

# Supplementary Information

## The effect of oral probiotic intervention on brain structure and function in human adults: a systematic review

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### Supplementary Note 1. Search Strategy

**Medline, first run on 2023-06-20, updated on 2024-01-09 and 2025-08-05.**

(Ovid MEDLINE(R) ALL 1946 to August 05, 2025)

/ =Mesh-term

**exp** =exploded Mesh-term

**ab** =abstract

**kf** =keyword heading word

**ti** =title

**nm** =name of substance word

| Search terms |   |                                                                                                                                                                                                                                                      | Number of results |
|--------------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Probiotics   |   |                                                                                                                                                                                                                                                      |                   |
|              | 1 | exp Probiotics/                                                                                                                                                                                                                                      |                   |
|              | 2 | exp Lactobacillus/                                                                                                                                                                                                                                   |                   |
|              | 3 | exp Bifidobacterium/                                                                                                                                                                                                                                 |                   |
|              | 4 | (probiotic* or psychobiotic* or pro-biotic* or psycho-biotic*).ab,kf,ti.                                                                                                                                                                             |                   |
|              | 5 | (Lactobacill* or "Betabacteri*" or "Lactobacileae" or Lactobacter* or acidophilus* or "enpac" or "lacfer" or "lacteol" or "lactophil" or "Thermobacterium intestinale" or "viacil" or "Bacillus casei g" or "Bacillus g" or "Betabacterium breve" or |                   |

|  |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|--|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  |    | "Levilactobacillus brevis" or "Bacterium curvatum" or "Bacillus acidificans longissimus" or "Bacillus delbrucki" or "bacillus delbrueckii" or "Bacterium delbrucki" or "Plocamobacterium delbrucki" or "Thermobacterium cereale" or "Ulvina delbrucki" or "Bacillus bulgaricus" or "Bacillus lactis acidii" or "Thermobacterium lactis" or "Bacillus casei e" or "Bacillus e" or "Caseobacterium e" or "Plocamobacterium helveticum" or "thermobacterium helveticum" or "Streptobacterium plantarum").ab,kf,ti,nm. |  |
|  | 6  | (Bifidobacter* or "Actinobacterium bifidum" or "Actinomyces bifidus" or "Actinomyces parabifidus" or "Bacillus bifidus" or "Bacterium bifidum" or "Bacteroides bifidus" or "Bifidibacterium bifidum" or "Cohnistreptothrix bifidus" or "Nocardia bifida" or "Tissieria bifida").ab,kf,ti,nm.                                                                                                                                                                                                                       |  |
|  | 7  | exp Lacticaseibacillus/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
|  | 8  | (Lacticaseibacillus or Lactobacillus casei or "Bacillus a" or "Bacillus casei a" or "Bacterium casei a" or "casei, lactobacillus" or "caseobacterium vulgare" or "lactobacilli casei" or "Lactobacterium casei" or "streptobacterium casei" or "Lactobacillus casei").ab,kf,ti,nm.                                                                                                                                                                                                                                 |  |
|  | 9  | Bacillus/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
|  | 10 | Bacillus clausii/ or Bacillus coagulans/ or Bacillus licheniformis/ or Bacillus pumilus/ or Bacillus subtilis/                                                                                                                                                                                                                                                                                                                                                                                                     |  |
|  | 11 | (bacillus or "clostridium licheniforme" or "Denitrobacillus licheniformis" or "Bacillus licheniformis" or "b. subtilis" or "Bacillus natto" or "Bacillus subtilis spore" or "Bacillus uniflagellatus" or "Bacterium subtilis" or "Vibrio subtilis" or "Bacillus subtilis" or "Alkalihalobacillus clausii").ab,kf,ti,nm.                                                                                                                                                                                            |  |
|  | 12 | exp Lactococcus/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|  | 13 | (Lactococcus or "Enterococcus seriolicida" or "Enterococcus serolicida" or "Streptococcus garvieae" or "Bacterium lacti*" or "Streptococcus lactis").ab,kf,ti,nm.                                                                                                                                                                                                                                                                                                                                                  |  |
|  | 14 | Limosilactobacillus fermentum/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
|  | 15 | ("Limosilactobacillus fermentum" or "Bacillus casei d" or "Bacillus d" or "fermenti, lactobacillus" or "Lactobacillus cellobiosus" or "lactobacillus fermenti" or "lactobacillus fermentii" or "Lactobacterium fermentum" or "Limosilactobacillus fermentum" or "Lactobacillus fermentum").ab,kf,ti,nm.                                                                                                                                                                                                            |  |

|              |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
|--------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|              | 16 | Limosilactobacillus reuteri/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|              | 17 | ("Limosilactobacillus reuteri" or "Lactobacillus fermentum reuteri" or "Lactobacillus reuteri").ab,kf,ti,nm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|              | 18 | Pediococcus pentosaceus/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|              | 19 | "Pediococcus pentosaceus".ab,kf,ti,nm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
|              | 20 | exp Propionibacterium/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
|              | 21 | ("Propionibacterium" or "bacterium acidi propionici" or "Bacillus acnes" or "Corynebacterium acnes" or "Corynebacterium parvum" or "Corynebacterium parvum infectiosum" or "Cutibacterium acnes" or "P. acnes" or "Propionibacteria acnes" or "Propionicibacterium acnes" or "Propionobacterium acnes" or "Propionibacterium acnes" or "strain CN 6134" or "Bacterium acidi propionici a" or "Bacterium acidi propionici d" or "Propionicibacterium freudenreichii" or "Propionicibacterium freudenreichii shermanii" or "Bacille granuleux" or "Corynebacterium granulosum" or "Propionicibacterium granulosum").ab,kf,ti,nm. |  |
|              | 22 | exp Saccharomyces/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|              | 23 | (Saccharomyce* or "CBS 5926" or "baker yeast" or "baker`s yeast" or "brewer yeast" or "brewer`s yeast" or "s cerevisiae" or "saccaromyces cerevisiae").ab,kf,ti,nm.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
|              | 24 | Streptococcus salivarius/ or Streptococcus thermophilus/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|              | 25 | ("Streptococcus salivarius" or "Streptococcus thermophilus").ab,kf,ti,nm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
|              | 26 | "Weizmannia coagulans".ab,kf,ti,nm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
|              | 27 | Bifidus.ab,kf,ti,nm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
|              | 28 | Escherichia coli/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
|              | 29 | ("Escherichia coli Nissle" or "Escherichia coli strain Nissle").ab,kf,ti,nm.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|              | 30 | or/1-29                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Neuroimaging |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
|              | 31 | exp Neuroimaging/ or Functional Neuroimaging/ or exp Electroencephalography/ or Magnetoencephalography/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
|              | 32 | ("neuro imag*" or neuroimag* or "brain activit*" or "brain electrical activity mapping" or "brain cortical thickness" or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |

|                    |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
|--------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                    |    | magnetoencephalography or magneto-encephalography or magnetoencephalogram* or "diffusion tensor imag*" or "diffusion tensor magnetic resonance imaging" or "diffusion tensor mri" or "dti mri" or "diffusion tractograph*" or "functional brain imag*" or "brain mapping" or "brain radiography" or "brain scinitsscanning" or neurography or connectome or "dopaminergic mapping" or neuroradiology or "cerebral angiography" or echoencephalography or myelography or pneumoencephalography or eeg or electroencephalogram* or electroencephalography or "brain wave*" or brainwave* or "alpha rhythm" or "beta rhythm" or "delta rhythm" or "gamma rhythm" or "theta rhythm" or "cortical synchronization" or "functional connectivity" or "resting state" or "brain activit*").ti,ab,kf.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
|                    | 33 | 31 or 32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| Imaging techniques |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
|                    | 34 | exp Magnetic Resonance Imaging/ or exp Tomography, Emission-Computed/ or exp positron-emission tomography/ or single-photon/ or exp tomography, x-ray computed/ or spectroscopy, near-infrared/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
|                    | 35 | ("magnetic resonance imaging" or "echo-planar imaging" or "fluorine-19 magnetic resonance imaging" or "magnetic resonance angiography" or "nmr imaging" or "mr tomograph*" or "nmr tomograph*" or "steady state free precession mri" or zeugmatograph* or "chemical shift imaging*" or "chemical shift imaging" or "magnetic resonance image*" or "magnetization transfer contrast imaging" or "mri scan*" or "proton spin tomograph*" or fmri* or "functional mri*" or "functional magnetic resonance imaging" or "nuclear magnetic resonance imaging" or "diffusion weighted imaging" or "echo planar imaging" or "fluid-attenuated inversion recovery imaging" or "functional magnetic resonance imaging" or "multiparametric magnetic resonance imaging" or "T1 weighted imaging" or "T2 weighted imaging" or "emission tomography" or "computer assisted emission tomography" or "photon emission tomography" or "positron emission tomograph*" or "positron-emission tomography imaging" or "pet scan*" or "pet imaging*" or "near-infrared spectroscop*" or "near infrared spectroscop*" or "nir spectroscop*" or "near-infrared spectrometr*" or "near infrared spectrometr*" or "functional near-infrared spectroscopy" or "time resolved near infrared spectroscop*").ti,ab,kf. |  |
|                    | 36 | 34 or 35                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| Brain              |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |

|                                                        |    |                                                                                                                                                                                                                                           |     |
|--------------------------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|                                                        | 37 | exp Brain/                                                                                                                                                                                                                                |     |
|                                                        | 38 | (brain or encephal* or prosencephalon or mesencephalon or rhombencephalon or cerebrum or cerebellum or brainstem or pons or cerebra* or intracranial or cerebrovascular or neurovascular or cranial or intracerebral or neuro*).ab,kf,ti. |     |
|                                                        | 39 | 37 or 38                                                                                                                                                                                                                                  |     |
| Imaging techniques combined with brain                 |    |                                                                                                                                                                                                                                           |     |
|                                                        | 40 | 36 and 39                                                                                                                                                                                                                                 |     |
| Neuroimaging OR Imaging techniques combined with brain |    |                                                                                                                                                                                                                                           |     |
|                                                        | 41 | 33 or 40                                                                                                                                                                                                                                  |     |
| Sets combined                                          |    |                                                                                                                                                                                                                                           |     |
|                                                        | 42 | 30 and 41                                                                                                                                                                                                                                 |     |
| Limit to English language                              |    |                                                                                                                                                                                                                                           |     |
|                                                        | 43 | limit 42 to english language                                                                                                                                                                                                              | 532 |

**Embase.com, first run on 2023-06-20, updated on 2024-01-09 and 2025-08-05.**

**/de** =Emtree term

**/exp** =exploded Emtree term

**:ti,ab,kw** =title, abstract, keyword

| Search terms |   |                                                                                                                                                                                                                                                                                          | Number of results |
|--------------|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Probiotics   |   |                                                                                                                                                                                                                                                                                          |                   |
|              | 1 | 'probiotic agent'/exp                                                                                                                                                                                                                                                                    |                   |
|              | 2 | 'lactobacillus'/exp                                                                                                                                                                                                                                                                      |                   |
|              | 3 | 'bifidobacterium'/exp                                                                                                                                                                                                                                                                    |                   |
|              | 4 | probiotic*:ti,ab,kw OR psychobiotic*:ti,ab,kw OR 'pro biotic':ti,ab,kw OR 'psycho biotic':ti,ab,kw                                                                                                                                                                                       |                   |
|              | 5 | lactobacill*:ti,ab,kw OR 'betabacteri*':ti,ab,kw OR 'lactobacilleae':ti,ab,kw OR lactobacter*:ti,ab,kw OR acidophilus*:ti,ab,kw OR 'enpac':ti,ab,kw OR 'lacfer':ti,ab,kw OR 'lacteol':ti,ab,kw OR 'lactophil':ti,ab,kw OR 'thermobacterium intestinale':ti,ab,kw OR 'viacil':ti,ab,kw OR |                   |

|  |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
|--|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  |    | 'bacillus casei g':ti,ab,kw OR 'bacillus g':ti,ab,kw OR 'betabacterium breve':ti,ab,kw OR 'levilactobacillus brevis':ti,ab,kw OR 'bacterium curvatum':ti,ab,kw OR 'bacillus acidificans longissimus':ti,ab,kw OR 'bacillus delbrucki':ti,ab,kw OR 'bacillus delbrueckii':ti,ab,kw OR 'bacterium delbrucki':ti,ab,kw OR 'plocamobacterium delbrucki':ti,ab,kw OR 'thermobacterium cereale':ti,ab,kw OR 'ulvina delbrucki':ti,ab,kw OR 'bacillus bulgaricus':ti,ab,kw OR 'bacillus lactis acidii':ti,ab,kw OR 'thermobacterium lactis':ti,ab,kw OR 'bacillus casei e':ti,ab,kw OR 'bacillus e':ti,ab,kw OR 'caseobacterium e':ti,ab,kw OR 'plocamobacterium helveticum':ti,ab,kw OR 'thermobacterium helveticum':ti,ab,kw OR 'streptobacterium plantarum':ti,ab,kw OR bifidobacter*:ti,ab,kw OR 'actinobacterium bifidum':ti,ab,kw OR 'actinomyces bifidus':ti,ab,kw OR 'actinomyces parabifidus':ti,ab,kw OR 'bacillus bifidus':ti,ab,kw OR 'bacterium bifidum':ti,ab,kw OR 'bacteroides bifidus':ti,ab,kw OR 'bifidibacterium bifidum':ti,ab,kw OR 'cohnistreptothrix bifidus':ti,ab,kw OR 'nocardia bifida':ti,ab,kw OR 'tissieria bifida':ti,ab,kw |  |
|  | 6  | bifidobacter*:ti,ab,kw OR 'actinobacterium bifidum':ti,ab,kw OR 'actinomyces bifidus':ti,ab,kw OR 'actinomyces parabifidus':ti,ab,kw OR 'bacillus bifidus':ti,ab,kw OR 'bacterium bifidum':ti,ab,kw OR 'bacteroides bifidus':ti,ab,kw OR 'bifidibacterium bifidum':ti,ab,kw OR 'cohnistreptothrix bifidus':ti,ab,kw OR 'nocardia bifida':ti,ab,kw OR 'tissieria bifida':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
|  | 7  | 'lacticaseibacillus'/exp                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|  | 8  | (lacticaseibacillus:ti,ab,kw OR lactobacillus:ti,ab,kw) AND casei:ti,ab,kw OR 'bacillus a':ti,ab,kw OR 'bacillus casei a':ti,ab,kw OR 'bacterium casei a':ti,ab,kw OR 'casei, lactobacillus':ti,ab,kw OR 'caseobacterium vulgare':ti,ab,kw OR 'lactobacilli casei':ti,ab,kw OR 'lactobacterium casei':ti,ab,kw OR 'streptobacterium casei':ti,ab,kw OR 'lactobacillus casei':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
|  | 9  | 'bacillus'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
|  | 10 | 'bacillus clausii'/de OR 'bacillus coagulans'/de OR 'bacillus licheniformis'/de OR 'bacillus pumilus'/de OR 'bacillus subtilis'/exp                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
|  | 11 | bacillus:ti,ab,kw OR 'clostridium licheniforme':ti,ab,kw OR 'denitrobacillus licheniformis':ti,ab,kw OR 'bacillus licheniformis':ti,ab,kw OR 'b. subtilis':ti,ab,kw OR 'bacillus natto':ti,ab,kw OR 'bacillus subtilis spore':ti,ab,kw OR 'bacillus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |

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|--|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|  |    | uniflagellatus':ti,ab,kw OR 'bacterium subtilis':ti,ab,kw OR 'vibrio subtilis':ti,ab,kw OR 'bacillus subtilis':ti,ab,kw OR 'alkalihalobacillus clausii':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |
|  | 12 | 'lactococcus'/exp                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|  | 13 | lactococcus:ti,ab,kw OR 'enterococcus seriolicida':ti,ab,kw OR 'enterococcus serolicida':ti,ab,kw OR 'streptococcus garvieae':ti,ab,kw OR 'bacterium lacti*':ti,ab,kw OR 'streptococcus lactis':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|  | 14 | 'lactobacillus fermentum'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
|  | 15 | 'limosilactobacillus fermentum':ti,ab,kw AND 'bacillus casei d':ti,ab,kw OR 'bacillus d':ti,ab,kw OR 'fermenti, lactobacillus':ti,ab,kw OR 'lactobacillus cellobiosus':ti,ab,kw OR 'lactobacillus fermenti':ti,ab,kw OR 'lactobacillus fermentii':ti,ab,kw OR 'lactobacterium fermentum':ti,ab,kw OR 'limosilactobacillus fermentum':ti,ab,kw OR 'lactobacillus fermentum':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
|  | 16 | 'lactobacillus reuteri'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |
|  | 17 | 'lactobacillus fermentum reuteri':ti,ab,kw OR 'limosilactobacillus reuteri':ti,ab,kw OR 'lactobacillus reuteri':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|  | 18 | 'pediococcus pentosaceus'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |  |
|  | 19 | 'pediococcus pentosaceus':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
|  | 20 | 'propionibacterium'/exp                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
|  | 21 | 'propionibacterium':ti,ab,kw OR 'bacterium acidi propionici':ti,ab,kw OR 'bacillus acnes':ti,ab,kw OR 'corynebacterium acnes':ti,ab,kw OR 'corynebacterium parvum':ti,ab,kw OR 'corynebacterium parvum infectiosum':ti,ab,kw OR 'cutibacterium acnes':ti,ab,kw OR 'p. acnes':ti,ab,kw OR 'propionibacteria acnes':ti,ab,kw OR 'propionicibacterium acnes':ti,ab,kw OR 'propionobacterium acnes':ti,ab,kw OR 'proprionibacterium acnes':ti,ab,kw OR 'strain cn 6134':ti,ab,kw OR 'bacterium acidi propionici a':ti,ab,kw OR 'bacterium acidi propionici d':ti,ab,kw OR 'propionicibacterium freudenreichii':ti,ab,kw OR 'propionicibacterium freudenreichii shermanii':ti,ab,kw OR 'bacille granuleux':ti,ab,kw OR 'corynebacterium granulosum':ti,ab,kw OR 'propionicibacterium granulosum':ti,ab,kw |  |
|  | 22 | 'saccharomyces'/exp                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| 23           | saccharomyce*:ti,ab,kw OR 'cbs 5926':ti,ab,kw OR 'baker yeast':ti,ab,kw OR 'baker`s yeast':ti,ab,kw OR 'brewer yeast':ti,ab,kw OR 'brewer`s yeast':ti,ab,kw OR 's cerevisiae':ti,ab,kw OR 'saccaromyces cerevisiae':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| 24           | 'streptococcus salivarius'/de OR 'streptococcus thermophilus'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| 25           | 'streptococcus salivarius':ti,ab,kw OR 'streptococcus thermophilus':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |
| 26           | 'weizmannia coagulans':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| 27           | bifidus:ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| 28           | 'escherichia coli'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| 29           | 'escherichia coli nissle':ti,ab,kw OR 'escherichia coli strain nissle':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| 30           | 'streptococcus salivarius'/de OR 'streptococcus thermophilus'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
| 31           | #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
| Neuroimaging |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
| 32           | 'brain mapping'/exp OR 'brain radiography'/exp OR 'brain scintiscanning'/exp OR 'connectome'/exp OR 'electroencephalography'/exp OR 'neurography'/exp OR 'neuroimaging'/exp OR 'functional neuroimaging'/exp OR 'magnetoencephalography'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| 33           | 'neuro imag*':ti,ab,kw OR neuroimag*:ti,ab,kw OR 'brain activit*':ti,ab,kw OR 'brain electrical activity mapping':ti,ab,kw OR magnetoencephalography:ti,ab,kw OR 'magneto-encephalography':ti,ab,kw OR magnetoencephalogram*:ti,ab,kw OR 'brain cortical thickness':ti,ab,kw OR 'diffusion tensor imag*':ti,ab,kw OR 'diffusion tensor magnetic resonance imaging':ti,ab,kw OR 'diffusion tensor mri':ti,ab,kw OR 'dti mri':ti,ab,kw OR 'diffusion tractograph*':ti,ab,kw OR 'functional brain imag*':ti,ab,kw OR 'brain radiography':ti,ab,kw OR 'brain scinitscanning':ti,ab,kw OR neurography:ti,ab,kw OR connectome:ti,ab,kw OR 'brain mapping':ti,ab,kw OR 'dopaminergic mapping':ti,ab,kw OR neuroradiology:ti,ab,kw OR 'cerebral angiography':ti,ab,kw OR echoencephalography:ti,ab,kw OR electroencephalography:ti,ab,kw OR myelography:ti,ab,kw OR |  |

|                    |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
|--------------------|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                    |    | pneumoencephalography:ti,ab,kw OR eeg:ti,ab,kw OR electroencephalogram*:ti,ab,kw OR 'brain wave*:ti,ab,kw OR brainwave*:ti,ab,kw OR 'alpha rhythm':ti,ab,kw OR 'beta rhythm':ti,ab,kw OR 'delta rhythm':ti,ab,kw OR 'gamma rhythm':ti,ab,kw OR 'theta rhythm':ti,ab,kw OR 'cortical synchronization':ti,ab,kw OR 'functional connectivity':ti,ab,kw OR 'resting state':ti,ab,kw                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
|                    | 34 | #32 OR #33                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| Imaging techniques |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |
|                    | 35 | 'nuclear magnetic resonance imaging'/de OR 'diffusion tensor imaging'/de OR 'diffusion weighted imaging'/exp OR 'echo planar imaging'/de OR 'fluid-attenuated inversion recovery imaging'/de OR 'functional magnetic resonance imaging'/de OR 'multiparametric magnetic resonance imaging'/de OR 't1 weighted imaging'/de OR 't2 weighted imaging'/de OR 'computer assisted emission tomography'/exp OR 'near infrared spectroscopy'/de OR 'functional near-infrared spectroscopy'/de OR 'time resolved near infrared spectroscopy'/de                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|                    | 36 | 'magnetic resonance imaging':ti,ab,kw OR 'echo-planar imaging':ti,ab,kw OR 'fluorine-19 magnetic resonance imaging':ti,ab,kw OR 'magnetic resonance angiography':ti,ab,kw OR 'nmr imaging':ti,ab,kw OR 'mr tomograph*:ti,ab,kw OR 'nmr tomograph*:ti,ab,kw OR 'steady state free precession mri':ti,ab,kw OR zeugmatograph*:ti,ab,kw OR 'chemical shift imaging*:ti,ab,kw OR 'chemical shift imaging':ti,ab,kw OR 'magnetic resonance image*:ti,ab,kw OR 'magnetization transfer contrast imaging':ti,ab,kw OR 'mri scan*:ti,ab,kw OR 'proton spin tomograph*:ti,ab,kw OR fmri*:ti,ab,kw OR 'functional mri*:ti,ab,kw OR 'nuclear magnetic resonance imaging':ti,ab,kw OR 'diffusion weighted imaging':ti,ab,kw OR 'echo planar imaging':ti,ab,kw OR 'fluid-attenuated inversion recovery imaging':ti,ab,kw OR 'functional magnetic resonance imaging':ti,ab,kw OR 'multiparametric magnetic resonance imaging':ti,ab,kw OR 't1 weighted imaging':ti,ab,kw OR 't2 weighted imaging':ti,ab,kw OR 'emission tomography':ti,ab,kw OR 'computer assisted emission tomography':ti,ab,kw OR 'photon emission tomography':ti,ab,kw OR 'positron emission tomograph*:ti,ab,kw OR 'positron-emission tomography imaging':ti,ab,kw OR 'pet scan*:ti,ab,kw OR 'pet imaging*:ti,ab,kw OR 'near-infrared spectroscop*:ti,ab,kw OR 'near infrared spectroscop*:ti,ab,kw OR 'nir spectroscop*:ti,ab,kw OR 'near-infrared spectrometr*:ti,ab,kw OR 'near infrared spectrometr*:ti,ab,kw OR 'functional near- |  |

|                                                        |    |                                                                                                                                                                                                                                                                                                                                                                                                 |      |
|--------------------------------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
|                                                        |    | infrared spectroscopy':ti,ab,kw OR 'time resolved near infrared spectroscop*':ti,ab,kw                                                                                                                                                                                                                                                                                                          |      |
|                                                        | 37 | #35 OR #36                                                                                                                                                                                                                                                                                                                                                                                      |      |
| Brain                                                  |    |                                                                                                                                                                                                                                                                                                                                                                                                 |      |
|                                                        | 38 | 'brain'/exp                                                                                                                                                                                                                                                                                                                                                                                     |      |
|                                                        | 39 | brain:ti,ab,kw OR encephal*:ti,ab,kw OR<br>prosencephalon:ti,ab,kw OR mesencephalon:ti,ab,kw OR<br>rhombencephalon:ti,ab,kw OR cerebrum:ti,ab,kw OR<br>cerebellum:ti,ab,kw OR brainstem:ti,ab,kw OR pons:ti,ab,kw<br>OR cerebra*:ti,ab,kw OR intracranial:ti,ab,kw OR<br>cerebrovascular:ti,ab,kw OR neurovascular:ti,ab,kw OR<br>cranial:ti,ab,kw OR intracerebral:ti,ab,kw OR neuro*:ti,ab,kw |      |
|                                                        | 40 | #38 OR #39                                                                                                                                                                                                                                                                                                                                                                                      |      |
| Imaging techniques combined with brain                 |    |                                                                                                                                                                                                                                                                                                                                                                                                 |      |
|                                                        | 41 | #37 AND #40                                                                                                                                                                                                                                                                                                                                                                                     |      |
| Neuroimaging OR Imaging techniques combined with brain |    |                                                                                                                                                                                                                                                                                                                                                                                                 |      |
|                                                        | 42 | #34 OR #41                                                                                                                                                                                                                                                                                                                                                                                      |      |
| Sets combined                                          |    |                                                                                                                                                                                                                                                                                                                                                                                                 |      |
|                                                        | 43 | #31 AND #42                                                                                                                                                                                                                                                                                                                                                                                     |      |
| Exclusion of conference abstracts                      |    |                                                                                                                                                                                                                                                                                                                                                                                                 |      |
|                                                        | 44 | #43 NOT 'conference abstract'/it                                                                                                                                                                                                                                                                                                                                                                |      |
| Limit to English language                              |    |                                                                                                                                                                                                                                                                                                                                                                                                 |      |
|                                                        | 45 | #43 NOT 'conference abstract'/it AND [english]/lim                                                                                                                                                                                                                                                                                                                                              | 1532 |

**Web of Science Core Collection via Clarivate, first run on 2023-06-20, updated on 2024-01-09 and 2025-08-05.**

**TS=** title, abstract and author keywords.

Indexes:

- WOS.IC: 1993 to 2025
- WOS.CCR: 1985 to 2025
- WOS.SCI: 1900 to 2025

- WOS.AHCI: 1975 to 2025
- WOS.BHCI: 2005 to 2025
- WOS.BSCI: 2005 to 2025
- WOS.ESCI: 2005 to 2025
- WOS.ISTP: 1990 to 2025
- WOS.SSCI: 1900 to 2025
- WOS.ISSHP: 1990 to 2025

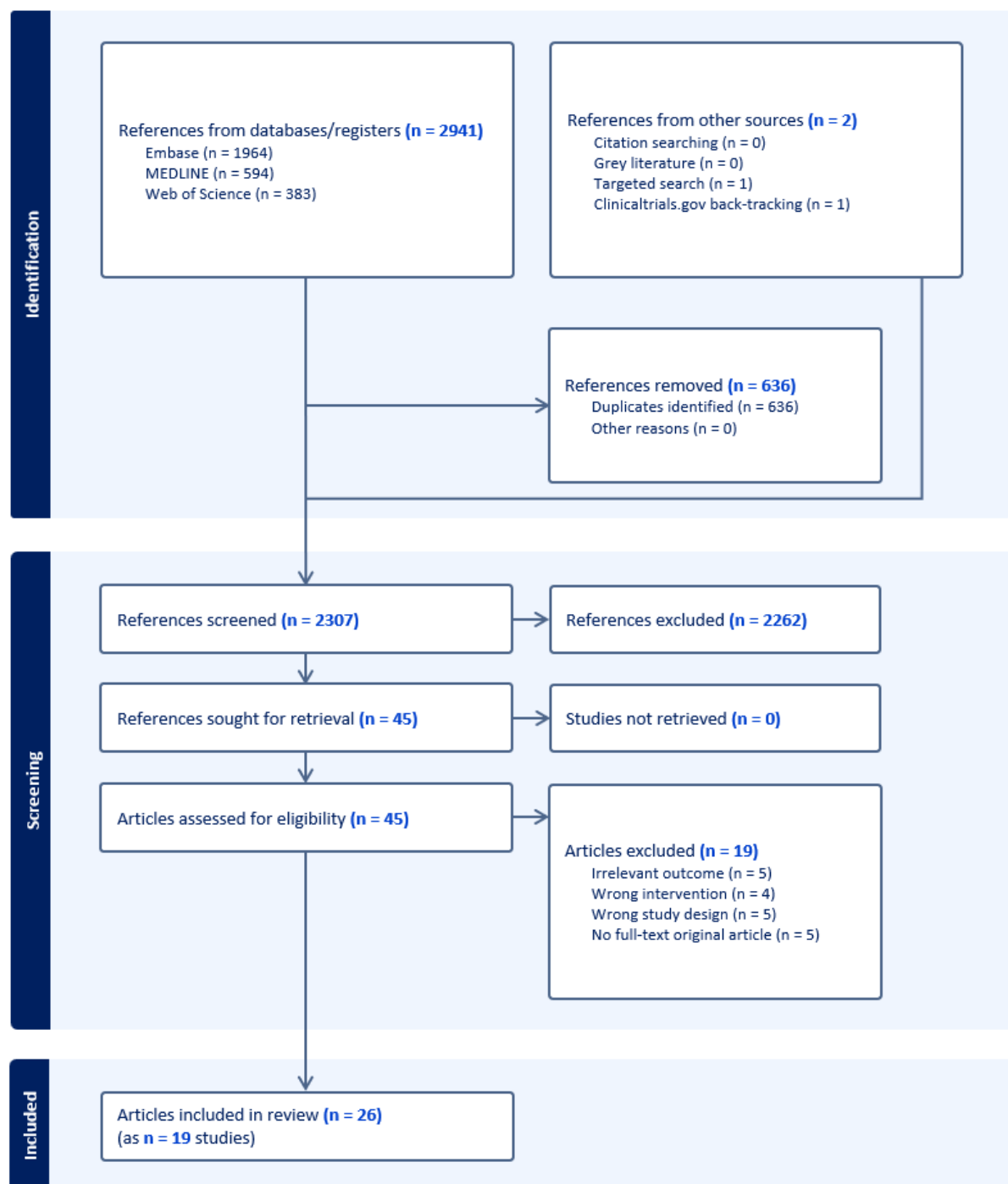
| Search terms |   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Number of results |
|--------------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Probiotics   |   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
|              | 1 | TS=("Escherichia coli Nissle" OR "Escherichia coli strain Nissle")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                   |
|              | 2 | TS=("Bifidus")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
|              | 3 | TS=("Weizmannia coagulans")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                   |
|              | 4 | TS=("Streptococcus salivarius" OR "Streptococcus thermophilus")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                   |
|              | 5 | TS=(Saccharomyce* or "CBS 5926" or "baker yeast" or "baker`s yeast" or "brewer yeast" or "brewer`s yeast" or "s cerevisiae" or "saccaromyces cerevisiae")                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                   |
|              | 6 | TS=("Propionibacterium" or "bacterium acidi propionici" or "Bacillus acnes" or "Corynebacterium acnes" or "Corynebacterium parvum" or "Corynebacterium parvum infectiosum" or "Cutibacterium acnes" or "P. acnes" or "Propionibacteria acnes" or "Propionicibacterium acnes" or "Propionobacterium acnes" or "Propriobacterium acnes" or "strain CN 6134" or "Bacterium acidi propionici a" or "Bacterium acidi propionici d" or "Propionicibacterium freudenreichii" or "Propionicibacterium freudenreichii shermanii" or "Bacille granuleux" or "Corynebacterium granulosum" or "Propionicibacterium granulosum") |                   |
|              | 7 | TS=("Pediococcus pentosaceus")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                   |
|              | 8 | TS=("Limosilactobacillus reuteri" or "Lactobacillus fermentum reuteri" or "Limosilactobacillus reuteri" or "Lactobacillus reuteri")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                   |
|              | 9 | TS=("Limosilactobacillus fermentum" or "Bacillus casei d" or "Bacillus d" or "fermenti, lactobacillus" or "Lactobacillus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                   |

|              |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
|--------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|              |    | cellobiosus" or "lactobacillus fermenti" or "lactobacillus fermentii" or "Lactobacterium fermentum" or "Limosilactobacillus fermentum" or "Lactobacillus fermentum")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |
|              | 10 | TS=(Lactococcus or "Enterococcus seriolicida" or "Enterococcus serolicida" or "Streptococcus garvieae" or "Bacterium lacti*" or "Streptococcus lactis")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |
|              | 11 | TS=("bacillus" or "clostridium licheniforme" or "Denitrobacillus licheniformis" or "Bacillus licheniformis" or "b. subtilis" or "Bacillus natto" or "Bacillus subtilis spore" or "Bacillus uniflagellatus" or "Bacterium subtilis" or "Vibrio subtilis" or "Bacillus subtilis" or "Alkalihalobacillus clausii")                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
|              | 12 | TS=(Lacticaseibacillus or Lactobacillus casei or "Bacillus a" or "Bacillus casei a" or "Bacterium casei a" or "casei, lactobacillus" or "caseobacterium vulgare" or "lactobacilli casei" or "Lactobacterium casei" or "streptobacterium casei" or "Lactobacillus casei")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
|              | 13 | TS=(Bifidobacter* or "Actinobacterium bifidum" or "Actinomyces bifidus" or "Actinomyces parabifidus" or "Bacillus bifidus" or "Bacterium bifidum" or "Bacteroides bifidus" or "Bifidibacterium bifidum" or "Cohnistreptothrix bifidus" or "Nocardia bifida" or "Tissieria bifida")                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |
|              | 14 | TS=(Lactobacill* or "Betabacteri*" or "Lactobacileae" or Lactobacter* or acidophilus* or "enpac" or "lacfer" or "lacteol" or "lactophil" or "Thermobacterium intestinale" or "viacil" or "Bacillus casei g" or "Bacillus g" or "Betabacterium breve" or "Levilactobacillus brevis" or "Bacterium curvatum" or "Bacillus acidificans longissimus" or "Bacillus delbrucki" or "bacillus delbrueckii" or "Bacterium delbrucki" or "Plocamobacterium delbrucki" or "Thermobacterium cereale" or "Ulvina delbrucki" or "Bacillus bulgaricus" or "Bacillus lactis acidii" or "Thermobacterium lactis" or "Bacillus casei e" or "Bacillus e" or "Caseobacterium e" or "Plocamobacterium helveticum" or "thermobacterium helveticum" or "Streptobacterium plantarum") |  |
|              | 15 | TS=(probiotic* or psychobiotic* or pro-biotic* or psycho-biotic*)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |
|              | 16 | #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |  |
| Neuroimaging |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  |
|              | 17 | TS=("neuro imag*" or neuroimag* or "brain activit*" or "brain electrical activity mapping" or "brain cortical thickness" or magnetoencephalography or magneto-encephalography or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |

|                                                                   |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|-------------------------------------------------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
|                                                                   |    | magnetoencephalogram* or "diffusion tensor imag*" or "diffusion tensor magnetic resonance imaging" or "diffusion tensor mri" or "dti mri" or "diffusion tractograph*" or "functional brain imag*" or "brain mapping" or "brain radiography" or "brain scinitsscanning" or neurography or connectome or "dopaminergic mapping" or neuroradiology or "cerebral angiography" or echoencephalography or myelography or pneumoencephalography or eeg or electroencephalogram* or electroencephalography or "brain wave*" or brainwave* or "alpha rhythm" or "beta rhythm" or "delta rhythm" or "gamma rhythm" or "theta rhythm" or "cortical synchronization" or "functional connectivity" or "resting state" or "brain activit*")                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |  |
| Imaging techniques                                                |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|                                                                   | 18 | TS=("magnetic resonance imaging" or "echo-planar imaging" or "fluorine-19 magnetic resonance imaging" or "magnetic resonance angiography" or "nmr imaging" or "mr tomograph*" or "nmr tomograph*" or "steady state free precession mri" or zeugmatograph* or "chemical shift imaging*" or "chemical shift imaging" or "magnetic resonance image*" or "magnetization transfer contrast imaging" or "mri scan*" or "proton spin tomograph*" or fmri* or "functional mri*" or "functional magnetic resonance imaging" or "nuclear magnetic resonance imaging" or "diffusion weighted imaging" or "echo planar imaging" or "fluid-attenuated inversion recovery imaging" or "functional magnetic resonance imaging" or "multiparametric magnetic resonance imaging" or "T1 weighted imaging" or "T2 weighted imaging" or "emission tomography" or "computer assisted emission tomography" or "photon emission tomography" or "positron emission tomograph*" or "positron-emission tomography imaging" or "pet scan*" or "pet imaging*" or "near-infrared spectroscop*" or "near infrared spectroscop*" or "nir spectroscop*" or "near-infrared spectrometr*" or "near infrared spectrometr*" or "functional near-infrared spectroscopy" or "time resolved near infrared spectroscop*") |  |
| Brain                                                             |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|                                                                   | 19 | TS=(brain or encephal* or prosencephalon or mesencephalon or rhombencephalon or cerebrum or cerebellum or brainstem or pons or cerebra* or intracranial or cerebrovascular or neurovascular or cranial or intracerebral or neuro*)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |
| Imaging techniques combined with brain                            |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |
|                                                                   | 20 | #18 AND #19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |
| Neuroimaging techniques OR Imaging techniques combined with brain |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  |

|                           |    |                                     |     |
|---------------------------|----|-------------------------------------|-----|
|                           | 21 | #17 OR #20                          |     |
| Sets combined             |    |                                     |     |
|                           | 22 | #21 AND #16                         |     |
| Limit to English language |    |                                     |     |
|                           | 23 | #21 AND #16 and English (Languages) | 298 |

**Supplementary Figure 2. Flow chart of the selection process**

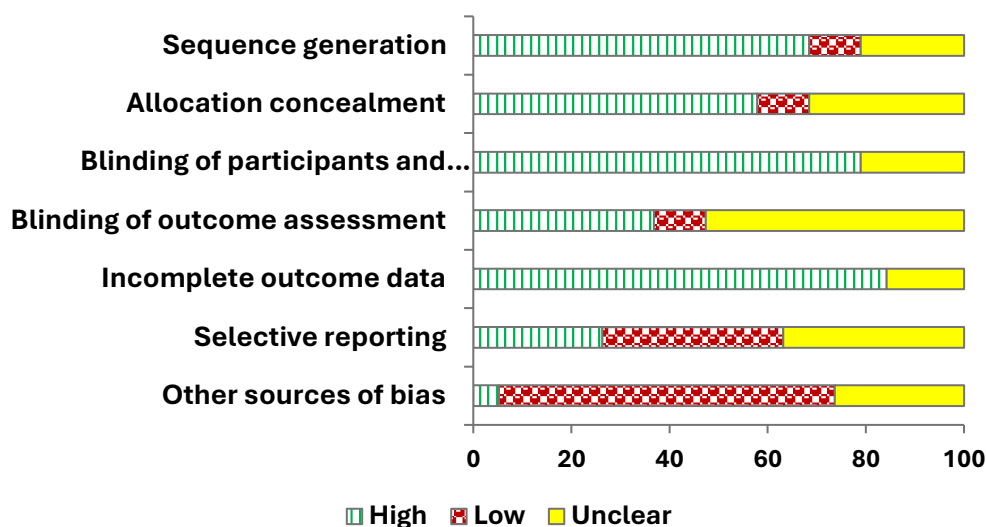


Supplementary Figure

### Supplementary Note 3. Risk of bias and study quality assessment – results

The quality of the studies was scored *High* for the majority of the studies for sequence generation<sup>32-33, 35-36, 40-44, 47-57, 81</sup>. In addition, nearly all the studies were scored as *High* and none of the studies was scored as *Low* for blinding of participants and personnel and incomplete outcome data. However, many studies were *Unclear* in reporting descriptions of allocation concealment<sup>34, 37-39, 45-46, 49</sup> and the blinding of outcome assessment<sup>34, 36-38, 45, 47-52, 56-57</sup>. Several of the included studies did not report on all outcomes included in trial registrations or published study protocols<sup>39-40, 48, 52-57, 81</sup> (scored as low quality, if study published before 2023), had little information in trial registration<sup>31-33, 50-51</sup>, or did not have a trial registration or study protocol<sup>35-38, 45, 49</sup>. Therefore, these studies were scored as *Low* or *Unclear* for selective reporting. Finally, the majority of the included studies were scored *Low* for other sources of bias, as several had *Unclear* selective reporting and had a sponsor involved, had potential sponsor involvement, or had potential funding bias<sup>31-34, 36-39, 41-57</sup>. Despite the obvious commercial interest, the vast majority of probiotic intervention studies with neuroimaging outcomes seem to be published no matter their outcome. We identified only two studies that were completed more than two years ago without any results being published yet (see Supplementary Note 7 below). Thus, we can conclude that this field has a low prevalence of publishing bias.

### Supplementary Figure 4. Study quality assessment – proportions per category.



Supplementary Figure. Colours indicate *High* (green) and *Low* (red) quality, and *Unclear* (yellow) indicates that not enough information was available for judgement of study quality.

### Supplementary Table 5. Study quality assessment – absolute number of studies per category

High and low indicate quality, and unclear indicate that not enough information was available for judgement of study quality

|                                        | High | Low | Unclear |
|----------------------------------------|------|-----|---------|
| Sequence generation                    | 13   | 2   | 4       |
| Allocation concealment                 | 11   | 2   | 6       |
| Blinding of participants and personnel | 15   | 0   | 4       |
| Blinding of outcome assessment         | 7    | 2   | 10      |

|                         |    |    |   |
|-------------------------|----|----|---|
| Incomplete outcome data | 16 | 0  | 3 |
| Selective reporting     | 5  | 7  | 7 |
| Other sources of bias   | 1  | 13 | 5 |

**Supplementary Table 6. Study quality assessment – detailed study-by-study scoring**

| First author and year of study                                                  | Sequence generation | Allocation concealment | Blinding of participants and personnel | Blinding of outcome assessment | Incomplete outcome data | Selective reporting | Other sources of bias |
|---------------------------------------------------------------------------------|---------------------|------------------------|----------------------------------------|--------------------------------|-------------------------|---------------------|-----------------------|
| Malaguarna et al. (2007) <sup>49</sup>                                          | High                | Unclear                | Unclear                                | Unclear                        | High                    | Low                 | Unclear               |
| Tillisch et al. (2013) <sup>31</sup>                                            | Low                 | Low                    | High                                   | Low                            | High                    | Low                 | Low                   |
| Kelly et al. (2017) <sup>34</sup>                                               | Unclear             | Unclear                | Unclear                                | Unclear                        | High                    | High                | Low                   |
| Pinto-Sanchez et al. (2017) <sup>50</sup><br>Martin et al. (2024) <sup>51</sup> | High                | High                   | High                                   | Unclear                        | High                    | Unclear             | Low                   |
| Takada et al. (2017) <sup>36</sup>                                              | High                | High                   | High                                   | Unclear                        | Unclear                 | Low                 | Low                   |
| Bagga et al. (2018) <sup>37</sup><br>Bagga et al. (2019) <sup>38</sup>          | Unclear             | Unclear                | Unclear                                | Unclear                        | Unclear                 | Low                 | Low                   |
| Nakagawa et al. (2018) <sup>45</sup>                                            | Unclear             | Unclear                | Unclear                                | Unclear                        | High                    | Low                 | Low                   |
| Papalini et al. (2019) <sup>32</sup><br>Bloemendaal et al. (2021) <sup>33</sup> | High                | High                   | High                                   | High                           | High                    | Unclear             | Low                   |
| Wang et al. (2019) <sup>39</sup>                                                | Low                 | Unclear                | High                                   | High                           | High                    | Low                 | Low                   |
| Adikari et al. (2020) <sup>35</sup>                                             | High                | Low                    | High                                   | Low                            | Unclear                 | Low                 | High                  |
| Ho et al. (2021) <sup>46</sup>                                                  | Unclear             | Unclear                | High                                   | High                           | High                    | High                | Unclear               |

|                                                                                                                               |      |      |      |         |      |         |         |
|-------------------------------------------------------------------------------------------------------------------------------|------|------|------|---------|------|---------|---------|
| Asaoka et al. (2022) <sup>48</sup>                                                                                            | High | High | High | Unclear | High | Unclear | Low     |
| Ascone et al. (2022) <sup>40, 81</sup>                                                                                        | High | High | High | High    | High | Unclear | Unclear |
| Edebol-Carlman et al. (2022) <sup>41</sup><br><br>Rode et al. (2022) <sup>42</sup><br><br>Rode et al. (2022) <sup>43</sup>    | High | High | High | High    | High | High    | Low     |
| Schaub et al. (2022) <sup>53</sup><br><br>Yamanbaeva et al. (2023) <sup>54</sup><br><br>Schneider et al. (2023) <sup>55</sup> | High | High | High | High    | High | Unclear | Unclear |
| Kikuchi-Hayakawa et al. (2023) <sup>47</sup>                                                                                  | High | High | High | Unclear | High | High    | Low     |
| Mutoh et al. (2023) <sup>44</sup>                                                                                             | High | High | High | High    | High | High    | Low     |
| Ranisavljev et al. (2025) <sup>52, 57</sup>                                                                                   | High | High | High | Unclear | High | Unclear | Low     |
| Li et al. (2025) <sup>56</sup>                                                                                                | High | High | High | Unclear | High | Unclear | Unclear |

### Supplementary Note 7. Assessment of potential publication bias – results

On clinicaltrials.gov, we identified a small number of studies conducted in participants aged 18 years and older whose neuroimaging outcomes were not published. Studies assessing populations including participants with a lower age were excluded from the judgement, even if the age range spanned above the age of 18.

One study was found to be completed in 2024 (NCT06013072), back-tracking via the NCT number provided its publication (Ranisavljev 2025<sup>52, 57</sup>). The results of this study have been included in this review, see main text.

One study with status “completed” in 2017 (NCT02417454) as well as one study with status “unknown” and estimated study completion date in 2021 without update (NCT03877393, protocol published as Karakula-Juchnowicz 2019<sup>74</sup>), do not seem to be published. One study (with published protocol Wallace 2020<sup>74</sup>) stated termination due to covid-19 in 2021 (NCT03277586) and another study was withdrawn in 2016 due to unsuccessful recruitment (NCT02552862).

One study with status “completed” in 2020, so far published baseline data but no intervention outcomes (NCT05029765, Cardelo 2022<sup>76</sup>). One study with the status “completed” and an actual study completion date in 2022 (NCT03991195) and one completed in 2024 (NCT05801042) were not found to be published yet. The neuroimaging outcomes of three

studies with status “completed” and an actual study completion date in 2022 (NCT03893162, NCT04823533) or 2023 (NCT05145881) were found to be not published yet, however, the results of other outcome parameters had been published (Nikolova 2023<sup>78</sup>, Nikolova 2025<sup>79</sup>, Morales-Torres 2023<sup>80</sup>, Hsu 2023<sup>77</sup>). Several studies with estimated completion dates in the future seem to be ongoing. We are aware that it takes time from study completion to publication, hence we predict that the majority of those trials will be published soon.

**Supplementary Table 8. Additional information on probiotic interventions such as commercial product name, product manufacturer and study funding source**

| Study                                                                           | Probiotic strain(s)                                  | Commercial name and manufacturer of the study product | The study products / probiotic strains provided by                                                                    | Company involvement in the study                                                                                                                              |
|---------------------------------------------------------------------------------|------------------------------------------------------|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Studies analysing single-strain products</b>                                 |                                                      |                                                       |                                                                                                                       |                                                                                                                                                               |
| Malaguamera et al. (2007) <sup>49</sup>                                         | <i>Bifidobacterium longum</i> W11                    | Zirfos, manufactured by Alfa Wasserman, Italy         | -                                                                                                                     | Funding sources not reported.                                                                                                                                 |
| Kelly et al. (2017) <sup>34</sup>                                               | <i>Lactocaseibacillus rhamnosus</i>                  | -                                                     | The study products were provided by Alimentary Health Ltd, Ireland.                                                   | One of the authors is affiliated to Alimentary Health Ltd, Ireland                                                                                            |
| Takada et al. (2017) <sup>36</sup>                                              | <i>Lactocaseibacillus paracasei</i> Shirota YIT 9029 | -                                                     | The probiotic strain was obtained from the Culture Collection Research Laboratory of Yakult Central Institute, Japan. | The study received funding from Yakult Honsha Co., Ltd, Japan.<br>Eight of the authors received salaries from Yakult Honsha Co., Ltd, Japan.                  |
| Pinto-Sanchez et al. (2017) <sup>50</sup><br>Martin et al. (2024) <sup>51</sup> | <i>Bifidobacterium longum</i> NCC3001                | -                                                     | -                                                                                                                     | The study received funding from Nestlé SA, Switzerland.<br>Two of the authors were employed by Nestec SA, Switzerland.<br>Two of the authors were employed by |

|                                              |                                                      |                                                                |                                                                                                                       |                                                                                                                                |
|----------------------------------------------|------------------------------------------------------|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
|                                              |                                                      |                                                                |                                                                                                                       | Nestlé<br>Institute of<br>Health<br>Sciences<br>SA.                                                                            |
| Nakagawa et al. (2018) <sup>45</sup>         | <i>Lactobacillus helveticus</i> MIKI-020             | -                                                              | MIKI Corporation,<br>Japan                                                                                            | The study received funding from MIKI Corporation, Japan.<br><br>Three of the authors were employed by MIKI Corporation, Japan. |
| Wang et al. (2019) <sup>39</sup>             | <i>Bifidobacterium longum</i> 1714™                  | 1714-Serenitas, manufactured by Alimentary Health Ltd, Ireland | The study products were provided by Alimentary Health Ltd, Ireland.                                                   | One of the authors is employed by Alimentary Health Ltd, Ireland.                                                              |
| Adikari et al. (2020) <sup>35</sup>          | <i>Lactocaseibacillus paracasei</i> Shirota          | Commercially available, manufacturer not named                 | -                                                                                                                     | No                                                                                                                             |
| Ho et al. (2021) <sup>46</sup>               | <i>Lactiplantibacillus plantarum</i> PS128           | -                                                              | The study products s were provided by Bened Biomedical Co. Ltd., Taiwan.                                              | No                                                                                                                             |
| Asaoka et al. (2022) <sup>48</sup>           | <i>Bifidobacterium breve</i> MCC1274                 | -                                                              | The probiotic strain was provided by Morinaga Milk Industries Co., Ltd, Japan.                                        | Two of the authors were employed by Morinaga Milk Industries Co., Ltd, Japan.                                                  |
| Kikuchi-Hayakawa et al. (2023) <sup>47</sup> | <i>Lactocaseibacillus paracasei</i> Shirota YIT 9029 | -                                                              | The probiotic strain was obtained from the Culture Collection Research Laboratory of Yakult Central Institute, Japan. | All authors were employed by Yakult Honsha Co., Ltd, Japan.                                                                    |
| Mutoh et al. (2023) <sup>44</sup>            | <i>Bifidobacterium breve</i> M-16V                   | -                                                              | The study products were provided by Morinaga Milk                                                                     | The study received funding from                                                                                                |

|                                                |                                                                                                                                                        |                                                                                                                     |                                                                                                                                                                                                               |                                                                                                                                                                 |
|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                |                                                                                                                                                        |                                                                                                                     | Industries Co., Ltd,<br>Japan.                                                                                                                                                                                | Morinaga<br>Milk<br>Industries<br>Co., Ltd,<br>Japan.<br><br>Six of the<br>authors were<br>employed by<br>Morinaga<br>Milk<br>Industries<br>Co., Ltd,<br>Japan. |
| Li et al.<br>(2025) <sup>56</sup>              | <i>Pediococcus<br/>acidilactici</i><br>CCFM6432                                                                                                        | -                                                                                                                   | The probiotic product<br>was developed by the<br>School of Food<br>Science and<br>Technology and<br>produced by the<br>Yangzhou Institute of<br>Food Biotechnology,<br>both at Jiangnan<br>University, China. | Publicly<br>funded.                                                                                                                                             |
| <b>Studies analysing multi-strain products</b> |                                                                                                                                                        |                                                                                                                     |                                                                                                                                                                                                               |                                                                                                                                                                 |
| Tillisch et al.<br>(2013) <sup>31</sup>        | <i>Bifidobacterium lactis</i><br><br><i>Lactobacillus<br/>bulgaricus</i><br><br><i>Lactococcus lactis</i><br><br><i>Streptococcus<br/>thermophilus</i> | -                                                                                                                   | The product was<br>prepared at Danone<br>Research, France.                                                                                                                                                    | The study<br>received<br>funding from<br>Danone<br>Research,<br>France.<br><br>Three of the<br>authors were<br>employed by<br>Danone<br>Research,<br>France.    |
| Bagga et al.<br>(2018) <sup>37</sup>           | <i>Bifidobacterium<br/>bifidum</i> W23<br><br><i>Bifidobacterium lactis</i><br>W51                                                                     | OmniBiotic® Stress Repair,<br>manufactured by Institut<br>Allergosan, Austria.                                      | -                                                                                                                                                                                                             | Study<br>received<br>funding from<br>Institut<br>Allergosan,<br>Austria and                                                                                     |
| Bagga et al.<br>(2019) <sup>38</sup>           | <i>Bifidobacterium lactis</i><br>W52                                                                                                                   | Probiotic mix in the product<br>called Ecologic®825,<br>manufactured by Winclove<br>Probiotics, the<br>Netherlands. |                                                                                                                                                                                                               | Winclove<br>Probiotics,<br>the<br>Netherlands.                                                                                                                  |
|                                                | <i>Lacticaseibacillus<br/>casei</i> W56                                                                                                                |                                                                                                                     |                                                                                                                                                                                                               |                                                                                                                                                                 |

|                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                     |                                                                         |   |                                                                                                                                                      |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|---|------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                     | <i>Lacticaseibacillus paracasei</i> W20<br><br><i>Lactiplantibacillus plantarum</i> W62<br><br><i>Lactobacillus acidophilus</i> W22<br><br><i>Lactococcus lactis</i> W19<br><br><i>Ligilactobacillus salivarius</i> W24                                                                                                                                                             |                                                                         |   |                                                                                                                                                      |
| Papalini et al. (2019) <sup>32</sup><br><br>Bloemendaal et al. (2021) <sup>33</sup> | <i>Bifidobacterium bifidum</i> W23<br><br><i>Bifidobacterium lactis</i> W51<br><br><i>Bifidobacterium lactis</i> W52<br><br><i>Lacticaseibacillus paracasei</i> W56<br><br><i>Lactobacillus acidophilus</i> W37<br><br><i>Lactococcus lactis</i> W19<br><br><i>Lactococcus lactis</i> W58<br><br><i>Levilactobacillus brevis</i> W63<br><br><i>Ligilactobacillus salivarius</i> W24 | Ecologic®Barrier, manufactured by Winclove Probiotics, the Netherlands. | - | The study received funding from Winclove Probiotics, the Netherlands.<br><br>One of the authors is employed by Winclove Probiotics, the Netherlands. |
| Ascone et al. (2022) <sup>40, 81</sup>                                              | <i>Bifidobacterium breve</i><br><br><i>Bifidobacterium lactis</i> NCIMB 30435<br><br><i>Bifidobacterium lactis</i> NCIMB 30436                                                                                                                                                                                                                                                      | Vivomixx®, manufactured by Mendes S.A., Switzerland                     | - | No                                                                                                                                                   |

|                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                      |                                                                             |                                                                 |                                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                               | <i>Lactocaseibacillus paracasei</i><br><br><i>Lactiplantibacillus plantarum</i><br><br><i>Lactobacillus acidophilus</i><br><br><i>Lactobacillus helveticus</i><br><br><i>Streptococcus thermophilus</i>                                                                                                                                              |                                                                             |                                                                 |                                                                                                                                   |
| Edebol-Carlamn et al. (2022) <sup>41</sup><br><br>Rode et al. (2022) <sup>42</sup><br><br>Rode et al. (2022) <sup>43</sup>    | <i>Bifidobacterium longum</i> R0175<br><br><i>Lactiplantibacillus plantarum</i> R1012<br><br><i>Lactobacillus helveticus</i> R0052                                                                                                                                                                                                                   | Puraflo, GSK Consumer Healthcare, Italy, manufactured by SIIT S.r.l., Italy | -                                                               | The study received funding from Pfizer Consumer Healthcare.<br><br>One of the authors was employed by Pfizer Consumer Healthcare. |
| Schaub et al. (2022) <sup>53</sup><br><br>Yamanbaeva et al. (2023) <sup>54</sup><br><br>Schneider et al. (2023) <sup>55</sup> | <i>Bifidobacterium breve</i> NCIMB 30441<br><br><i>Bifidobacterium lactis</i> NCIMB 30435<br><br><i>Bifidobacterium lactis</i> NCIMB 30436<br><br><i>Lactocaseibacillus paracasei</i> NCIMB 30439<br><br><i>Lactiplantibacillus plantarum</i> NCIMB 30437<br><br><i>Lactobacillus acidophilus</i> NCIMB 30442<br><br><i>Lactobacillus helveticus</i> | Vivomixx®, manufactured by Mendes S.A., Switzerland                         | The probiotic product was provided by Mendes S.A., Switzerland. | No                                                                                                                                |

|                                            |                                                                                                |                                                                                                      |                                                                 |                                                                                                                      |
|--------------------------------------------|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
|                                            | <i>Streptococcus thermophilus</i> NCIMB 30438                                                  |                                                                                                      |                                                                 |                                                                                                                      |
| Ranisavljev et al. (2025) <sup>52,57</sup> | <i>Lactocaseibacillus rhamnosus</i> DSM 32550                                                  |                                                                                                      |                                                                 | The study received funding from DSM Nutritional Products AG.                                                         |
|                                            | <i>Lactiplantibacillus plantarum</i> DSM 34532 (formerly known as <i>L. plantarum</i> TIFN101) | Some part of the product is part of <i>Humiome</i> ®, manufactured by DSM Firmenich AG, Switzerland. | The study products were provided by DSM-Firmenich, Switzerland. | One of the authors was employed by DSM Nutritional Products AG, affiliation DSM-Firmenich, Health, Nutrition & Care. |
|                                            | <i>Bifidobacterium lactis</i> DSM 32269                                                        |                                                                                                      |                                                                 |                                                                                                                      |
|                                            | <i>Bifidobacterium longum</i> DSM 32946                                                        |                                                                                                      |                                                                 |                                                                                                                      |

**Supplementary Table 9. Overview of analyses bases applied in the various studies for the assessment of intervention effects on brain health outcomes**

|                                                                                                                            | Whole-brain analysis? | Selected brain regions included in targeted analyses                                                                                                                                                  |
|----------------------------------------------------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Studies utilising MRI, fMRI, ASL, DTI</i>                                                                               |                       |                                                                                                                                                                                                       |
| Tillisch et al. (2013) <sup>31</sup>                                                                                       | yes                   | Additionally, amygdala, insula subregions, somatosensory regions<br><br>Posthoc analyses with data-driven seed selection                                                                              |
| Pinto-Sanchez et al. (2017) <sup>50</sup><br>Martin et al. (2024) <sup>51</sup>                                            | yes                   | Additionally, amygdala                                                                                                                                                                                |
| Bagga et al. (2018) <sup>37</sup><br><br>Bagga et al. (2019) <sup>38</sup>                                                 | yes                   | no                                                                                                                                                                                                    |
| Papalini et al. (2019) <sup>32</sup><br>Bloemendaal et al. (2021) <sup>33</sup>                                            | yes                   | no                                                                                                                                                                                                    |
| Asaoka et al. (2022) <sup>48</sup>                                                                                         | yes                   | Additionally, study-specific, selected by data-driven approach                                                                                                                                        |
| Ascone et al. (2022) <sup>40, 81</sup>                                                                                     | yes                   | Additionally, hippocampus                                                                                                                                                                             |
| Edebol-Carlman et al. (2022) <sup>41</sup><br><br>Rode et al. (2022) <sup>42</sup><br><br>Rode et al. (2022) <sup>43</sup> | Yes                   | Additionally:<br><br>For rsfMRI: default mode network, salience network, frontoparietal network, language network, cerebellar network, dorsal attention network, sensorimotor network, visual network |

|                                                                                                                                   |                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                   |                                                                                                                     | <p>For EAT#: precuneus, amygdala, thalamus, (para)hippocampus, caudate, putamen, cingulate gyrus, temporal gyrus, prefrontal cortex, frontal cortex, insula</p> <p>MIST#: thalamus, insula, caudate, putamen, cingulate cortex, temporal gyrus, orbital cortex, prefrontal cortex</p> <p>#reported whole-brain results, but draw conclusions on regions of interest</p> |
| <p>Schaub et al. (2022)<sup>53</sup></p> <p>Yamanbaeva et al. (2023)<sup>54</sup></p> <p>Schneider et al. (2023)<sup>55</sup></p> | <p>For emotional task: yes</p> <p>For working memory task: yes</p> <p>For voxel-based morphometry analyses: yes</p> | <p>For DTI: Uncinate fasciculus tract</p> <p>For rsfMRI# and ASL:</p> <p>Orbitofrontal cortex, temporal pole, insula, hippocampus, amygdala, subcallosal cortex/subgenual anterior cingulate cortex</p> <p>Additionally, working memory task: hippocampus</p> <p>#Posthoc region of interest analyses</p>                                                               |
| <i>Studies utilising fNIRS</i>                                                                                                    |                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                         |
| Mutoh et al. (2023) <sup>44</sup>                                                                                                 | yes                                                                                                                 | Focused on reporting prefrontal laterality index                                                                                                                                                                                                                                                                                                                        |
| <i>Studies utilising MEG</i>                                                                                                      |                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                         |
| Wang et al. (2019) <sup>39</sup>                                                                                                  | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Studies utilising EEG</i>                                                                                                      |                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                         |
| Malaguarnera et al. (2007) <sup>49</sup>                                                                                          | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| Kelly et al. (2017) <sup>34</sup>                                                                                                 | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| Takada et al. (2017) <sup>36</sup>                                                                                                | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| Nakagawa et al. (2018) <sup>45</sup>                                                                                              | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| Adikari et al. (2020) <sup>35</sup>                                                                                               | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| Ho et al. (2021) <sup>46</sup>                                                                                                    | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| Kikuchi-Hayakawa et al. (2023) <sup>47</sup>                                                                                      | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| Li et al. (2025) <sup>56</sup>                                                                                                    | yes                                                                                                                 | no                                                                                                                                                                                                                                                                                                                                                                      |
| <i>Studies utilising MRS</i>                                                                                                      |                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                         |
| Ranisavljev et al. (2025) <sup>52, 57</sup>                                                                                       | no                                                                                                                  | Thalamus, frontal, precentral, paracentral, and parietal white and grey matter                                                                                                                                                                                                                                                                                          |

MRI: magnetic resonance imaging; fMRI: functional magnetic resonance imaging; ASL: arterial spin labelling; DTI: diffusion tensor imaging; fNIRS: functional near-infrared spectroscopy; MEG: magnetoencephalography; EEG: electroencephalography; MRS: magnetic resonance spectroscopy.



## PRISMA 2020 Checklist

**Supplementary Table 10. PRISMA checklist**

| Section and Topic             | Item # | Checklist item                                                                                                                                                                                                                                                                                       | Location where item is reported                    |
|-------------------------------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| <b>TITLE</b>                  |        |                                                                                                                                                                                                                                                                                                      |                                                    |
| Title                         | 1      | Identify the report as a systematic review.                                                                                                                                                                                                                                                          | Page 1                                             |
| <b>ABSTRACT</b>               |        |                                                                                                                                                                                                                                                                                                      |                                                    |
| Abstract                      | 2      | See the PRISMA 2020 for Abstracts checklist.                                                                                                                                                                                                                                                         | Page 1-2                                           |
| <b>INTRODUCTION</b>           |        |                                                                                                                                                                                                                                                                                                      |                                                    |
| Rationale                     | 3      | Describe the rationale for the review in the context of existing knowledge.                                                                                                                                                                                                                          | Pages 3-5                                          |
| Objectives                    | 4      | Provide an explicit statement of the objective(s) or question(s) the review addresses.                                                                                                                                                                                                               | Pages 3-5                                          |
| <b>METHODS</b>                |        |                                                                                                                                                                                                                                                                                                      |                                                    |
| Eligibility criteria          | 5      | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.                                                                                                                                                                                          | Pages 23-24                                        |
| Information sources           | 6      | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.                                                                                            | Page 23                                            |
| Search strategy               | 7      | Present the full search strategies for all databases, registers and websites, including any filters and limits used.                                                                                                                                                                                 | Pages 23 and Supplementary Note 1                  |
| Selection process             | 8      | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.                     | Pages 23-24                                        |
| Data collection process       | 9      | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. | Page 23-24                                         |
| Data items                    | 10a    | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.                        | Prospero entry, ID given on page 22<br>Pages 24-25 |
|                               | 10b    | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.                                                                                         | Pages 24-25                                        |
| Study risk of bias assessment | 11     | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.                                    | Pages 24-25                                        |
| Effect measures               | 12     | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.                                                                                                                                                                  | Page 24                                            |
| Synthesis methods             | 13a    | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).                                                                                 | Pages 23-24, Table 1                               |
|                               | 13b    | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.                                                                                                                                                | -                                                  |
|                               | 13c    | Describe any methods used to tabulate or visually display results of individual studies and syntheses.                                                                                                                                                                                               | Page 24                                            |
|                               | 13d    | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.                                          | Page 24                                            |



## PRISMA 2020 Checklist

| Section and Topic             | Item # | Checklist item                                                                                                                                                                                                                                                                       | Location where item is reported |
|-------------------------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
|                               | 13e    | Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).                                                                                                                                                 | -                               |
|                               | 13f    | Describe any sensitivity analyses conducted to assess robustness of the synthesized results.                                                                                                                                                                                         | -                               |
| Reporting bias assessment     | 14     | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).                                                                                                                                                              | Pages 24-25                     |
| Certainty assessment          | 15     | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.                                                                                                                                                                                | -                               |
| <b>RESULTS</b>                |        |                                                                                                                                                                                                                                                                                      |                                 |
| Study selection               | 16a    | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.                                                                                         | Supplementary Figure 2, Page 5  |
|                               | 16b    | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.                                                                                                                                                          | Pages 17-22                     |
| Study characteristics         | 17     | Cite each included study and present its characteristics.                                                                                                                                                                                                                            | Table 1                         |
| Risk of bias in studies       | 18     | Present assessments of risk of bias for each included study.                                                                                                                                                                                                                         | Supplementary Information 3-6   |
| Results of individual studies | 19     | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.                                                     | Pages 5-16, Tables 1-7          |
| Results of syntheses          | 20a    | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.                                                                                                                                                                               | -                               |
|                               | 20b    | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | -                               |
|                               | 20c    | Present results of all investigations of possible causes of heterogeneity among study results.                                                                                                                                                                                       | -                               |
|                               | 20d    | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.                                                                                                                                                                           | -                               |
| Reporting biases              | 21     | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.                                                                                                                                                              | Supplementary Note 7            |
| Certainty of evidence         | 22     | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.                                                                                                                                                                                  | -                               |
| <b>DISCUSSION</b>             |        |                                                                                                                                                                                                                                                                                      |                                 |
| Discussion                    | 23a    | Provide a general interpretation of the results in the context of other evidence.                                                                                                                                                                                                    | Pages 17-22                     |
|                               | 23b    | Discuss any limitations of the evidence included in the review.                                                                                                                                                                                                                      | Pages 17-22                     |
|                               | 23c    | Discuss any limitations of the review processes used.                                                                                                                                                                                                                                | Pages 17-22                     |
|                               | 23d    | Discuss implications of the results for practice, policy, and future research.                                                                                                                                                                                                       | Pages 17-22                     |
| <b>OTHER INFORMATION</b>      |        |                                                                                                                                                                                                                                                                                      |                                 |
| Registration and protocol     | 24a    | Provide registration information for the review, including register name and registration number, or state that the review was not registered.                                                                                                                                       | Page 22                         |
|                               | 24b    | Indicate where the review protocol can be accessed, or state that a protocol was not prepared.                                                                                                                                                                                       | Page 22                         |
|                               | 24c    | Describe and explain any amendments to information provided at registration or in the protocol.                                                                                                                                                                                      | None                            |
| Support                       | 25     | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.                                                                                                                                                        | Page 25                         |



## PRISMA 2020 Checklist

| Section and Topic                              | Item # | Checklist item                                                                                                                                                                                                                             | Location where item is reported |
|------------------------------------------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| Competing interests                            | 26     | Declare any competing interests of review authors.                                                                                                                                                                                         | Page 26                         |
| Availability of data, code and other materials | 27     | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. | Page 25                         |

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71  
For more information, visit: <http://www.prisma-statement.org/>