

Table 1: Overview of all studies collated in this paper.

Study [first author, Year, Journal]	Reference [number in bibliography]	Patient groups with n	Study design	Scanner used	Intervention?	Time between scans (washout in cross-over studies)	Baseline pre-treatment?	Meal 1	Time point meal 1	Time point last scan (min)	Scan intervals (min)	Meal 2	Time point meal 2	Used for fasted baseline (healthy, no pretreatment; N=only the cohort of healthy volunteers was used)	Used for repeat baseline	SBWC data published?
Alyami 2019 Br J Nutr	Alyami, J. et al. Glycaemic, gastrointestinal, hormonal and appetite responses to pearl millet or oats porridge breakfasts: a randomised, crossover trial in healthy humans. <i>Br. J. Nutr.</i> 122, 1142–1154 (2019). [60]	23 HV	randomised cross-over	1.5T Philips Achieva	Porridge made of Scottish oats or pearl millet	1 week	none	220 kcal: porridge, water	after T0	135	30			y	y	n
Chaddock 2014 Neurogastro Motil	Chaddock, G. et al. Novel MRI tests of orocecal transit time and whole gut transit time: studies in normal subjects. <i>Neurogastroenterol. Motil.</i> 26, 205–214 (2014). [58]	21 HV	observational	1.5T Philips Achieva	N/A	N/A	1g unlabeled lactose ureide three times during the day preceding the scans	362 kcal: 220 g rice pudding with 34 g jam and 15 g bran and 100 ml orange juice	before T0	495	45	1007 kcal: 400 g macaroni cheese with 100 g chesecake and 250 ml water	T390	y	y	n
Coletta 2015 Br J Nutr	Coletta, M. et al. Effect of bread gluten content on gastrointestinal function: a crossover MRI study on healthy humans. <i>Br. J. Nutr.</i> 115, 55–61 (2016). [40]	12 HV	randomised cross-over	1.5T Philips Achieva	bread varying gluten	1 week	same breads for 1 week	645-659 kcal: 150g bread + 24g margarine + 34g raspb jam + 100ml orange juice	before T0	360	60			n	n	y
Garsed 2014 Gut	Garsed, K. et al. A randomised trial of ondansetron for the treatment of irritable bowel syndrome with diarrhoea. <i>Gut</i> 63, 1617–1625 (2014). [61]	51 IBS-D	randomised cross-over	1.5T Philips Achieva	ondansetron vs placebo	2-3 weeks	five weeks intake of ondansetron or placebo	baseline SBWC only						n	n	y
Gunn 2020 Am J Clin Nutr	Gunn, D. et al. Contrasting effects of viscous and particulate fibers on colonic fermentation in vitro and in vivo, and their impact on intestinal water studied by MRI in a randomized trial. <i>Am. J. Clin. Nutr.</i> 112, 595–602 (2020). [22]	13 HV	randomised cross-over	3T Philips Achieva	nopal vs ispaghula vs bran	at least 6 days	fibres given on day before	336 kcal: rice pudding + jam + orange juice plus fibres	before T0	240	60			n	n	y
Gunn 2021	Gunn, D. et al. Psyllium reduces inulin-induced colonic gas production in IBS: MRI and in vitro fermentation studies. <i>Gut</i> gptnl-2021-324784 (2021) doi:10.1136/gutnl-2021-324784. [62]	9 IBS-C, 10 IBS-D	randomised cross-over	1.5T GE	inulin vs ispaghula vs inulin+ispaghula vs glucose (control)	at least 6 days	none (standardised evening meal, low in fibre)	20 g of each fibre/glucose in 500 ml water with 50 ml lemon juice	before T0	360	60	low in fibre and fermentable carbohydrates	T135	n	n	y
Hussein 2015 J Nutr	Hussein, M. O. et al. Fat Emulsion Intragastric Stability and Droplet Size Modulate Gastrointestinal Responses and Subsequent Food Intake in Young Adults. <i>J. Nutr.</i> 145, 1170–1177 (2015). [16]	11 HV	randomised cross-over	1.5T Philips Achieva	3 different emulsions	1 week	none	531 kcal in 300mL 20% sunflower oil, water, stabilizer	before T0	300	60			y	y	y
Khalaf 2020 Am J Clin Nutr	Khalaf, A. et al. Gastrointestinal peptides and small-bowel hypomotility are possible causes for fasting and postprandial symptoms in active Crohn's disease. <i>Am. J. Clin. Nutr.</i> 111, 131–140 (2020). [63]	20 HV, 15 CD	case control	1.5T Philips Achieva	soup meal	N/A	none	204 kcal: cream of chicken soup or cream of mushroom soup	before T0	270	15/30			HV	n	y
Lam 2016 Neurogastro Motil	Lam, C. et al. Colonic response to laxative ingestion as assessed by MRI differs in constipated irritable bowel syndrome compared to functional constipation. <i>Neurogastroenterol. Motil.</i> 28, 861–870 (2016). [64]	23 FC, 20 IBS-C	observational	1.5T Philips Achieva	Moviprep	N/A	none	1 litre laxative (Moviprep)	before T0	240	60			n	n	y
Lam 2017 Am J Gastro	Lam, C. et al. Distinct Abnormalities of Small Bowel and Regional Colonic Volumes in Subtypes of Irritable Bowel Syndrome Revealed by MRI. <i>Am. J. Gastroenterol.</i> 112, 346–356 (2017). [68]	34 HV, 30 IBS-D, 16 IBS-C, and 11 IBS-M	observational	1.5T Philips Achieva	meals	N/A	1g unlabeled lactose ureide three times during the day preceding the scans	362 kcal: 220 g rice pudding with 34 g jam and 15 g bran and 100 ml orange juice	before T0	405	45	900 kcal: 600ml Fortisip	T375	HV	n	y
Lam 2019 UEGJ	Lam, C. et al. Increased fasting small-bowel water content in untreated coeliac disease and scleroderma as assessed by magnetic resonance imaging. <i>United Eur. Gastroenterol. J.</i> 7, 1353–1360 (2019). [28]	20 coeliac disease, 15 scleroderma	observational	1.5T Philips Achieva	N/A	N/A	none	none						n	n	y
Major 2017 Gastroint	Major, G. et al. Colon Hypersensitivity to Distension, Rather Than Excessive Gas Production, Produces Carbohydrate-Induced Symptoms in Individuals With Irritable Bowel Syndrome. <i>Gastroenterology</i> 152, 124–133.e2 (2017). [17]	29 IBS, 29 HV	two parallel cross-over studies	1.5T Philips Achieva	glucose vs fructose vs inulin drinks	1 week	none	60-156 kcal: 40g of glucose/fructose/inulin in 500 ml water with lemon juice	before T0	300	60			HV	y	y
Major 2018 Neurogastro Motil	Major, G. et al. Demonstration of differences in colonic volumes, transit, chyme consistency, and response to psyllium between healthy and constipated subjects using magnetic resonance imaging. <i>Neurogastroenterol. Motil.</i> 30, e13400 (2018). [21]	16 HV, 15 FC, 1 IBS-C	two parallel cross-over studies	1.5T Philips Achieva	psyllium vs maltodextrine	1 week	maltodextrin or psyllium for five days before scan day	331 kcal: 220 g rice pudding with 34 g jam and 100 ml orange juice	at T0	420	60	1007 kcal: 400 g macaroni cheese with 100 g chesecake and 250 ml water	T375	n	n	y
Marciani 2010 APT	Marciani, L. et al. Effects of a 5-HT(3) antagonist, ondansetron, on fasting and postprandial small bowel water content assessed by magnetic resonance imaging. <i>Aliment. Pharmacol. Ther.</i> 32, 655–663 (2010). [65]	16 HV	randomised cross-over	1.5T Philips Achieva	ondansetron v placebo	1 week	8 mg ondansetron / placebo three times on day before scan	362 kcal: 220 g rice pudding with 34 g jam and 15 g bran and 100 ml orange juice	before T0	270	45			y	n	y
Marciani 2010 Gastro	Marciani, L. et al. Postprandial Changes in Small Bowel Water Content in Healthy Subjects and Patients with Irritable Bowel Syndrome. <i>Gastroenterology</i> 138, 469–477.e1 (2010). [9]	(study 1): 11 HV (study 2): 16 HV	randomised cross-over randomised cross-over	3T Philips Achieva 1.5T Philips Achieva	mannitol vs glucose meal with bran vs without bran	1 week 1 week	none none	17.5 g mannitol in 250 ml water (29 kcal) or 17.5 g glucose in 350 ml water (70 kcal) 331/362 kcal: 220 g creamed rice pudding, 34 g seedless raspberry jam, 15 g coarse wheat bran (or without bran), 100 mL orange juice	at T0 before T0	220 495	30 45	1007 kcal: 400 g macaroni cheese with 100 g chesecake and 250 ml water		y y	n y	y y
Marciani 2012 J Nutr	Marciani, L. et al. Preventing gastric sipping by blending a solid/water meal enhances satiation in healthy humans. <i>J. Nutr.</i> 142, 1253–1258 (2012). [39]	18 HV	randomised cross-over	1.5T Philips Achieva	chicken and vegetable either whole or as soup	1 week	none	241 kcal: 75g grilled chicken, 62.5g roasted veg, 62.5g breaded mushrooms, 250ml water	before T0	180	45			y	y	AUC only
Marciani 2013 Eur J Clin Nutr	Marciani, L. et al. Delayed gastric emptying and reduced postprandial small bowel water content of eucaloric whole meal bread versus rice meals in healthy subjects: novel MRI insights. <i>Eur. J. Clin. Nutr.</i> 67, 754–759 (2013). [57]	12 HV	randomised cross-over	1.5T Philips Achieva	bread vs rice pudding	1 week	none	542 kcal: wholemeal bread or rice pudding, both with jam + orange juice	before T0	270	45			y	y	y
Marciani 2014 NGM	Marciani, L. et al. Stimulation of colonic motility by oral PEG electrolyte bowel preparation assessed by MRI: comparison of split vs single dose. <i>Neurogastroenterol. Motil.</i> 26, 1426–1436 (2014). [19]	2 times 12 HV	observational	1.5T Philips Achieva	Moviprep	N/A	none	2 times 1 litre vs 1 time 2 litres laxative (Moviprep)	before T0	240	60			y	y	y
Marciani 2015 Eur J Clin Nutr	Marciani, L. et al. Additive effects of gastric volumes and macronutrient composition on the sensation of postprandial fullness in humans. <i>Eur. J. Clin. Nutr.</i> 69, 380–384 (2015). [56]	13 HV	randomised cross-over	1.5T Philips Achieva	rice pudding with added fat or carbohydrates	1 week	none	436-532 kcal: 220 g rice pudding with 34 g jam and 100 ml orange juice, with either 50 g glucose polymer or 22 g cream added	before T0	270	45			y	y	y
Marciani 2019 Food Funct	Marciani, L. et al. Alginate and HM-pectin in sports-drink give rise to intra-gastric gelation in vivo. <i>Food Funct.</i> 10, 7892–7899 (2019). [66]	8 HV	randomised cross-over	3T Philips Achieva	sport drink with and without alginate and pectin	1 week	none	320 kcal drink in 500 ml water: with 79 g carbohydrates of which 33 g sugar, with and without added pectin and sodium alginate	before T0	300	60			y	y	y
Mudie 2014 ACS	Mudie, D. M. et al. Quantification of gastrointestinal liquid volumes and distribution following a 240 mL dose of water in the fasted state. <i>Mol. Pharm.</i> 11, 3039–3047 (2014). [14]	12 HV	observational	1.5T Philips Achieva	240 ml water	N/A	none	240 ml water	T0	120	2/4/13/15			y	n	y
Murray 2014 Am J Gastro	Murray, K. et al. Differential effects of FODMAPs (fermentable oligo-, di-, mono-saccharides and polyols) on small and large intestinal contents in healthy subjects shown by MRI. <i>Am. J. Gastroenterol.</i> 109, 110–119 (2014). [15]	16 HV	randomised cross-over	1.5T Philips Achieva	glucose vs fructose vs inulin vs glucose+fructose drinks	1 week	none	60-312 kcal: 40g of glucose/fructose/inulin or glucose and fructose in 500 ml water	at T0	315	60			y	y	y
Murray 2015 Am J Clin Nutr	Murray, K. et al. Aerated drinks increase gastric volume and reduce appetite as assessed by MRI: a randomized, balanced, crossover trial. <i>Am. J. Clin. Nutr.</i> 101, 270–278 (2015). [67]	18 HV	randomised cross-over	1.5T Philips Achieva	milk-based drink: not aerated vs stable foam vs less stable foam	1 week	none	110 kcal milk-based drink	at T0	240	20/30			y	y	n
Murray 2016 Am J Clin Nutr	Murray, K. A. et al. Corticotropin-releasing factor increases ascending colon volume after a fructose test meal in healthy humans: a randomized controlled trial. <i>Am. J. Clin. Nutr.</i> 103, 1318–1326 (2016). [20]	20 HV	randomised cross-over	1.5T Philips Achieva	injection of CRF vs saline, each followed by a fructose drink	1 week	none	156 kcal: 40g of fructose in 500 ml water with 5 ml lemon juice	at T0	315	30/60			y	y	y
Murray 2019 Plos one	Murray, K. A. et al. A pilot study of visceral fat and its association with adipokines, stool calprotectin and symptoms in patients with diverticulosis. <i>PloS One</i> 14, e0216229 (2019). [68]	54 diverticulosis	observational	1.5T Philips Achieva	none	N/A	none	baseline SBWC only						y	n	y
Ng 2020 JCF	Ng, C. et al. Postprandial changes in gastrointestinal function and transit in cystic fibrosis assessed by Magnetic Resonance Imaging. <i>J. Cyst. Fibros.</i> S1569199320307335 (2020) doi:10.1016/j.jcf.2020.06.004. [24]	12 HV and 12 CF	case control	3T Philips Ingenta	meals	N/A	none	519 kcal: 300 g rice pudding with 30 g cream and 25 g jam, 100 ml orange juice and 240 ml water	before T0	360	30/60	1110 kcal: 400 g macaroni cheese with 100 g chesecake and 240 ml water	T255	HV	n	y
Pritchard 2015 NGM	Pritchard, S. E. et al. Effect of experimental stress on the small bowel and colon in healthy humans. <i>Neurogastroenterol. Motil. Off. J. Eur. Gastrointest. Motil. Soc.</i> 27, 542–549 (2015). [69]	two cohorts of 18 HV	two parallel cross-over studies	1.5T Philips Achieva	2 stressors: CRF or cold water stimulus	1 week	none	362 kcal: 220 g rice pudding with 34 g jam and 15 g bran and 100 ml orange juice	at T15	270	45			y	y	y
Wilkinson-Smith 2018 JPEN	Wilkinson-Smith, V. C. et al. Insights Into the Different Effects of Food on Intestinal Secretion Using Magnetic Resonance Imaging. <i>J. Parenter. Enter. Nutr.</i> 42, 1342–1348 (2018). [70]	15 HV	randomised cross-over	1.5T Philips Achieva	lettuce vs rhubarb vs bread	1 week	none	243-248 kcal: 2 slices white bread with 10 g butter, 300 g rhubarb with 60 ml lactose free cream, 300 g lettuce with 30 mL mayonnaise; all with 200 ml water	before T0	180	60			y	y	y
Wilkinson-Smith 2019 AP&T	Wilkinson-Smith, V. et al. Mechanisms underlying effects of klawfull on intestinal function shown by MRI in healthy volunteers. <i>Aliment. Pharmacol. Ther.</i> (2019) doi:10.1111/apt.15127. [23]	14 HV	randomised cross-over	3T Philips Achieva	meals with kivi or maltodextrin	2 weeks	2x 2d kivi or maltodextrin	331 kcal: 220 g rice pudding with 34 g jam and 100 ml orange juice	before T0	420	60	1007 kcal: 400 g macaroni cheese with 100 g chesecake and 250 ml water	T375	n	n	y

Table 2: Data derived from the individual participant data meta-analyses. A) Mean and standard deviation as well as range of fasted baseline SBWC and age (not including studies that gave a specific treatment before the fasting scan). B) Collated data from studies in which interventions were the same: fructose drink, glucose drink, and rice pudding meals with and without bran.

<b>A</b>									
SBWC fasting baseline (Figure 1B and Figure S2). All data shown as mean (SD).									
Health status	n	SBWC (ml)	SBWC range (ml)	Age	Age range	Studies/publications			
Healthy volunteers	382	82 (65)	2-373	26 (10)	12-70	Alyami 2019, Chaddock 2015, Hussein 2015, Khalaf 2020, Lam 2016 AJG, Major 2017, Marciani 2010 Gastroenterology, Marciani 2012, Marciani 2013, Marciani 2014, Marciani 2015, Marciani 2019, Mudie 2014, Murray 2014, Murray 2015, Murray 2016, Ng 2020, Pritchard 2015, Wilkinson-Smith 2018			
Diverticulosis	54	70 (69)	1-354	63 (10)	27-79	Murray 2019			
HV and diverticulosis combined	436	81 (65)	1-373	30 (16)	12-79	As above			
IBS-C	51	62 (59)	4-256	37 (14)	18-65	Gunn 2020, Lam 2016 AJG, Lam 2016 NGM, Major 2017			
IBS-D	71	44 (35)	3-173	46 (14)	19-72	Gunn 2020, Lam 2016 AJG, Major 2017, Marciani 2010 Gastroenterology			
IBS-M	29	39 (44)	0-192	38 (16)	20-64	Lam 2016 AJG, Major 2017			
Functional constipation	23	114 (97)	17-455	44 (12)	21-68	Lam 2016 NGM			
Cystic fibrosis	12	179 (96)	40-334	20 (7)	12-36	Ng 2020			
Crohn's disease	15	37 (34)	5-138	37 (12)	19-57	Khalaf 2020			
Coeliac disease, untreated	20	202 (290)	40-1334	46 (14)	18-68	Ching 2019			
Scleroderma	15	118 (114)	13-455	63 (13)	37-83	Ching 2019			
<b>B</b>									
SBWC reaction to meals, summarised between studies, all healthy volunteers (Figures S3 and S4). All data shown as mean (SD).									
Meal	Frequency of scans (minutes)	n	fasting SBWC (ml)	peak SBWC (ml)	(time of peak after end of meal)	AUC	AUC length of observation (minutes)	AUC time frame (minutes relative to meal)	Studies/publications
40 g fructose	30	20	75 (43)	489 (144)	30	62,628 (28,222)	300	-60 to 240	Murray 2016
	60	65	70 (57)	341 (174)	60	54,968 (24,597)	300	-60 to 240	Major 2017, Murray 2014, Murray 2016
40 g glucose	60	45	63 (63)	104 (102)	0	10,013 (9,389)	120	-60 to 60	Major 2017, Murray 2014
220 g rice pudding, 15 g bran, 34 g jam, 100 ml orange juice	45	199	75 (71)	103 (65)	225	15,174 (11,567)	270	-45 to 225	Chaddock 2015, Lam 2016, Marciani 2010 APT, Marciani 2010 Gastroenterology, Pritchard 2014
220 g rice pudding, 34 g jam, 100 ml orange juice	45	16	105 (65)	94 (57)	135	20,213 (7,498)	270	-45 to 225	Marciani 2010 Gastroenterology

Table 3: SBWC reaction to a second meal (compare Fig 5). Ng 2020 JCF data is listed separately (and is not included in HV summary data, \*) because the morning rice pudding meal included an additional 30g of double cream and SBWC before the second meal was therefore considerably higher than in the other studies.

	Health group	n	T of meal	Time between start of meal and next scan (min)	two scans before meal		scan before meal		scan after meal		change during stable phase before meal				change during meal phase				P (comparing slope during meal phase to HV, Wilkinson)
					T	SBWC (ml)	T	SBWC (ml)	T	SBWC (ml)	time (min)	rate (ml)	slope (ml/min)	%	time (min)	rate (ml)	slope (ml/min)	%	
Ng 2020 JCF	HV	12	255	45	180	249 (103)	240	266 (100)	300	113 (76)	60	17 (100)	0.3 (1.7)	19 (45)	60	-153 (73)	-2.5 (1.2)	-59 (25)	--
Ng 2020 JCF	CF	12	255	45	180	294 (114)	240	309 (154)	300	299 (135)	60	15 (131)	0.3 (2.2)	9 (42)	60	-10 (121)	-0.2 (2.0)	13 (71)	0.002
Chaddock repeat 1	HV	21	390	15	315	105 (54)	360	92 (46)	405	53 (42)	45	-12 (32)	-0.3 (0.7)	0.03 (55)	45	-39 (50)	-0.9 (1.1)	-34 (47)	
Chaddock repeat 2	HV	20	390	15	315	107 (50)	360	91 (39)	405	44 (34)	45	-16 (40)	-0.4 (0.9)	-6 (39)	45	-46 (50)	-1.0 (0.9)	-45 (39)	
Wilkinson-Smith 2019 AP&T (maltodextrin group)	HV	14	390	30	300	107 (51)	360	120 (57)	420	28 (18)	60	14 (49)	0.2 (0.8)	23 (59)	60	-93 (50)	-1.5 (0.8)	-77 (15)	
Marciani 2010 Gastroent Study 2	HV	16	420	30	360	76 (49)	405	84 (69)	450	47 (36)	45	8 (38)	0.2 (0.9)	22 (76)	45	-38 (63)	-0.8 (1.4)	-21 (76)	
Lam 2016 Am J Gastro	HV	34	375	30	315	83 (48)	375	76 (41)	405	43 (35)	45	-7 (35)	-0.2 (0.8)	10 (76)	45	-33 (7)	-0.7 (1.0)	-33 (50)	
Lam 2016 Am J Gastro	IBS-C	16	375	30	315	73 (60)	375	81 (62)	405	44 (42)	45	9 (35)	0.2 (0.8)	25 (67)	45	-37 (47)	-0.8 (1.0)	38 (347)	
Lam 2016 Am J Gastro	IBS-D	30	375	30	315	71 (55)	375	58 (38)	405	41 (49)	45	-13 (37)	-0.3 (0.8)	53 (261)	45	-17 (43)	-0.4 (1.0)	-30 (61)	
Lam 2016 Am J Gastro	IBS-M	11	375	30	315	86 (52)	375	71 (46)	405	43 (35)	45	-15 (32)	-0.3 (0.7)	-14 (40)	45	-28 (49)	-0.6 (1.1)	-3 (131)	
Major 2018 NGM (malt.)	15 FC + 1 IBS-C	16	400	20	300	54 (28)	360	60 (37)	420	15 (10)	60	6 (30)	0.1 (0.5)	33 (117)	60	-45 (36)	-0.7 (0.6)	-64 (34)	
Major 2018 NGM (malt.)	HV	15	400	20	300	123 (50)	360	104 (59)	420	20 (20)	60	-18 (41)	-0.4 (0.8)	-13 (36)	60	-84 (49)	-1.4 (0.8)	-80 (18)	
	<b>all HV*</b>	<b>120</b>				<b>97 (52)</b>		<b>91 (51)</b>		<b>41 (34)</b>		<b>-6 (39)</b>	<b>-0.1 (0.8)</b>	<b>6 (61)</b>		<b>-50 (52)</b>	<b>-1.0 (1.0)</b>	<b>-45 (50)</b>	<b>--</b>
	<b>all IBSC</b>	<b>17</b>				<b>73 (57)</b>		<b>83 (61)</b>		<b>44 (40)</b>		<b>10 (35)</b>	<b>0.2 (0.8)</b>	<b>26 (65)</b>		<b>-39 (46)</b>	<b>-0.8 (1.0)</b>	<b>-32 (337)</b>	<b>0.636</b>
	<b>all FC</b>	<b>15</b>				<b>52 (28)</b>		<b>56 (35)</b>		<b>13 (8)</b>		<b>3 (30)</b>	<b>0.1 (0.5)</b>	<b>32 (121)</b>		<b>-43 (36)</b>	<b>-0.7 (0.6)</b>	<b>-64 (35)</b>	<b>0.336</b>
	<b>all IBS-D</b>	<b>30</b>				<b>71 (55)</b>		<b>58 (38)</b>		<b>41 (49)</b>		<b>-13 (37)</b>	<b>-0.3 (0.8)</b>	<b>53 (261)</b>		<b>-17 (43)</b>	<b>-0.4 (1.0)</b>	<b>-30 (61)</b>	<b>0.007</b>
	<b>all IBS-M</b>	<b>11</b>				<b>86 (52)</b>		<b>71 (46)</b>		<b>43 (35)</b>		<b>-15 (32)</b>	<b>-0.3 (0.7)</b>	<b>-14 (40)</b>		<b>-28 (49)</b>	<b>-0.6 (1.1)</b>	<b>-3 (131)</b>	<b>0.520</b>