decreasing the duration and incidence of strep throat.³⁰ *S salivarius* K12 also antagonizes the growth of *Streptococcus pyogenes*, the most important cause of pharyngeal infections in humans. It does so by colonizing the oral bacteria thereby reducing the opportunity for *S pyogenes* to colonize. It has also been shown to have an excellent safety profile.¹² Last, *S salivarius* 24SMB, a

probiotic in the same family as *S salivarius* K12, decreased the duration and occurrence of otitis media when used in a nasal spray.³¹ Several studies have shown that at risk groups such as older adults have an improved immune response to the influenza vaccine if they are concurrently taking probiotics.¹⁴ Probiotic supplementation in viral infections are thought to provide immunomodulatory effects and prevent colonization, thereby acting as a prophylactic.³⁵

Asthma involves chronic inflammation of the respiratory tract. A variety of inflammatory and immune cells such as activated mast cells, eosinophils, and T-helper 2 (T_H2) cells are implicated in the mechanism of asthma due to the production of inflammatory mediators that contribute to persistent airway inflammation.² The intestinal microbiota regulates $Th1/Th2$ immunity and immune tolerance early in life. Specifically, a combination of *B breve* M-16V, *L rhamnosus* GG, and *L reuteri* modulates the allergic response in asthma by decreasing airway hyper responsiveness to allergens, decreasing airway inflammation and attenuating the T_{H1}/T_H2 ratio. *Lactobacillus salivarius* combined with *B breve* was also shown to be beneficial in the reduction of asthma symptoms.¹⁹ Furthermore, the symbiotic use of prebiotics along with probiotics such as *B breve* prophylactically reduced the prevalence of atopic dermatitis in infants at risk for asthma development. The mechanism is not fully elucidated; however, it is thought to be resultant from a decrease in systemic production of T_H2 cytokines in response to exposure to allergens.²

Pneumonia is typically associated with infections with either *P aeruginosa* or *Streptococcus pneumoniae*. A combination of *L casei* and *L rhamnosus* decreased the incidence of pneumonia by preventing colonization of the lungs from both *P aeruginosa* and *S pneumoniae* strains.^{6,24,26}

In COPD, a chronic inflammatory disease often a result of smoke inhalation, pneumonia patients had an improvement in symptoms when supplementing with *L rhamnosus* and *B breve*.⁴

Last, the literature suggests that several probiotic strains that helped decrease pulmonary exacerbations associated with cystic fibrosis (CF). *L reuteri*, *L rhamnosus* GG, and a multistrain probiotic containing *L rhamnosus* GG all showed benefit in children with CF. The research has explored the gut microbiota as playing a role in lung health via the cross-talk between the gut-lung axis.⁴

The use of probiotics may have many applications for disease prevention in the respiratory tract by inhibiting colonization of certain pathogens and modulating the immune response. The use of multistrain probiotics as well as *L reuteri*, *L rhamnosus* GG, and *S salivarius* have been shown to specifically attenuate respiratory diseases and might be beneficial to consider as a first line of defense against viral infections of the respiratory tract.

Nutritional Supplements Overview

Professional and commercial dietary supplements containing probiotics are widely available.³⁶ In 2002, it was estimated that more than 100 companies in the United States marketed probiotic supplements and nearly 2 million adults consume them regularly.³⁷ In 2012, probiotic or prebiotic use was the third most commonly used nonvitamin, nonmineral dietary supplement and global sales are projected to reach to \$42 billion by the end of 2016.^{38,39} Using probiotics for general health versus targeting a specific health concern is more complex as the properties of probiotic species are strain specific.⁴⁰ Unfortunately, research models lack consistency in naming therapeutic strains while in addition, specific strains are often not listed on supplement labels. This challenge prevents the practitioner from distinguishing the researched strain from the supplemental product and is a limitation of these tables. If the researched strain was not readily available on the label or marketing material, the brand, potentially containing the strain, was not included in the table.

The Joint Food and Agriculture Organization of the United Nations/World Health Organization Expert Consultation on Evaluation of Health and Nutritional

Properties of Probiotics developed guidelines for evaluating probiotics in food.⁴¹ A combination of phenotypic and genotypic tests must be performed to determine the strain; however, regulations on species identification is not in place and supplement companies are not required to list this information on labels. During this multiseries review, it was identified that 30 species were specifically isolated for research purposes and were unavailable and another 56 strains were not commercially available. Due to the wide variety of formulations on the market, lack of knowledge, and poor labeling, it is difficult for practitioners and consumers to determine which brand contains specific strains researched to address a particular health concern.

This table is designed to be a resource to see what is available “at-a-glance.” The brands were chosen by searching the probiotic strain and/ strain-species in Google, several supplement companies, Probiotics Advisor,⁴² and the Clinical Guide to Probiotic Products.⁴³ Based on the results and in order to determine what was commercially available, the search was refined using Google Shopping. In some instances, the supplement company was called to determine if the formula contained a specific species.

Table 2. Summary of Nutritional Supplements by Health Concern

Health Concern	Professional and Commercial Products	Strains
Asthma	Baby's Jarro-Dophilus + FOS Powder (Jarrow Formulas; <i>B breve</i> M-16V, <i>B longum</i> BB536, <i>B lactis</i> Bl-04, <i>B bifidum</i> Bb-02, <i>L casei</i> RO215, <i>L rhamnosis</i> Lr-32) Jarro-Dophilus EPS (Jarrow Formulas; <i>B breve</i> M-16V)	<i>B breve</i> M-16V
Asthma	<i>Bifidus</i> Balance + FOS (Jarrow Formulas; <i>B breve</i> BR03, <i>B longum</i> BB536, <i>B bifidum</i> BB01, <i>B lactis</i> Bl-04)	<i>B breve</i> BR03
Asthma	Nature's Way	<i>L reuteri</i>
Asthma	Not available	<i>E faecalis</i>
Colds/Influenza	Advanced Multi-Billion Dophilus (Solgar; <i>L acidophilus</i> , LA-5, <i>B lactis</i> , BB-12, <i>L paracasei</i> , <i>L casei</i> 431, <i>L rhamnosus</i> GG, LGG) Flora 14-50 (Innate Response; contains families of <i>L acidophilus</i> , <i>L casei</i> , <i>L plantarum</i> , <i>L rhamnosis</i> , <i>L salivarius</i> , <i>L brevis</i> , <i>L bulgaricus</i> , <i>L gasseri</i> , <i>L lactis</i> , <i>B longum</i> , <i>B bifidum</i> , <i>B infantis</i> , <i>S thermophilus</i> —exact strains not specified) Ther-biotic Complete (contains families of <i>L rhamnosus</i> , <i>B bifidum</i> , <i>L acidophilus</i> , <i>L casei</i> , <i>L plantarum</i> , <i>S salivarius</i> , <i>B longum</i> , <i>S thermophilus</i> , <i>L bulgaricus</i> , <i>L paracasei</i> , <i>B lactis</i> , <i>B breve</i> —exact strains not specified and missing <i>L gasseri</i>) Probiotic <i>Lactobacillus</i> GG (Walgreens; <i>L rhamnosis</i> GG)	<i>L casei</i> DN114-001 (family of <i>L casei</i> found in many products, not exact strain) <i>L rhamnosus</i> GG <i>L brevis</i> KB290 (exact strain not found) <i>L gasseri</i> PA 16/8 + <i>B longum</i> SP07/3m+, <i>B bifidum</i> MG20/5 (these exact strains are not in any probiotic formulas that we could find, but the families are in many products)
Colds/Influenza	Pharmax HCL Multistrain: <i>L acidophilus</i> (CUL-60), <i>L acidophilus</i> (CUL-21), <i>B bifidum</i> (CUL-20), <i>B animalis</i> subsp <i>lactis</i> (CUL-34), <i>L salivarius</i> (CUL-61), <i>L paracasei</i> (CUL-08), <i>L plantarum</i> (CUL-66), <i>L casei</i> (CUL-06), <i>L fermentum</i> (CUL-67), <i>L gasseri</i> (CUL-09), <i>B animalis</i> subsp <i>lactis</i> (CUL-62), <i>B breve</i> (CUL-74), <i>S salivarius</i> subsp <i>thermophilus</i> (CUL-68), <i>L acidophilus</i> (NCFM), <i>B animalis</i> subsp <i>lactis</i> (HN019), <i>L rhamnosus</i> (HN001) Pharmax HCL Baby: <i>B bifidum</i> (CUL-20), <i>B animalis</i> subsp <i>lactis</i> (CUL-34), <i>L salivarius</i> (CUL-61), <i>L paracasei</i> (CUL-08). Does not contain <i>L acidophilus</i> .	<i>L acidophilus</i> + <i>B animalis</i> subsp <i>lactis</i> (Pharmax products tend to have <i>B animalis</i> subsp <i>lactis</i>)
COPD	No products found.	<i>L casei</i> Shirota (unavailable in supplements, found in Yakult drink)

Table 2. (continued)

Health Concern	Professional and Commercial Products	Strains
COPD	Adult's Blend Probiotic (Flora-Udo's Choice): <i>L casei</i> (HA-108), <i>L rhamnosis</i> (HA-111), <i>L acidophilus</i> (HA-122), <i>L plantarum</i> (HA-119), <i>B bifidum</i> (HA-132), <i>B breve</i> (HA-129) Dr Formulated Probiotics (Garden of Life): <i>L acidophilus</i> , <i>L plantarum</i> , <i>L gasseri</i> , <i>L paracasei</i> , <i>L bulgaricus</i> , <i>L brevis</i> , <i>L casei</i> , <i>L rhamnosus</i> , <i>L salivarius</i> , <i>B lactis</i> , <i>B bifidum</i> , <i>B breve</i> , <i>B infantis</i> , <i>B longus</i> , prebiotic fiber blend UltraFlora Immune Boost (Metagenics): <i>L paracasei</i> (8700:2), <i>L plantarum</i> (HEAL9)	<i>L plantarum</i>
COPD	iFlora (Sedona Labs): Short-chain fructooligosaccharide (NutraFlora, scFOS), <i>B bifidum</i> , <i>B breve</i> , <i>B lactis (infantis)</i> , <i>B lactis</i> HN019, <i>B longum</i> , <i>L acidophilus</i> , <i>L brevis</i> , <i>L bulgaricus</i> , <i>L casei</i> , <i>L gasseri</i> , <i>L paracasei</i> , <i>L plantarum</i> , <i>L rhamnosus</i> , <i>L salivarius</i> , <i>L lactis</i> , <i>S thermophiles</i> Jarro-Dophilus EPS (Jarrow Formulas): <i>L rhamnosus</i> R0011, <i>L casei</i> R0215, <i>L plantarum</i> R1012, <i>L acidophilus</i> R0052, <i>B longum</i> BB536 (<i>moringa</i> strain), <i>B breve</i> R0070, <i>P acidilactici</i> R1001, <i>L lactis ssp lactis</i> R105) Jarro-Dophilus Plus FOS (Jarrow Formulas): <i>L rhamnosus</i> R0011, <i>L casei</i> R0215, <i>B longum</i> BB536 (<i>moringa</i>), <i>L acidophilus</i> LA-14, <i>L plantarum</i> R1012, <i>B lactis</i> BI-04— does not contain B breve Maximum Strength Ultra Probiotics (Nature's Plus): FOS, <i>L acidophilus</i> , <i>L plantarum</i> , <i>L casei</i> , <i>L bulgaricus</i> , <i>L brevis</i> , <i>L rhamnosus</i> , <i>B lactis</i> , <i>B bifidum</i> , <i>L sporogenes</i> (<i>B coagulans</i>), <i>S salivarius</i> K12, <i>S salivarius</i> M18— does not contain B breve Nexabiotic (Bioprosper Labs): Contains families of <i>S boulardii</i> , <i>S thermophilus</i> , <i>L delbruecki</i> LE, <i>L rhamnosis</i> LB3, <i>L plantarum</i> LM, <i>L acidophilus</i> , <i>E faecium</i> , <i>L casei</i> , <i>L helveticus</i> , <i>L plantarum</i> , <i>L rhamnosus</i> , <i>L salivarius</i> , <i>L lactis</i> , <i>L paracasei</i> , <i>L brevis</i> , <i>L gasseri</i> , <i>B bifidum</i> , <i>B breve</i> , <i>B coagulans</i> , <i>B lactis</i> , <i>B animalis lactis</i> (formerly named <i>B infantis</i>), <i>B longum</i> , <i>B subtilis</i> Primal Defense Ultra (Garden of Life): <i>S boulardii</i> , organic barley grass, organic oat grass, <i>L plantarum</i> , <i>B subtilis</i> , <i>B lactis</i> , <i>B bifidum</i> , <i>L rhamnosus</i> , <i>B breve</i> , <i>L casei</i> , <i>L salivarius</i> , <i>L acidophilus</i> , <i>L brevis</i> , <i>B longum</i> , <i>L paracasei</i> Probiotic All-Flora (New Chapter): <i>S thermophiles</i> , <i>L rhamnosis</i> , <i>B breve</i> , <i>L acidophilus</i> , <i>B infantis</i> , <i>B longum</i> , <i>L plantarum</i> , <i>L salivarius</i> , <i>L helveticus</i> Ultimate Flora Critical Care 50 Billion (Renew Life): <i>B lactis</i> , <i>B breve</i> , <i>B longum</i> , <i>L acidophilus</i> , <i>L casei</i> , <i>L plantarum</i> , <i>L paracasei</i> , <i>L salivarius</i> , <i>L rhamnosus</i> , <i>L bulgaricus</i> Ther-biotic Complete: <i>L rhamnosis</i> , <i>B bifidum</i> , <i>L acidophilus</i> , <i>L casei</i> , <i>L plantarum</i> , <i>S salivarius</i> , <i>B longum</i> , <i>S thermophilus</i> , <i>L bulgaricus</i> , <i>L paracasei</i> , <i>B lactis</i> , <i>B breve</i>	<i>L rhamnosus</i> + <i>B breve</i>
Cystic Fibrosis	Advanced Multi-Billion Dophilus (Solgar): <i>L acidophilus</i> , LA-5, <i>B lactis</i> , BB-12, <i>L paracasei</i> , <i>L casei</i> 431, <i>L rhamnosus</i> GG, LGG	<i>L casei</i> , <i>L rhamnosus</i> , <i>S thermophilus</i> , <i>B breve</i> , <i>L acidophilus</i> , <i>B infantis</i> , <i>L bulgaricus</i> , <i>L rhamnosus</i> GG (LGG)
Cystic Fibrosis	iHealth (Culturelle; <i>L rhamnosis</i> GG) Probiotic LGG (Walgreens)	<i>L rhamnosus</i> GG (LGG)
Cystic Fibrosis	<i>L reuteri</i> (Nature's Way)	<i>L reuteri</i>
Cystic Fibrosis	Nexabiotic (Bioprosper Labs): Contains families of <i>S boulardii</i> , <i>S thermophilus</i> , <i>L delbruecki</i> LE, <i>L rhamnosis</i> LB3, <i>L plantarum</i> LM, <i>L acidophilus</i> , <i>E faecium</i> , <i>L casei</i> , <i>L helveticus</i> , <i>L plantarum</i> , <i>L rhamnosus</i> , <i>L salivarius</i> , <i>L lactis</i> , <i>L paracasei</i> , <i>L brevis</i> , <i>L gasseri</i> , <i>B bifidum</i> , <i>B breve</i> , <i>B coagulans</i> , <i>B lactis</i> , <i>B animalis lactis</i> (formerly named <i>B infantis</i>), <i>B longum</i> , <i>B subtilis</i> iFlora (Sedona Labs): Short-chain fructooligosaccharide (NutraFlora, scFOS), <i>B bifidum</i> , <i>B breve</i> , <i>B lactis (infantis)</i> , <i>B lactis</i> HN019, <i>B longum</i> , <i>L acidophilus</i> , <i>L brevis</i> , <i>L bulgaricus</i> , <i>L casei</i> , <i>L gasseri</i> , <i>L paracasei</i> , <i>L plantarum</i> , <i>L rhamnosus</i> , <i>L salivarius</i> , <i>L lactis</i> , <i>S thermophiles</i> Pharmax HCL Multistrain: <i>L acidophilus</i> (CUL-60), <i>L acidophilus</i> (CUL-21), <i>B bifidum</i> (CUL-20), <i>B animalis</i> subsp <i>lactis</i> (CUL-34), <i>L salivarius</i> (CUL-61), <i>L paracasei</i> (CUL-08), <i>L plantarum</i> (CUL-66), <i>L casei</i> (CUL-06), <i>L fermentum</i> (CUL-67), <i>L gasseri</i> (CUL-09), <i>B animalis</i> subsp <i>lactis</i> (CUL-62), <i>B breve</i> (CUL-74), <i>S salivarius</i> subsp <i>thermophilus</i> (CUL-68), <i>L acidophilus</i> (NCFM), <i>B animalis</i> subsp <i>lactis</i> (HN019), <i>L rhamnosus</i> (HN001) Probiotic All-Flora (New Chapter): <i>S thermophiles</i> , <i>L rhamnosis</i> , <i>B breve</i> , <i>L acidophilus</i> , <i>B infantis</i> , <i>B longum</i> , <i>L plantarum</i> , <i>L salivarius</i> , <i>L helveticus</i> Flora 14-50 (Innate Response; contains families of <i>L acidophilus</i> , <i>L casei</i> , <i>L plantarum</i> , <i>L rhamnosis</i> , <i>L salivarius</i> , <i>L brevis</i> , <i>L bulgaricus</i> , <i>L gasseri</i> , <i>L lactis</i> , <i>B longum</i> , <i>B bifidum</i> , <i>B infantis</i> , <i>S thermophiles</i> —exact strains not specified) Ther-biotic Complete (contains families of <i>L rhamnosus</i> , <i>B bifidum</i> , <i>L acidophilus</i> , <i>L casei</i> , <i>L plantarum</i> , <i>S salivarius</i> , <i>B longum</i> , <i>S thermophilus</i> , <i>L bulgaricus</i> , <i>L paracasei</i> , <i>B lactis</i> , <i>B breve</i> —exact strains not specified and missing <i>L gasseri</i>)	<i>L casei</i> , <i>L rhamnosus</i> , <i>S thermophilus</i> , <i>B breve</i> , <i>L acidophilus</i> , <i>B infantis</i> , <i>L bulgaricus</i> Note: <i>B infantis</i> is difficult to find in products; we found it in: Probiotic All-flora and Innate Response Clinical Flora 50-14

Table 2. (continued)

Health Concern	Professional and Commercial Products	Strains
Gingivitis/ Periodontitis	Advanced Multi-Billion Dophilus (Solgar; <i>L. acidophilus</i> , LA-5, <i>B. lactis</i> , BB-12, <i>L. paracasei</i> , <i>L. casei</i> 431, <i>L. rhamnosus</i> GG, LGG)	<i>L. salivarius</i> M18, <i>L. rhamnosus</i> CG, <i>L. casei</i> , <i>Bifidobacterium</i> DN-173-0101, <i>L. reuteri</i> DSM17938, <i>L. reuteri</i> Prodentis ATCCPTA5289, <i>L. salivarius</i> OMZ520 + <i>L. gasseri</i> OMZ525, <i>S. thermophiles</i> MCC1561 + <i>L. lactis</i> NCC2211
Gingivitis/ Periodontitis	Flora 14-50 (Innate Response; contains families of <i>L. acidophilus</i> , <i>L. casei</i> , <i>L. plantarum</i> , <i>L. rhamnosus</i> , <i>L. salivarius</i> , <i>L. brevis</i> , <i>L. bulgaricus</i> , <i>L. gasseri</i> , <i>L. lactis</i> , <i>B. longum</i> , <i>B. bifidum</i> , <i>B. infantis</i> , <i>S. thermophiles</i> —exact strains not specified) Nexabiotic (Bioprosper Labs): Contains families of <i>S. boulardii</i> , <i>S. thermophilus</i> , <i>L. delbruecki</i> LE, <i>L. rhamnosus</i> LB3, <i>L. plantarum</i> LM, <i>L. acidophilus</i> , <i>E. faecium</i> , <i>L. casei</i> , <i>L. helveticus</i> , <i>L. plantarum</i> , <i>L. rhamnosus</i> , <i>L. salivarius</i> , <i>L. lactis</i> , <i>L. paracasei</i> , <i>L. brevis</i> , <i>L. gasseri</i> , <i>B. bifidum</i> , <i>B. breve</i> , <i>B. coagulans</i> , <i>B. lactis</i> , <i>B. animalis lactis</i> (formerly named <i>B. infantis</i>), <i>B. longum</i> , <i>B. subtilis</i> iFlora (Sedona Labs): Short-chain fructooligosaccharide (NutraFlora, scFOS), <i>B. bifidum</i> , <i>B. breve</i> , <i>B. lactis</i> (<i>infantis</i>), <i>B. lactis</i> HN019, <i>B. longum</i> , <i>L. acidophilus</i> , <i>L. brevis</i> , <i>L. bulgaricus</i> , <i>L. casei</i> , <i>L. gasseri</i> , <i>L. paracasei</i> , <i>L. plantarum</i> , <i>L. rhamnosus</i> , <i>L. salivarius</i> , <i>L. lactis</i> , <i>S. thermophiles</i>) Ther-biotic Complete (contains families of <i>L. rhamnosus</i> , <i>B. bifidum</i> , <i>L. acidophilus</i> , <i>L. casei</i> , <i>L. plantarum</i> , <i>S. salivarius</i> , <i>B. longum</i> , <i>S. thermophilus</i> , <i>L. bulgaricus</i> , <i>L. paracasei</i> , <i>B. lactis</i> , <i>B. breve</i> —exact strains not specified and missing <i>L. gasseri</i>)	<i>L. salivarius</i> M18, <i>L. rhamnosus</i> CG, <i>L. casei</i> , <i>Bifidobacterium</i> DN-173-0101, <i>L. reuteri</i> DSM17938, <i>L. reuteri</i> Prodentis ATCCPTA5289, <i>L. salivarius</i> OMZ520 + <i>L. gasseri</i> OMZ525, <i>S. thermophiles</i> MCC1561 + <i>L. lactis</i> NCC2211
Gingivitis/ Periodontitis	FLORASSIST Oral Hygiene (Life Extension)	<i>S. salivarius</i> M18
Gingivitis/ Periodontitis	<i>L. reuteri</i> (Nature's Way)	<i>L. reuteri</i>
Gingivitis/ Periodontitis	Probiotic Synergy (Designs for Health): Contains families of <i>L. acidophilus</i> , <i>B. bifidum</i> , <i>L. casei</i> , <i>L. rhamnosus</i> , <i>L. reuteri</i> , <i>B. breve</i> , <i>B. longum</i> , <i>S. thermophiles</i> —exact strain not specified	<i>L. salivarius</i> M18, <i>L. rhamnosus</i> CG, <i>L. casei</i> , <i>Bifidobacterium</i> DN-173-0101, <i>L. reuteri</i> DSM17938, <i>L. reuteri</i> Prodentis ATCCPTA5289, <i>L. salivarius</i> OMZ520 + <i>L. gasseri</i> OMZ525, <i>S. thermophiles</i> MCC1561 + <i>L. lactis</i> NCC2211
Gingivitis/ Periodontitis	Prodegin Chewable (Klaire Labs): Contains family of <i>L. acidophilus</i> , <i>L. rhamnosus</i> , <i>L. salivarius</i> , <i>L. paracasei</i> , <i>L. plantarum</i> —exact strain not specified	<i>L. salivarius</i> M18, <i>L. rhamnosus</i> CG, <i>L. casei</i> , <i>Bifidobacterium</i> DN-173-0101, <i>L. reuteri</i> DSM17938, <i>L. reuteri</i> Prodentis ATCCPTA5289, <i>L. salivarius</i> OMZ520 + <i>L. gasseri</i> OMZ525, <i>S. thermophiles</i> MCC1561 + <i>L. lactis</i> NCC2211
Gingivitis/ Periodontitis	Probiotic LGG (Walgreens; <i>L. rhamnosus</i> GG ATCC 53103 only)	<i>L. salivarius</i> M18, <i>L. rhamnosus</i> CG, <i>L. casei</i> , <i>Bifidobacterium</i> DN-173-0101, <i>L. reuteri</i> DSM17938, <i>L. reuteri</i> Prodentis ATCCPTA5289, <i>L. salivarius</i> OMZ520 + <i>L. gasseri</i> OMZ525, <i>S. thermophiles</i> MCC1561 + <i>L. lactis</i> NCC2211
Otitis Media	Probiotic GX (Nature's Bounty) Prodegin Chewable (Klaire Labs): Contains family of <i>L. acidophilus</i> , <i>L. rhamnosus</i> , <i>L. salivarius</i> , <i>L. paracasei</i> , <i>L. plantarum</i> —exact strain not specified	<i>L. plantarum</i>
Otitis Media	Blis K12 Throat Guard Daily (BLIS Technologies Ltd)	<i>S. salivarius</i> K12 is the main species showing decreased incidence
Otitis Media	Citrus Oral Care Probiotics (TheraBreath Oral Care Probiotics): BLIS K12 and M18 iHealth (Culturelle; <i>L. rhamnosus</i> GG)	<i>S. salivarius</i> K12 is the main species showing decreased incidence <i>L. rhamnosus</i> GG
Otitis Media	Synbiotic 2000 (<i>P. pentoseceus</i> 5–33:3, <i>L. mesenteroides</i> 32–77:1, <i>L. paracasei</i> ssp <i>paracasei</i> 19, and <i>L. plantarum</i> 2362, as well as 2.5 g inulin, oat bran, pectin, and resistant starch)	<i>Lactobacillus</i> spp including <i>L. plantarum</i> and FOS

Table 2. (continued)

Health Concern	Professional and Commercial Products	Strains
Otitis Media	ENT Biotic Lozenge (Protocols for Life Balance) Florassist Throat Health (Life Extension) Maximum Strength Ultra Probiotics (Nature's Plus) PRO-Dental (Hyperbiotics) ProENT (Rightway Nutrition) TrueOC Quick Melt Oral Care Probiotics (NatureCity)	<i>S salivarius</i> K12 is the main species showing decreased incidence
Otitis Media	Probiotic LGG (Walgreens) (<i>Lactobacillus rhamnosus</i> GG)	<i>L rhamnosus</i> GG
Pneumonia	Advanced Multi-Billion Dophilus (Solgar; <i>L. acidophilus</i> , LA-5, <i>B. lactis</i> , BB-12, <i>L. paracasei</i> , <i>L. casei</i> 431, <i>L. rhamnosus</i> GG, LGG)	<i>L. casei</i> , <i>L. rhamnosus</i> EO1-AO2-S06, <i>L. casei</i>
Pneumonia	Probiotic LGG (Walgreens)	<i>L. casei</i> , <i>L. rhamnosus</i> EO1-AO2-S06, <i>L. casei</i> , <i>L. rhamnosus</i> LR05
Strep Throat/ Pharyngitis	<i>S salivarius</i> K12 ENT Biotic Lozenge (Protocols for Life Balance) Florassist Throat Health (Life Extension) Maximum Strength Ultra Probiotics (Nature's Plus) Citrus Oral Care Probiotics (TheraBreath) TrueOC Quick Melt Oral Care Probiotics (NatureCity) PRO-Dental (Hyperbiotics) ProENT (Rightway Nutrition) Blis K12 Throat Guard Daily (BLIS Technologies Ltd) CHEWABLE CHILDREN'S ORAL PROBIOTICS-7 Strains with BLIS K12 & M18 (Great Oral Health) Clinical Grade Oral Probiotics (PUR Nutraceuticals)	<i>S salivarius</i> K12

Abbreviations: COPD, chronic obstructive pulmonary disease; FOS, fructooligosaccharides; LGG, *Lactobacillus* GG.

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