Efficacy of an Irritable Bowel Syndrome diet in treating Small Intestinal Bacterial Overgrowth: A Narrative Review †

Justyna Paulina Wielgosz
Małgorzata Ewa Drywień
Nicole Domanski
Department of Nutrition, Institute of Human Nutrition Sciences
Warsaw University of Life Sciences, 02-776 Warsaw, Poland
Faculty of Pharmaceutical Sciences, University of British Columbia. Vancouver, BC, Canada

MICROBIOTA

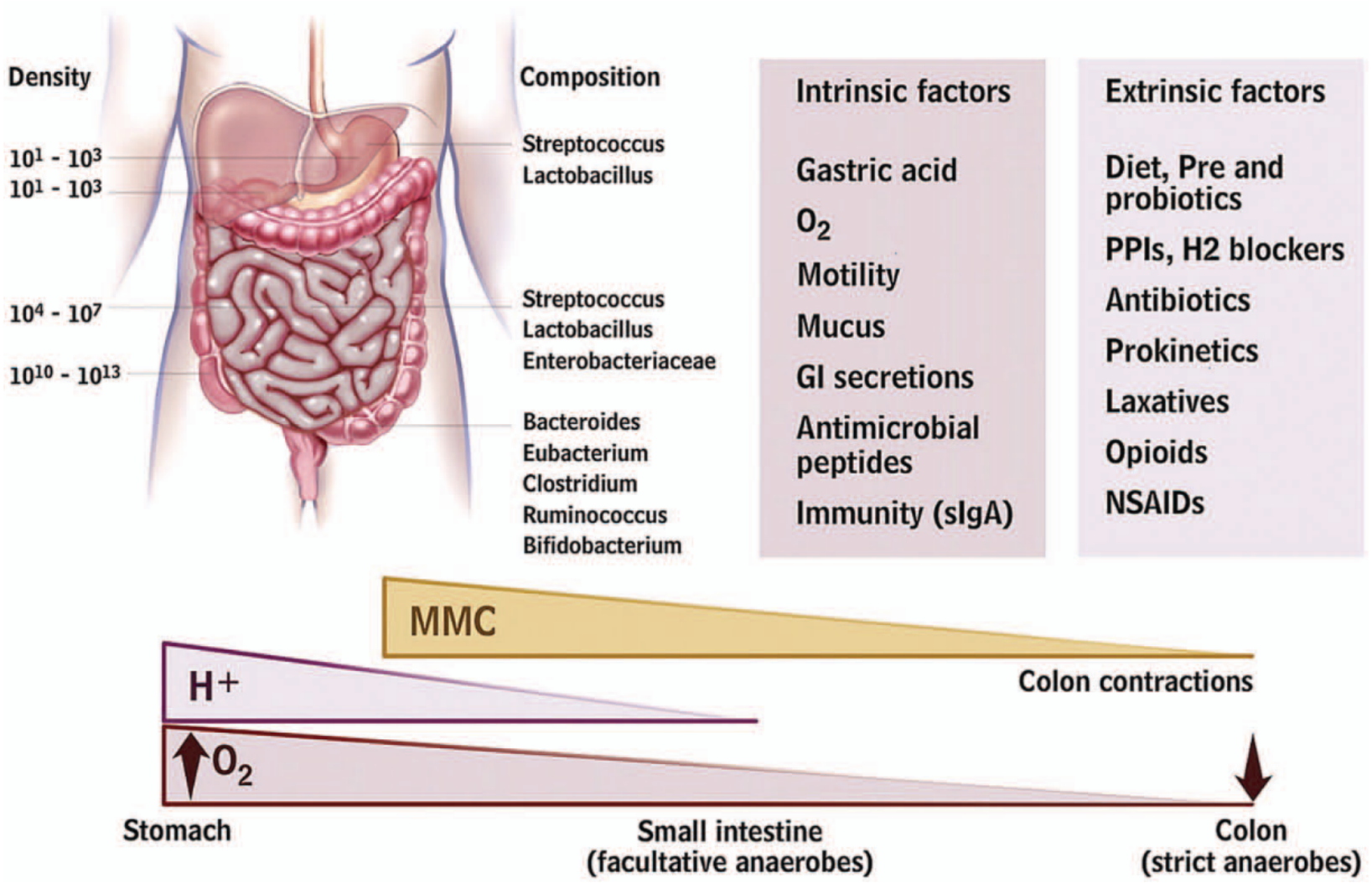
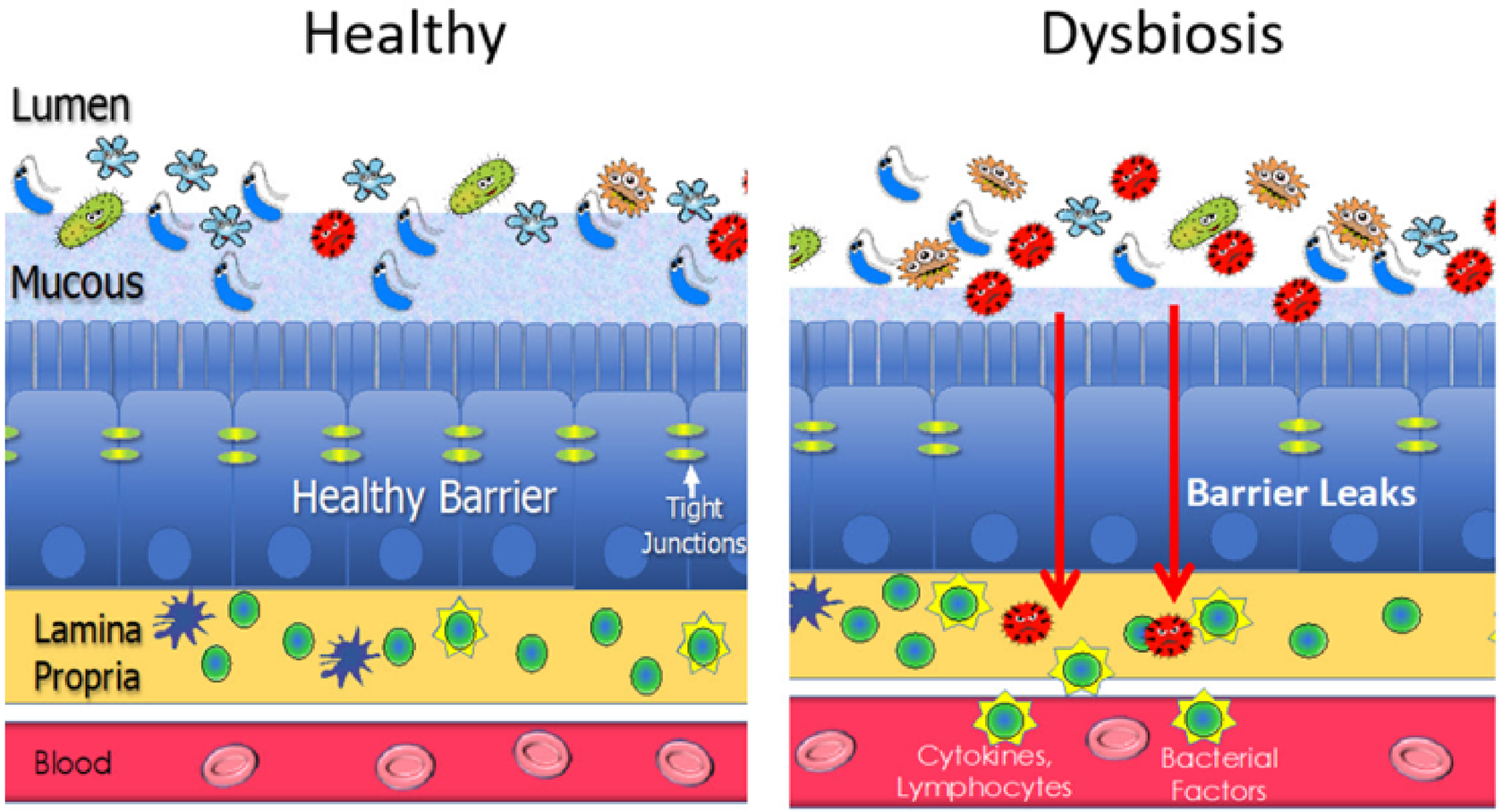


Figure 1.Multiple intrinsic and extrinsic factors can affect the microbiota.

Bohm et al., 2013



DYSBIOSIS

Imbalance of the gut microbiota

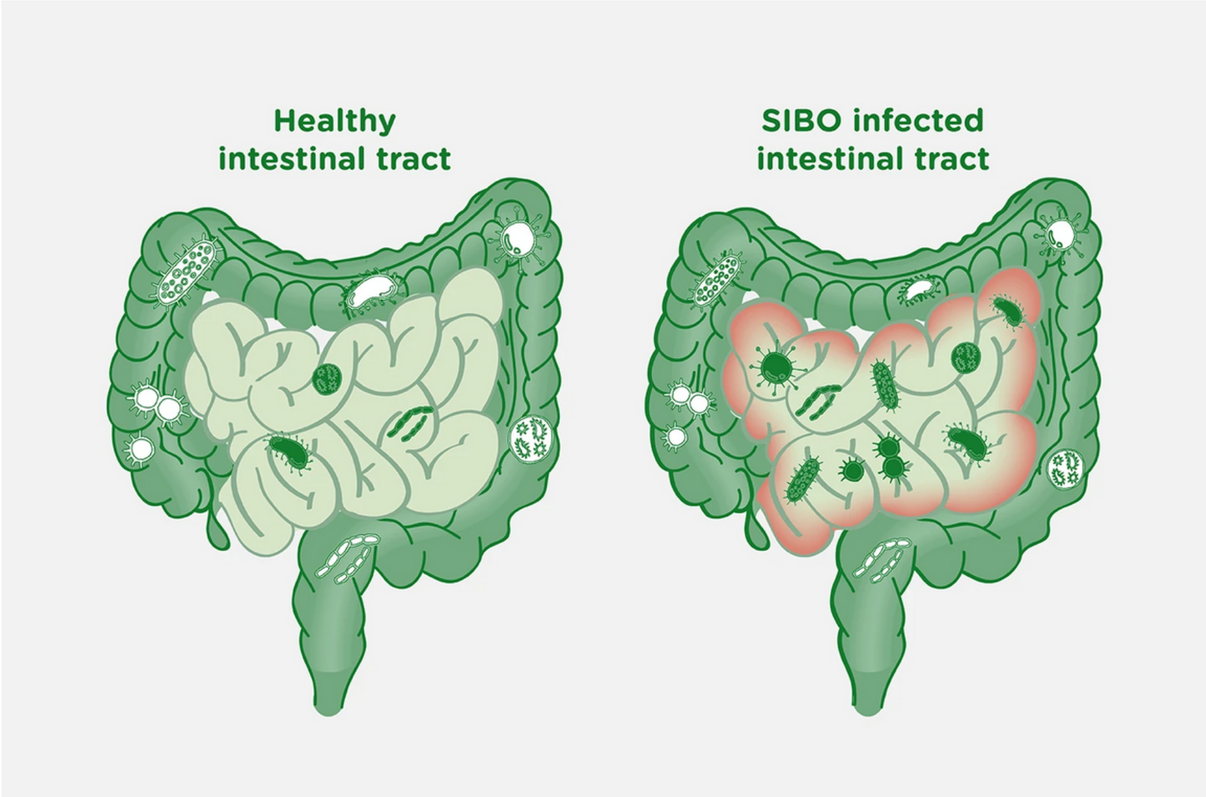
Figure 2. A state of Eubiosis and Dysbiosis.

MCcabe, 2015

SIBO

excessive amount of bacteria or methanogens in the small intestine

Pseudomonas aeruginosa, Escherichia coli, Klebisiella pneumoniae, Methanobrevibacter smithii, Enterococcus faecalis, Streptococcus and Staphylococcus



graphics: https://biokplus.com/

Pyleris et al., 2012

SIBO

Carbohydrate fermentation in the small intestine

Gastrointestinal symptoms

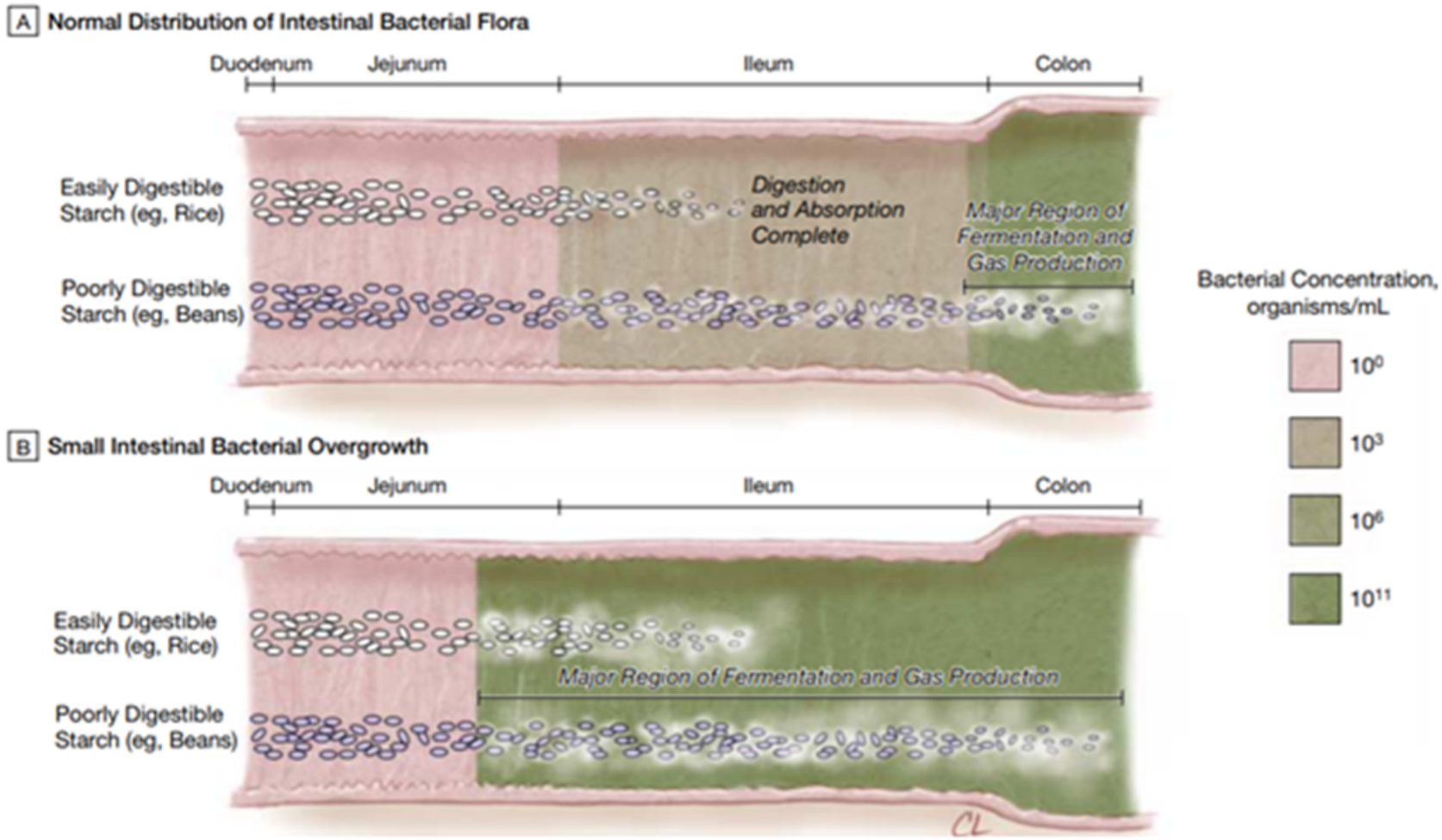


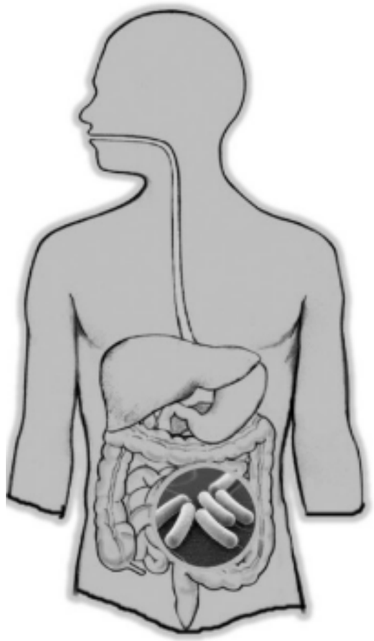
Figure 3. Distribution of Intestinal Bacterial Flora in Normal Gut and in Small Intestinal Bacterial Overgrowth

Lin, 2004

SIBO

is
highly prevalent
in

IBS.



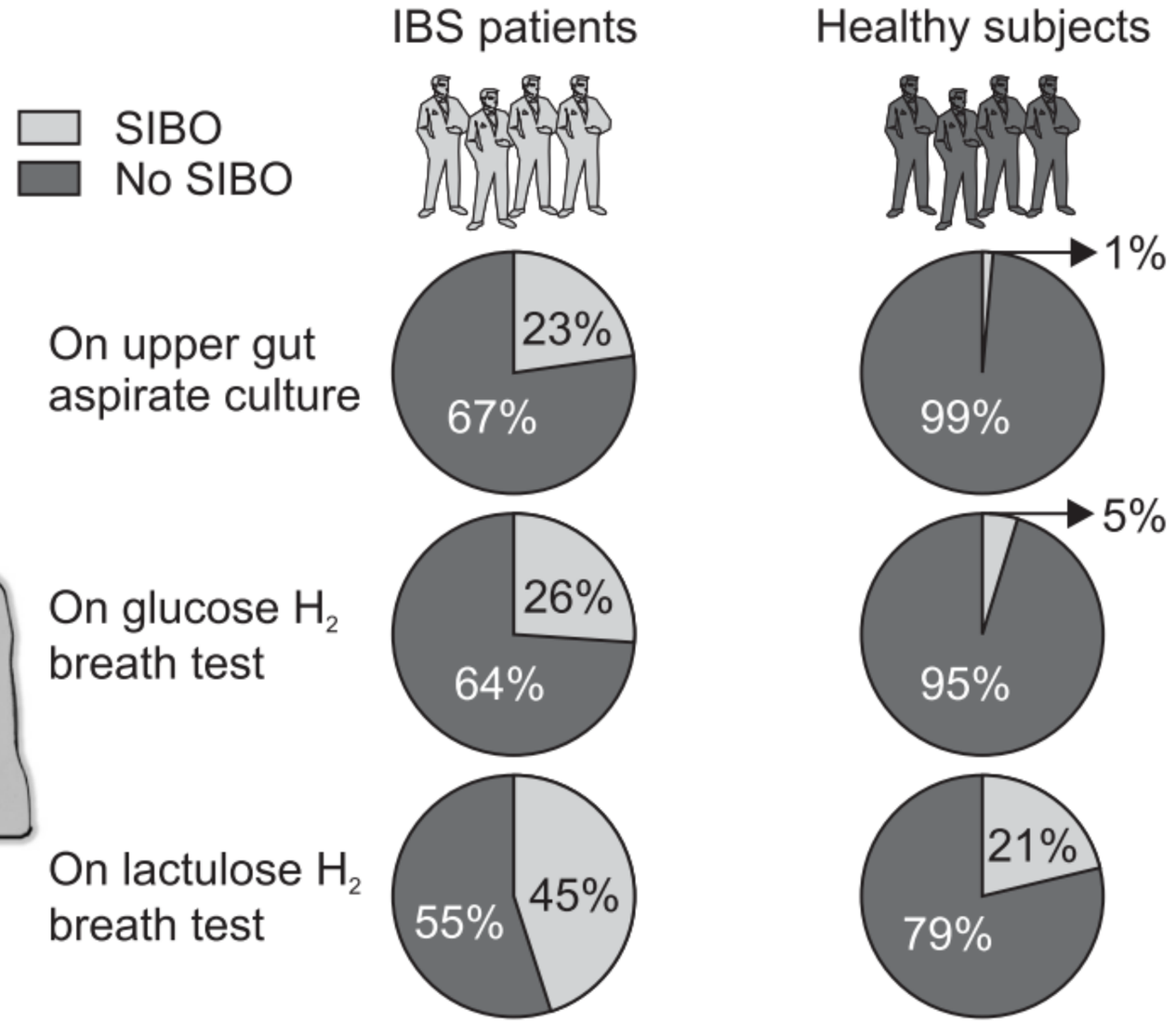


Figure 4. The frequency of SIBO using different diagnosis methods among patients with IBS.

Uday C. Ghoshal, 2017

Narrative review

The objective of this study is to determine whether the current recommendations regarding nutrition in IBS would be suitable for patients with SIBO.

STUDIES ON PEOPLE

with SIBO, IBS, FGID's, healthy participants

TIME FRAME

2012-2022

DATA BASES

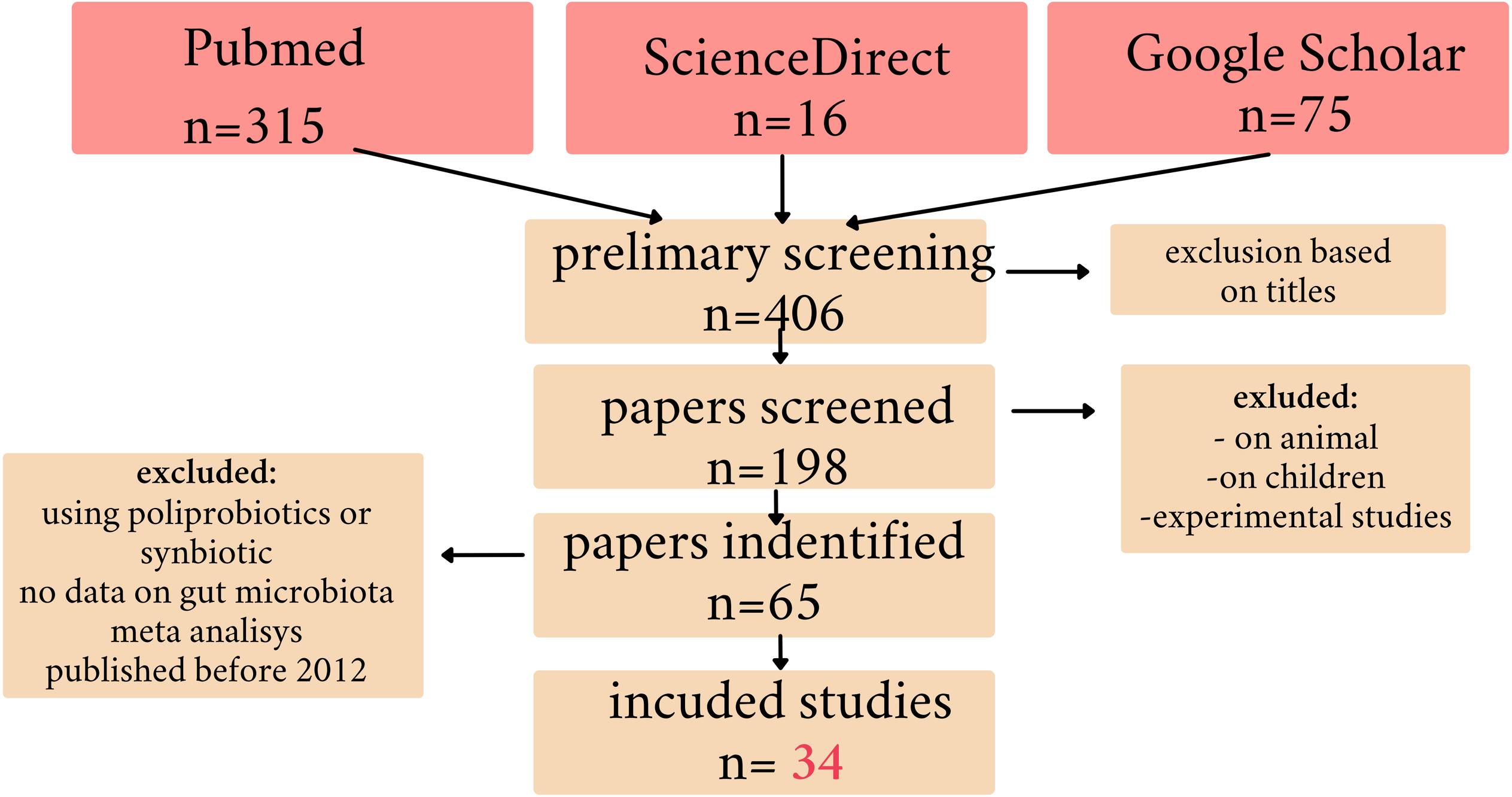
Pubmed, Google Scholar, ScienceDirect

KEY WORDS

microbiota; dysbiosis; IBS; SIBO; FODMAP; probiotics; prebiotics; MMC

SEVERAL EXPLORE CATEGORIES

(low fodmap OR high fodmap)
(clinical trial OR randomized controlled trail OR cross-sectional study OR crossover study OR retrospective study)
(ibs OR irritable bowel syndrome)
(sibo OR small intestinal bacterial overgrowth)
(probiotic OR monoprobiotic OR bacterial strain)
(fiber OR soluble fiber OR psyllium OR inulin OR phgg)
(mmc OR migrating motor complex)
(mindful eating or mindfulness training).


Pubmed
n=315
ScienceDirect
n=16
Google Scholar
n=75
prelimary screening
n=406
exclusion based
on titles
papers screened
n=198
exluded:
- on animal
-on children
-experimental studies
papers indentified
n=65
excluded:
using poliprobiotics or
synbiotic
no data on gut microbiota
meta analisys
published before 2012
incuded studies
n= 34

Analysis of these findings

presented under 4 categories

Low FODMAP

monoprobiotc

fiber

mindfull eating

LOW FODMAP

included studies

12 studies:

- 11 Randomized controlled trial
- 1 Clinical trial

Studies:

last from 3 weeks to 6 months

Methods:

- 16S RNA
- Breath test
- GA-map Dysbiosis

LOW FODMAP

Author, Year,	Period	Study Group	Intervention/control	Methods	Outcome
Zhang et al.,2021	3 weeks	100 IBS	LFD/TDA	16S rRNA	↓Bifidobacterium,Fusobacterium ↑ Bilophila
Staudacher et al.,2021	4 weeks	95 IBS	LFD+(probiotic/placebo)/ Sham diet+ (probiotic/placebo)	16S rRNA	↓ Bifidobacterium, ↑Bacterioides
Naseri et al., 2021	6 weeks	42 IBS	LF-GFD	16S rRNA	↑Bacterioides, ↑Bifidobacterium, Lactobacillus
Wilson et al., 2020	4 weeks	69 IBS	LFD +(B-GOS/placebo)/Sham diet+placebo	16S rRNA	↓Bifidobacterium
Patcharatrakul et al., 2019	4 weeks	62 IBS	SILFD/BRD	Breath test	↓ H_2 volume
Bennet et al., 2018	4 weeks	67 IBS	LFD /TDA	GA-map Dysbiosis Test	↓Bifidobacterium, ↑Dysbiosis Index

LFD- low fodmap diet; TDA- traditional dietary advices; LF-GFD- low fodmap gluter free diet, SLFD- structural individual low-fodmap diet BRD- brief advice on a commonly recommended diet,

Figure 5. Characteristics of included studies connected with a Low Fodmap diet on gut microbiota.

LOW FODMAP

Author, Year,	Period	Study Group	Intervention/control	Methods	Outcome
Hustoft et al., 2017	9 weeks	20 IBS	LFD/ LFD +FOS	16S rRNA	↓ Bifidobacterium, Clostridium Faecalibacterium
Halmos et al., 2015	3 weeks	27 IBS 6 Healthy	LFD/ Australian diet	16S rRNA	↓ Bifidobacterium, Akkermansia muciniphila
Staudacher et al., 2012	4 weeks	41 IBS	LFD / Habitual diet	FISH, 16S RNA	↓ Bifidobacterium
Huaman et al., 2018	4 wk	40 FGIs	LFD / Mediterranean diet	16S rRNA	↓ Bifidobacteria, ↑Bilophila wadsworthia No difference in overall alpha or beta diversity
McIntosh et al., 2017	3 weeks	37 IBS	LFD/ HFD	16S rRNA Breath test	↓ H_2 volume, Actinobacteria No difference in overall alpha or beta diversity
Harvie et al.,2017	6 month	50 IBS	LFD/ TDA LFD/LFD+ reintroduction	16S rRNA	no change in the microbiota

LFD- low fodmap diet; TDA- traditional dietary advices; HFD- high fodmap diet

Figure 6. Characteristics of included studies connected with a Low Fodmap diet on gut microbiota.

LOW FODMAP

summary

reduce gastrointestinal symptoms

undesirable alteration in gut microbiota

adding FOS might reverse this changes

little data in SIBO patients

MONO PROBIOTICS

inculded studies

11 studies:

- 8 Randomized controlled trial
- 2 Clinical trial
- 1Retrospective study

Supplementation:

last from 3 weeks to 3 months

Methods:

- Breath tests
- Bristol stool scale
- IBS-SSS
- Likert scale
- CTT,SBM

MONO PROBIOTICS

Authors, Year, Study type	Duration of study	Study group	Intervention/Control
Gayathri et al., 2021 Randomized controlled trial	8 weeks	100 IBS	S. cerevisiae CNCM I-3856/placebo
Gupta et al., 2021 Randomized controlled trial	80 days	40 IBS	B. coagulans LBSC [DSM17654]/placebo
Madempud et al., 2020 Randomized controlled trial	4 weeks	100 functional constipation	B. coagulans Unique IS2/placebo
García-Collinot et al., 2020 Clinical Trial	2 months	40 SIBO and Systemic sclerosis	S.Boulardii(SB)/Metronidazol(M) SB+M
Lewis et al., 2020 Randomized controlled trial	8 weeks	251 IBS	Lactobacillus paracasei HA-196 /Bifidobacterium longum R0175/placebo
Krishma Kumar et al., 2018 Randomized controlled trial	2 weeks	19 healthy	B.infantis 35624/placebo

Figure 7. Characteristics of included studies connected with monoprobiotics.

MONO PROBIOTICS

Authors, Year, Study type	Duration of study	Study group	Intervention/Control
Ojetti et al., 2017 Retrospective study	4 weeks	20 constipation	L. reuteri (DSM 17938)
Majeed et al., 2016 Randomized controlled trial	3 months	36 IBS-D	B. coagulans (MTCC 5856)/placebo
Eskesen et al., 2015 Randomized controlled trial	4 weeks	1248 with low defecation frequency	B. subsp. lactis, BB-12 1 or 10 billion BB-12/placebo
Akhondi-Meybodi et al., 2014 Randomized controlled trial	3 weeks	60 IBS	S. boulardii CNCM I 745/placebo
Ducrotté et al, 2012 Clinical Trial	4 weeks	214 IBS	L. plantarum 299v (DSM 9843)/placebo

IBS-D- diarrhea predominant IBS

Figure 7. Characteristics of included studies connected with monoprobiotics.

Fully characterized strains	Key results							
	Diarrhea	Stool frequency/ consistency	Bloating	Abdominal pain	SBM	Gas release	H_2 volume	CH_4 volume
B.infantis 35624	ND	ND	ND	ND	-	ND	No change	↑
L. reuteri (DSM 17938)	ND	ND	ND	ND	-	ND	No change	↓
B. coagulans (MTCC 5856)	↓	↑	↓	↓	-	ND	ND	ND
B. coagulans LBSC (DSM17654)	↓	↑	↓	↓	-	ND	ND	ND
B. coagulans Unique IS2	ND	↑	ND	↓	-	ND	ND	ND
L. plantarum 299v (DSM 9843)	ND	ND	↓	↓	-	ND	ND	ND
S. cerevisiae CNCM I-3856	ND	↑	ND	↓	-	ND	ND	ND
S. boulardii CNCM I 745	↓	ND	↓	↓	-	↓	↓	ND
B. animalis subsp. lactis, BB-12	ND	↑	↓	↓	-	ND	ND	ND
L. paracasei HA-196	ND	ND	ND	ND	↑	ND	ND	ND

Figure 8. The outcomes of included studies.

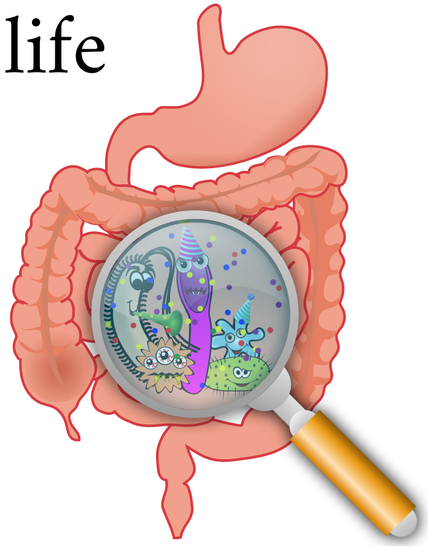
MONO PROBIOTICS

summary

might **enhance eradication**

might be a favorable strategy **in preventing** the progression of symptoms

might **improve** quality of life



FIBER

included studies

7studies:

- 4 Randomized controlled trial
- 2 Clinical trial
- 1 pilot dietary intervention study

Studies duration:

last from 7 days till 18 weeks

Methods:

- 16S RNA
- Breath test

FIBER

Author, Year	Duration of study	Study group	Intervention/ Controls	Methods	Key results
Jalanka et al., 2021	7 days	16 constipation 8 healthy	Psyllium husk/ maltodextrin	16S rRNA	↓ Christensenella Coriobacteria ↑ Lachnospira Faecalibacterium Phascolarctobacterium, Veillonella Sutterella
Reider et al., 2020	9 weeks	20 healthy	5g PHGG/3 time per day	16S rRNA	↑ Ruminococcus, Fusicatenibacter, Faecalibacterium Bacteroides ↓ Roseburia, Lachnospiracea Blautia
Holscher et al., 2015	21 day	29 healthy	0.0g/5.0g/7.5 g agave inulin	16S rRNA	↑ Actinobacteria Bifidobacterium ↓ Desulfovibrio fecal 4-methyphenol pH
Saffouri et al., 2019	7 days	16 healthy	> 11 g fiber/ 1000 cal/day	Breath test	↓ GI symptoms In 2/16 SIBO was developed

Figure 9. Characteristics of included studies connected with fiber intake and gut microbiota.

FIBER

Author, Year	Duration of study	Study group	Intervention/ Controls	Methods	Key results
Niv et al., 2016	18 weeks	121 IBS	6g PHGG group/placebo	Francis Severity IBS score	↓ bloating score ↓ gasses score
Polymeros et al., 2013	4 weeks	49 chronic constipation	5 mg PHGG	CTT Bristol stool scale	↑ colon transit time ↑ stool form ↑ spontaneous bowel movements ↓ abdominal pain
Linetzky et al., 2012	3 weeks	60 constipation	15g Inulin+ PHGG/ maltodextrin	PCR	↓ Clostridium

Figure 10. Characteristics of included studies connected with fiber intake and gut microbiota.

FIBER

summary

positive changes in the bacterial composition or diversity of the gut microbiota

psyllium husk or PHGG may improve IBS symptoms

deficency of fiber in diet might be a risk factor for SIBO

Mindful eating

included studies

4 studies:

- 2 Randomized controlled trial
- 2 Cross-sectional study

Methods:

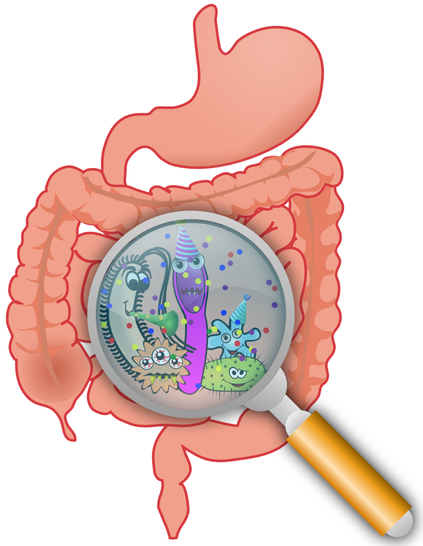
- meal pattern
- chewing quality
- FFQ
- food diary

Author, Year	Study group	Methods	Key results
Vakhshuury et al., 2019 Cross-sectional study	600 army personel	Rome III questionnaire -FFQ Questions about: -breakfast consumption -lunch intake time -chewing efficiency	Slowly lunch consumption declined prevalence of IBS Chewing meals well lower percentage of IBS, FC, and FDi
Khayyatzadeh et al., 2018 Randomized controlled trial	988 women	Rome III questionnaire FFQ Dietary behaviors assessment Questions about: meal pattern Quality of chewing	The highest prevalence of IBS was found in subjects with chewing insufficiency.
Zaribaf et al., 2019 Cross-sectional study	4763 adult	Rome III questionnaire Questions about: meal patterns eating rate chewing quality	Irregular meal pattern was related to frequency and severity of abdominal pain.
Böhn et al., 2015 Randomized controlled trial	75 IBS	Rome III criteria IBS-SSS questionnaire 4-day food diary	Fousing more on how, when to eat rather than what to eat gives satisfactory results in reducing IBS symptoms same as the Low foodmap diet.

Figure 11. Characteristics of included studies connected with mindful eating and GI tract.

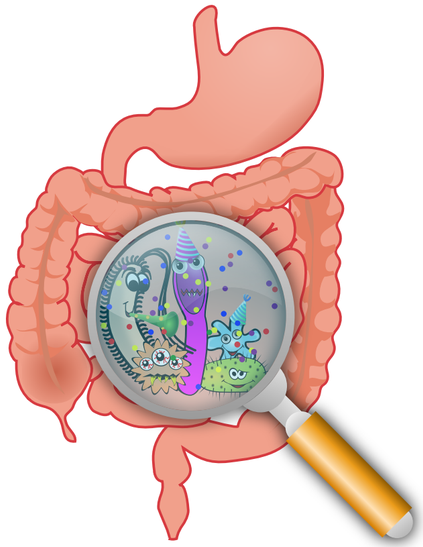
SUMMARY

This narrative review suggested that there is a favourable association with a low FODMAP diet, monoprobiotics and fiber supplementation and mindful eating on the gut microbiome, especially in IBS patients.



SUMMARY

Applying these recommendations to the treatment of SIBO is inconclusive due to a lack of research including SIBO patients in the studies. The potential efficacy of the IBS diet in SIBO is largely hypothetical and future research is needed to characterize specific dietary recommendations for the treatment of SIBO .



Bibliography:

1.Singh, R.; Zogg, H.; Wei, L.; Bartlett, A.; Ghoshal, U.C.; Rajender, S.; Ro, S. Gut microbial dysbiosis in the pathogenesis of gastrointestinal dysmotility and metabolic disorders. J. Neurogastroenterol. Motil.2021, 27, 19–34, doi:10.5056/JNM20149.

2. Rezaie, A.; Buresi, M.; Lembo, A.; Lin, H.; McCallum, R.; Rao, S.; Schmulson, M.; Valdovinos, M.; Zakko, S.; Pimentel, M. Hydrogen and Methane-Based Breath Testing in Gastrointestinal Disorders: The North American Consensus. Am. J. Ga-stroenterol.2017, 112, 775–784, doi:10.1038/ajg.2017.46.

3. Takakura, W.; Pimentel, M. Small Intestinal Bacterial Overgrowth and Irritable Bowel Syndrome – An Update. Front. Psy-chiatry2020, 11, 1–9, doi:10.3389/fpsyt.2020.00664.

4. Ghoshal, U.C.; Shukla, R.; Ghoshal, U. Small intestinal bacterial overgrowth and irritable bowel syndrome: A bridge be-tween functional organic dichotomy. Gut Liver2017, 11, 196–208, doi:10.5009/gnl16126.

5. Vasant, D.H.; Paine, P.A.; Black, C.J.; Houghton, L.A.; Everitt, H.A.; Corsetti, M.; Agrawal, A.; Aziz, I.; Farmer, A.D.; Eugenicos, M.P.; et al. British Society of Gastroenterology guidelines on the management of irritable bowel syndrome. Gut2021, 70, 1214–1240, doi:10.1136/gutjnl-2021-324598.

6. Bonetto, S.; Fagoonee, S.; Battaglia, E.; Grassini, M.; Saracco, G.M.; Pellicano, R. Recent advances in the treatment of irritable bowel syndrome. Polish Arch. Intern. Med.2021, 131, 709–715, doi:10.20452/pamw.16067.

7. Algera, J.; Colomier, E.; Simrén, M. The dietary management of patients with irritable bowel syndrome: A narrative review of the existing and emerging evidence. Nutrients2019, 11, doi:10.3390/nu11092162.

8. Staudacher, H.M.; Lomer, M.C.E.; Anderson, J.L.; Barrett, J.S.; Muir, J.G.; Irving, P.M.; Whelan, K. Fermentable carbohy-drate restriction reduces luminal bifidobacteria and gastrointestinal symptoms in patients with irritable bowel syndrome. J. Nutr.2012, 142, 1510–1518, doi:10.3945/jn.112.159285.

9. Staudacher, H.M.; Scholz, M.; Lomer, M.C.; Ralph, F.S.; Irving, P.M.; Lindsay, J.O.; Fava, F.; Tuohy, K.; Whelan, K. Gut microbiota associations with diet in irritable bowel syndrome and the effect of low FODMAP diet and probiotics. Clin. Nutr.2021, 40, 1861–1870, doi:10.1016/j.clnu.2020.10.013.

10. Huaman, J.W.; Mego, M.; Manichanh, C.; Cañellas, N.; Cañueto, D.; Segurola, H.; Jansana, M.; Malagelada, C.; Accarino, A.; Vulevic, J.; et al. Effects of Prebiotics vs a Diet Low in FODMAPs in Patients With Functional Gut Disorders. Gastroenterology2018, 155, 1004–1007, doi:10.1053/j.gastro.2018.06.045.

11. Zhang Y, Feng L, Wang X, Fox M, Luo L, Du L, Chen B, Chen X, He H, Zhu S, Hu Z, Chen S, Long Y, Zhu Y, Xu L, Deng Y, Misselwitz B, Lang BM, Yilmaz B, Kim JJ, Owyang C, D.N. Low fermentable oligosaccharides, disaccharides, monosac-charides, and polyols diet compared with traditional dietary advice for diarrhea-predominant irritable bowel syndrome: a parallel-group, randomized controlled trial with analysis of clinical and micr. Am. J. Clin. Nutr.2021, 113, 1–15.
12. Hustoft, T.N.; Hausken, T.; Ystad, S.O.; Valeur, J.; Brokstad, K.; Hatlebakk, J.G.; Lied, G.A. Effects of varying dietary con-tent of fermentable short-chain carbohydrates on symptoms, fecal microenvironment, and cytokine profiles in patients with irritable bowel syndrome. Neurogastroenterol. Motil.2017, 29, 1–9, doi:10.1111/nmo.12969.
13. Halmos, E.P.; Christophersen, C.T.; Bird, A.R.; Shepherd, S.J.; Gibson, P.R.; Muir, J.G. Diets that differ in their FODMAP content alter the colonic luminal microenvironment. Gut2015, 64, 93–100, doi:10.1136/gutjnl-2014-307264.
14. Bennet, S.M.P.; Böhn, L.; Störsrud, S.; Liljebo, T.; Collin, L.; Lindfors, P.; Törnblom, H.; Öhman, L.; Simrén, M. Multivariate modelling of faecal bacterial profiles of patients with IBS predicts responsiveness to a diet low in FODMAPs. Gut2018, 67, 872–881, doi:10.1136/gutjnl-2016-313128.
15. McIntosh, K.; Reed, D.E.; Schneider, T.; Dang, F.; Keshteli, A.H.; De Palma, G.; Madsen, K.; Bercik, P.; Vanner, S. FODMAPs alter symptoms and the metabolome of patients with IBS: A randomised controlled trial. Gut2017, 66, 1241–1251, doi:10.1136/gutjnl-2015-311339.
16. Patcharatrakul T.; Juntrapirat A.; Lakananurak N.; Gonlachanvit S.; Effect of Structural Individual Low-FODMAP Dietary Advice vs. Brief Advice on a Commonly Recommended Diet on IBS Symptoms and Intestinal Gas Production. Nu-trients2019, 21,1–12, doi:10.3390/nu11122856.
17. Wilson, B.; Rossi, M.; Kanno, T.; Parkes, G.C.; Anderson, S.; Mason, A.J.; Irving, P.M.; Lomer, M.C.; Whelan, K. β-Galactooligosaccharide in Conjunction with Low FODMAP Diet Improves Irritable Bowel Syndrome Symptoms but Reduces Fecal Bifidobacteria. Am. J. Gastroenterol.2020, 115, 906–915, doi:10.14309/ajg.0000000000000641.
18. Harvie, R.M.; Chisholm, A.W.; Bisanz, J.E.; Burton, J.P.; Herbison, P.; Schultz, K.; Schultz, M. Long-term irritable bowel syndrome symptom control with reintroduction of selected FODMAPs. World J. Gastroenterol.2017, 23, 4632–4643, doi:10.3748/wjg.v23.i25.4632.
19. Naseri, K.; Dabiri, H.; Rostami-Nejad, M.; Yadegar, A.; Houri, H.; Olfatifar, M.; Sadeghi, A.; Saadati, S.; Ciacci, C.; Iovino, P.; et al. Influence of low FODMAP-gluten free diet on gut microbiota alterations and symptom severity in Iranian patients with irritable bowel syndrome. BMC Gastroenterol.2021, 21, 1–14, doi:10.1186/s12876-021-01868-5.
20. Nanayakkara, W.S.; Skidmore, P.M.; O'Brien, L.; Wilkinson, T.J.; Gearry, R.B. Efficacy of the low FODMAP diet for treating irritable bowel syndrome: The evidence to date. Clin. Exp. Gastroenterol.2016, 9, 131–142, doi:10.2147/CEG.S86798.
21. Bellini, M.; Tonarelli, S.; Nagy, A.G.; Pancetti, A.; Costa, F.; Ricchiuti, A.; de Bortoli, N.; Mosca, M.; Marchi, S.; Rossi, A. Low FODMAP diet: Evidence, doubts, and hopes. Nutrients2020, 12, 1–21, doi:10.3390/nu12010148.
22. Hills, R.D.; Pontefract, B.A.; Mishcon, H.R.; Black, C.A.; Sutton, S.C.; Theberge, C.R. Gut microbiome: Profound implica-tions for diet and disease. Nutrients2019, 11, 1–40, doi:10.3390/nu11071613.
23. García-Collinot, G.; Madrigal-Santillán, E.O.; Martínez-Bencomo, M.A.; Carranza-Muleiro, R.A.; Jara, L.J.; Vera-Lastra, O.; Montes-Cortes, D.H.; Medina, G.; Cruz-Domínguez, M.P. Effectiveness of Saccharomyces boulardii and Metronidazole for Small Intestinal Bacterial Overgrowth in Systemic Sclerosis. Dig. Dis. Sci.2020, 65, 1134–1143, doi:10.1007/s10620-019-05830-0.
24. Kumar, K.; Saadi, M.; Ramsey, F. V.; Schey, R.; Parkman, H.P. Effect of Bifidobacterium infantis 35624 (Align) on the Lactulose Breath Test for Small Intestinal Bacterial Overgrowth. Dig. Dis. Sci.2018, 63, 989–995, doi:10.1007/s10620-018-4945-3.

25. Eskesen, D.; Jespersen, L.; Michelsen, B.; Whorwell, P.J.; Müller-Lissner, S.; Morberg, C.M. Effect of the probiotic strain Bi-fidobacterium animalis subsp. lactis, BB-12®, on defecation frequency in healthy subjects with low defecation frequency and abdominal discomfort: A randomised, double-blind, placebo-controlled, parallel-group trial. Br. J. Nutr.2015, 114, 1638–1646, doi:10.1017/S0007114515003347.
26. Ojetti, V.; Petruzziello, C.; Migneco, A.; Gnarra, M.; Gasbarrini, A.; Franceschi, F. Effect of Lactobacillus reuteri (DSM 17938) on methane production in patients affected by functional constipation: a retrospective study. Eur. Rev. Med. Phar-macol. Sci.2017, 21, 1702–1708, doi:10.1016/s0016-5085(17)33419-4.
27. Majeed, M.; Nagabhushanam, K.; Natarajan, S.; Sivakumar, A.; Ali, F.; Pande, A.; Majeed, S.; Karri, S.K. Bacillus coagulans MTCC 5856 supplementation in the management of diarrhea predominant Irritable Bowel Syndrome: A double blind randomized placebo controlled pilot clinical study. Nutr. J.2016, 15, 1–10, doi:10.1186/s12937-016-0140-6.
28. Madempudi, R.S.; Neelamraju, J.; Ahire, J.J.; Gupta, S.K.; Shukla, V.K. Bacillus coagulans Unique IS2 in Constipation: A Double-Blind, Placebo-Controlled Study. Probiotics Antimicrob. Proteins2020, 12, 335–342, doi:10.1007/s12602-019-09542-9.
29. Ducrotté, P.; Sawant, P.; Jayanthi, V. Clinical trial: Lactobacillus plantarum 299v (DSM 9843) improves symptoms of irritable bowel syndrome. World J. Gastroenterol.2012, 18, 4012–4018, doi:10.3748/wjg.v18.i30.4012.
30. Gayathri, R.; Aruna, T.; Malar, S.; Shilpa, B.; Dhanasekar, K.R. Efficacy of Saccharomyces cerevisiae CNCM I-3856 as an add-on therapy for irritable bowel syndrome. Int. J. Colorectal Dis.2020, 35, 139–145, doi:10.1007/s00384-019-03462-4.
31. Akhondi-Meybodi, M.; Rahimian, M.; Salmanroghani, H.; Amirbeigy, M.; Baghbanian, M.; Ghelmani, S. Study of the Effect of Probiotic Saccharomyces Boulardii on the Treatment of Irritable Bowel Syndrome. J. Biol. Today's World2014, 3, 152–156, doi:10.15412/j.jbtw.01030703.
32. Lewis, E.D.; Antony, J.M.; Crowley, D.C.; Piano, A.; Bhardwaj, R.; Tompkins, T.A.; Evans, M. Efficacy of Lactobacillus paracasei HA-196 and Symptoms of Irritable Bowel Syndrome (IBS): A Randomized, Placebo-Controlled Study. Nu-trients2020, 12, 1–19.
33. Gupta, A.K.; Maity, C. Efficacy and safety of Bacillus coagulans LBSC in irritable bowel syndrome: A prospective, inter-ventional, randomized, double-blind, placebo-controlled clinical study [CONSORT Compliant. Medicine (Baltimore).2021, 100, e23641, doi:10.1097/MD.0000000000023641.
34. Khalighi, A.R.; Khalighi, M.R.; Behdani, R.; Jamali, J.; Khosravi, A.; Kouhestani, S.; Radmanesh, H.; Esmaeelzadeh, S.; Khalighi, N. Evaluating the efficacy of probiotic on treatment in patients with small intestinal bacterial overgrowth (SIBO) - A pilot study. Indian J. Med. Res.2014, 140, 604–608.
35. Zhong, C.; Qu, C.; Wang, B.; Liang, S.; Zeng, B. Probiotics for Preventing and Treating Small Intestinal Bacterial Over-growth. J. Clin. Gastroenterol.2017, 51, 300–311, doi:10.1097/MCG.0000000000000814.
36. Saffouri, G.B.; Shields-Cutler, R.R.; Chen, J.; Yang, Y.; Lekatz, H.R.; Hale, V.L.; Cho, J.M.; Battaglioli, E.J.; Bhattarai, Y.; Thompson, K.J.; et al. Small intestinal microbial dysbiosis underlies symptoms associated with functional gastrointestinal disorders. Nat. Commun.2019, 10, 1–11, doi:10.1038/s41467-019-09964-7.
37. Jalanka, J.; Major, G.; Murray, K.; Singh, G.; Nowak, A.; Kurtz, C.; Silos-Santiago, I.; Johnston, J.M.; de Vos, W.M.; Spiller, R. The effect of psyllium husk on intestinal microbiota in constipated patients and healthy controls. Int. J. Mol. Sci.2019, 20, doi:10.3390/ijms20020433.
38. Niv, E.; Halak, A.; Tiommny, E.; Yanai, H.; Strul, H.; Naftali, T.; Vaisman, N. Randomized clinical study: Partially hydro-lyzed guar gum (PHGG) versus placebo in the treatment of patients with irritable bowel syndrome. Nutr. Metab.2016, 13, 1–7, doi:10.1186/s12986-016-0070-5.
39. Reider, S.J.; Moosmang, S.; Tragust, J.; Trgovec-Greif, L.; Tragust, S.; Perschy, L.; Przysiecki, N.; Sturm, S.; Tilg, H.; Stupp-ner, H.; et al. Prebiotic effects of partially hydrolyzed guar gum on the composition and function of the human microbi-ota—results from the PAGODA trial. Nutrients2020, 12, doi:10.3390/nu12051257.

40. Polymeros, D.; Beintaris, I.; Gaglia, A.; Karamanolis, G.; Papanikolaou, I.S.; Dimitriadis, G.; Triantafyllou, K. Partially Hy-drolyzed Guar Gum Accelerates Colonic Transit Time and Improves Symptoms in Adults with Chronic Constipation. Dig. Dis. Sci.2014, 59, 2207–2214, doi:10.1007/s10620-014-3135-1.
41. Holscher, H.D.; Bauer, L.L.; Gourineni, V.; Pelkman, C.L.; Fahey, G.C.; Swanson, K.S. Agave inulin supplementation affects the fecal microbiota of healthy adults participating in a randomized, double-blind, placebo-controlled, crossover trial. J. Nutr.2015, 145, 2025–2032, doi:10.3945/jn.115.217331.
42. Linetzky Waitzberg D, Alves Pereira CC, Logullo L, Manzoni Jacintho T, Almeida D, Teixeira da Silva ML, M. de M.T.R. Microbiota benefits after inulin and partially hydrolized guar gum supplementation: a randomized clinical trial in consti-pated women. Nutr. Hosp.2012, 27, 123–129, doi:10.1590/S0212-16112012000100014.
43. Oskouie, F.H.; Vahedi, H.; Shahrbaf, M.A.; Sadeghi, A.; Rashidkhani, B.; Hekmatdoost, A. Gastroenterology and Hepa-tology From Bed to Bench. Dietary fiber and risk of irritable bowel syndrome: a case-control study. Gastroenterol Hepatol Bed Bench2018, 11, 20–24.
44. Garg, P. Inflammation in irritable bowel syndrome (IBS): Role of psyllium fiber supplementation in decreasing inflammation and physiological management of IBS. Turkish J. Gastroenterol.2021, 32, 108–110, doi:10.5152/tjg.2020.20229.
45. Ginnebaugh, B.; Chey, W.D.; Saad, R. Small Intestinal Bacterial Overgrowth: How to Diagnose and Treat (and Then Treat Again). Gastroenterol. Clin. North Am. 2020, 49, 571–587.
46. Khayyatzadeh, S.S.; Kazemi-Bajestani, S.M.R.; Mirmousavi, S.J.; Heshmati, M.; Khoshmohabbat, S.; Ferns, G.A.; Ghayour-Mobarhan, M. Dietary behaviors in relation to prevalence of irritable bowel syndrome in adolescent girls. J. Ga-stroenterol. Hepatol.2018, 33, 404–410, doi:10.1111/jgh.13908.
47. Böhn, L.; Störsrud, S.; Liljebo, T.; Collin, L.; Lindfors, P.; Törnblom, H.; Simrén, M. Diet Low in FODMAPs Reduces Symptoms of Irritable Bowel Syndrome as Well as Traditional Dietary Advice: A Randomized Controlled Trial. Gastroen-terology2015, 149, 1399-1407.e2, doi:10.1053/j.gastro.2015.07.054.
48. Zaribaf, F.; Keshteli, A.H.; Esmaillzadeh, A.; Saneei, P.; Feizi, A.; Daghaghzadeh, H.; Feinle-Bisset, C.; Adibi, P. Empirically derived dietary habits are associated with irritable bowel syndrome. Eur. J. Clin. Nutr.2018, 72, 1537–1547, doi:10.1038/s41430-018-0109-y.
49. Vakhshuury, M.; Khoshdel, A. The Relation between Dietary Patterns and Functional Gastrointestinal Disorders among Iranian Military Men. Adv. Biomed. Res.2019, 8, 2, doi:10.4103/abr.abr_180_18.

Thank you for your attention