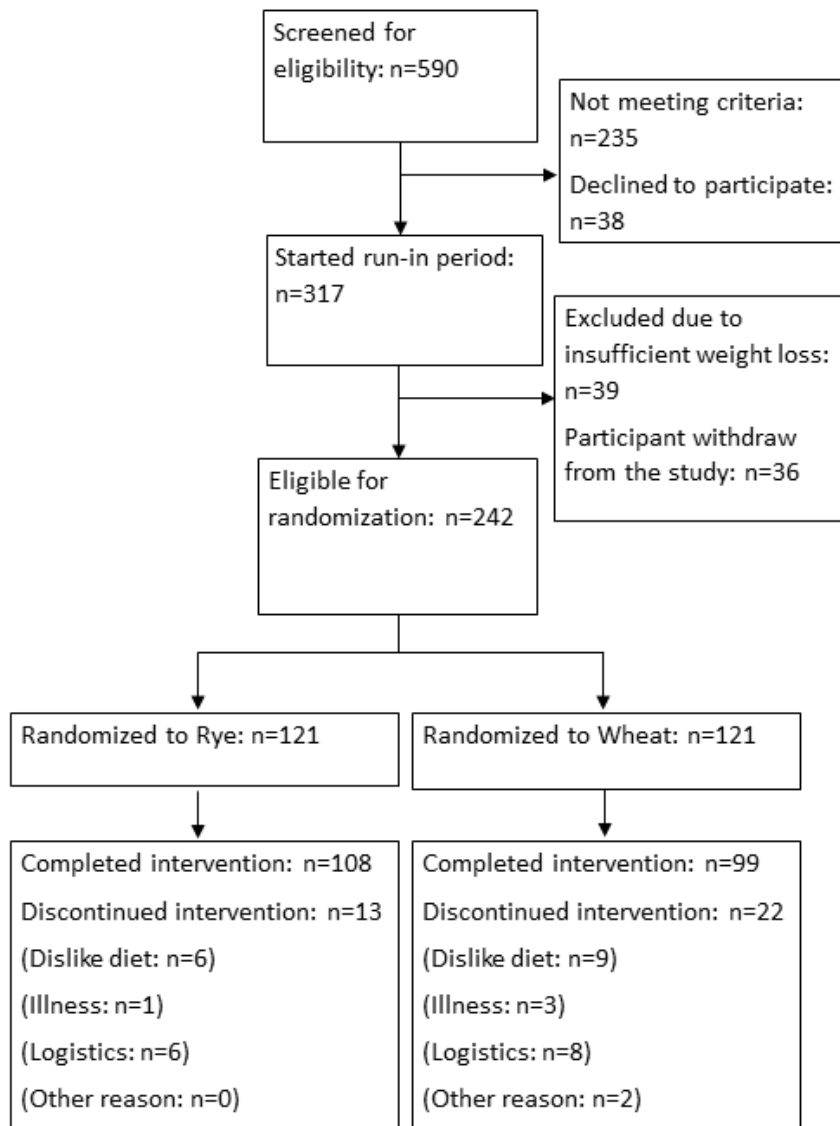
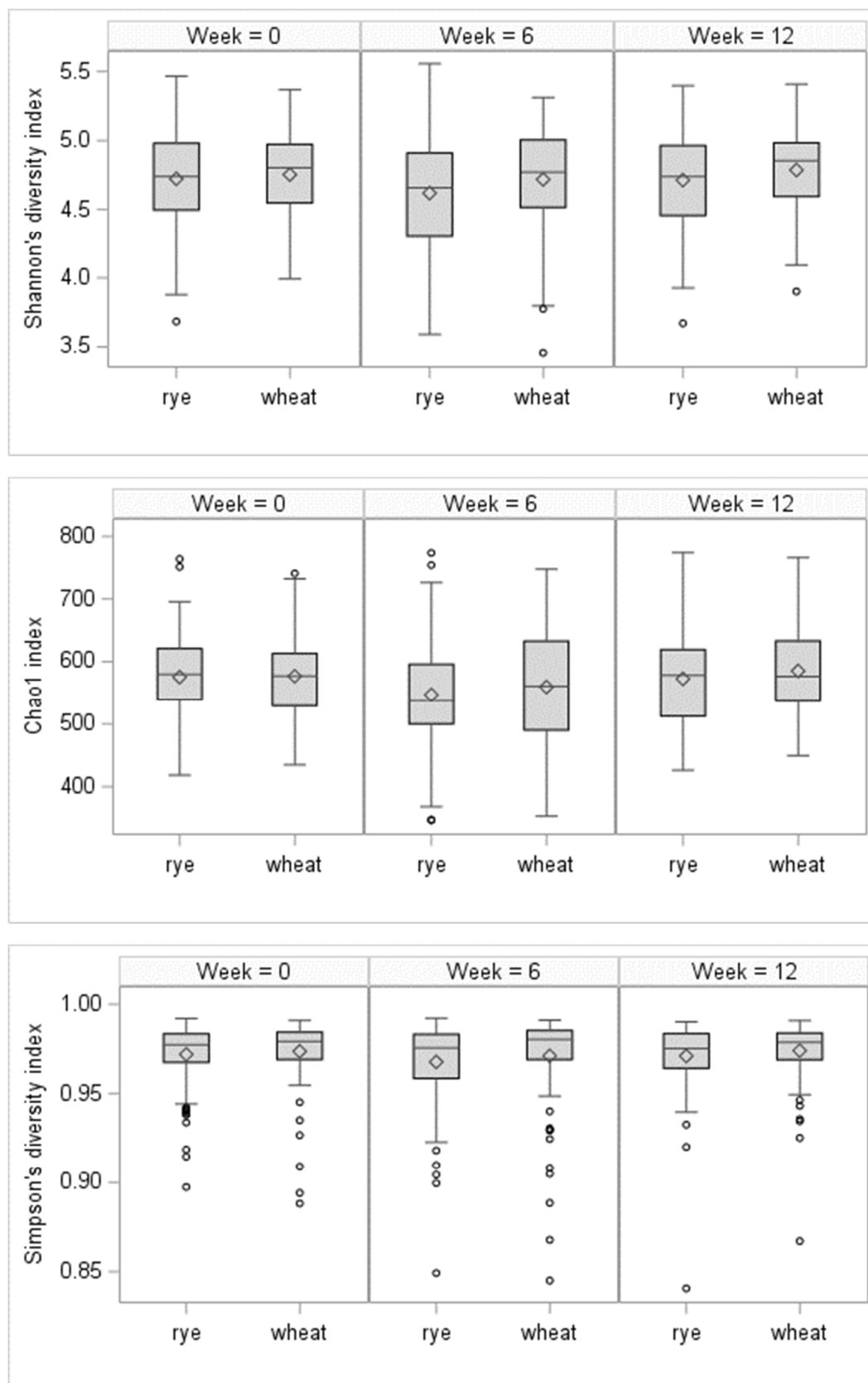


Supplemental figure S1: Design of the RyeWeight study. Abbreviations: DXA, dual-energy x-ray absorptiometry; 3DWFR, 3-day weighed food record.



Supplemental figure S2: Flow chart of the participants in the RyeWeight study



Supplemental figure S3: Alpha diversity, shown as Shannon's diversity index (top), Chao1 index (middle) and Simpson's index (bottom) in the rye and the wheat groups at week 0, week 6 and week 12. There was no significant difference between the groups at any time point ($p > 0.05$).

Supplemental table S1: Overview of the intervention products used in the RyeWeight study

	Cereal ingredients	Fermentation (breads)	Supplier (Commercial name)
Extruded rye puffs	Whole grain rye flour (100% of flour weight)	-	Lantmännen (-*)
Rolled rye flakes	100% wholegrain rye	-	Lantmännen (AXA Rågflingor)
Rye crisp bread 'Rågi'	Whole grain rye flour (73% of flour weight), sifted rye flour (27% of flour weight)	Yeast	Barilla (Wasa Rågi)
Rye crisp bread 'Husman'	Whole grain rye flour (100% of flour weight)	Yeast	Barilla (Wasa Husman)
Rye crisp bread 'Sport'	Whole grain rye flour (100% of flour weight)	Yeast	Barilla (Wasa Sport)
Rye crisp bread 'Delikatess'	Whole grain rye flour (100% of flour weight)	Unfermented	Barilla (Wasa Delikatess)
Soft rye bread	Whole grain rye flour (100% of flour weight)	Yeast	Lantmännen (-*)
Extruded wheat puffs	Sifted wheat flour (100% of flour weight)	-	Lantmännen (-*)
Wheat semolina	100% Sifted wheat	-	Lantmännen (AXA mannagryn)
Wheat crisp bread	Sifted wheat flour (100% of flour weight)	Yeast	Barilla (Wasa Frukost)
Soft wheat bread	Sifted wheat flour (100% of flour weight)	Yeast	Lantmännen (Schulstad Sandwino Sub)

*Product was developed and produced for the study and is not commercially available.

Supplemental table S2: Composition of intervention products, per 100 g edible product. Participants were instructed to consume 60 g breakfast cereals (puffs or flakes/semolina), 4-6 slice of crisp bread (53-66g) and one serving of soft bread (Wheat: 70g, rye: 119g) per day, why the intake as per protocol varied depending on the participants choice of crisp bread and breakfast cereals.

		Product weight (g)	Energy (kcal)	CHO (g)	Protein (g)	Fat (g)	Dietary fiber (g) ⁺			Arabinoxylans (g)			Fructans (g)	Klason lignin (g)	Glucose (g)	Total AR (mg)	C17:0/C21:0 ratio
							Total	Extr.	Unextr.	Total	Extr.	Unextr.					
Per 100g edible product																	
<i>Rye products</i>																	
		100	345.6	64.0	9.0	2.2	16.78	6.86	9.92	7.16	2.29	4.87	3.85	1.28	3.59	24.9	1.15
		100	345.8	63.7	8.6	2.2	18.33	7.41	10.92	8.34	3.29	5.05	3.02	1.34	4.69	35.8	0.98
		100	339.8	65.9	8.8	1.4	14.14	5.60	8.54	6.59	2.47	4.10	2.30	0.65	3.74	39.5	0.93
		100	335.6	63.1	9.0	1.5	16.95	6.65	10.30	8.16	2.98	5.18	2.45	1.24	4.18	39.7	1.00
		100	337.5	63.6	8.4	1.6	17.50	6.11	11.39	8.07	2.44	5.64	2.61	1.09	4.80	43.3	0.97
		100	336.1	61.0	10.0	1.5	19.27	7.39	11.88	8.43	2.54	5.89	3.79	1.19	4.96	38.3	0.97
		100	225.6	34.4	7.5	4.1	10.62	3.75	6.87	4.54	1.50	3.04	1.52	1.04	2.92	32.9	0.86
<i>Wheat products</i>																	
		100	367.7	73.4	11.5	1.9	5.42	2.51	2.91	2.36	1.24	1.12	1.05	0.78	0.75	0.8	nd**
		100	353.5	75.0	10.0	0.8	2.95	1.33	1.63	1.17	0.56	0.61	0.62	0.17	0.54	nd*	nd*
		100	392.4	65.6	12.4	7.7	5.56	1.52	4.04	2.56	0.86	1.69	0.39	0.50	1.50	4.1	0.05
		100	252.2	43.3	13.7	1.9	3.53	1.03	2.50	1.24	0.76	0.49	0.15	0.71	1.05	1.6	nd**
Average daily amount of intervention products prescribed per protocol																	
Rye	Mean	235	664	114.6	19.2	7.0	32.7	12.3	20.4	14.4	4.9	9.5	5.4	2.6	8.4	80.01	0.93
	(minimum)	(232)	(656)	(112.5)	(18.8)	(6.9)	(30.2)	(11.5)	(18.7)	(13.2)	(4.5)	(8.7)	(4.8)	(2.3)	(7.6)	(75.00)	(0.91)
	(maximum)	(239)	(679)	(117.5)	(19.8)	(7.2)	(34.2)	(12.9)	(21.6)	(15.2)	(5.4)	(10.0)	(6.2)	(2.7)	(9.2)	(86.62)	(0.95)
Wheat	Mean	196	652	118.1	24.2	7.2	8.7	2.9	5.8	3.6	1.6	2.0	0.9	1.1	2.1	4.09	0.03
	(minimum)	(196)		(117.6)				(2.5)						(0.9)		(3.86)	(0.03)

(maximum) (196) (648) (118.6) (23.8) (6.9) (7.9) (3.2) (5.4) (3.3) (1.4) (1.8) (0.7) (1.3) (2.0) (4.33) (0.04)
(656) (24.7) (7.6) (9.4) (6.2) (4.0) (1.8) (2.1) (1.0) (2.2)

[†]Including arabinoxylans, fructans, klason lignin and glucose, ^{*}no alkylresorcinol detected in the product, ^{**}no C17:0 detected in the product.

Abbreviations: CHO, carbohydrate; extr, extractable, unextr, unextractable; AR, alkylresorcinols.

Supplemental table S3: Bacteria that differed in abundance between the groups at week 6 and/or week 12 before FDR correction, but not after (bacteria that differed even after FDR are shown in results section of the paper).

		Week 0*	Week 6*	Week 12*	p-value, raw**		p-value, FDR**	
					Week 6	Week12	Week 6	Week 12
<i>Flavonifractor</i>	Wheat	0.049 (0.038;0.064)	0.033 (0.024;0.045)	0.034 (0.025;0.045)	0.0015	0.0038	0.1545	0.3800
	Rye	0.048 (0.037;0.062)	0.017 (0.013;0.023)	0.02 (0.015;0.026)				
<i>Romboutsia</i>	Wheat	0.091 (0.076;0.109)	0.106 (0.088;0.128)	0.104 (0.09;0.12)	0.004	0.0061	0.3960	0.5978
	Rye	0.123 (0.103;0.146)	0.079 (0.066;0.094)	0.086 (0.075;0.1)				
<i>Erysipelatoclostridium</i>	Wheat	0.012 (0.009;0.016)	0.006 (0.005;0.008)	0.01 (0.007;0.013)	0.0103	0.0024	0.9373	0.2496
	Rye	0.011 (0.008;0.014)	0.004 (0.003;0.005)	0.005 (0.004;0.007)				
<i>[Eubacterium] xylanophilum group</i>	Wheat	0.28 (0.238;0.328)	0.34 (0.292;0.396)	0.282 (0.24;0.331)	0.0012	0.0083	0.1248	0.7802
	Rye	0.271 (0.232;0.316)	0.45 (0.389;0.521)	0.361 (0.31;0.421)				
<i>Dorea</i>	Wheat	0.848 (0.745;0.964)	0.865 (0.756;0.989)	0.841 (0.753;0.94)	0.0047	0.0048	0.4606	0.4752
	Rye	0.732 (0.647;0.828)	0.635 (0.558;0.722)	0.651 (0.585;0.724)				
<i>UBA1819</i>	Wheat	0.067 (0.056;0.079)	0.055 (0.047;0.065)	0.06 (0.052;0.069)	0.011	0.0038	0.9768	0.3800
	Rye	0.061 (0.052;0.072)	0.04 (0.034;0.047)	0.044 (0.038;0.05)				
<i>Negativibacillus</i>	Wheat	0.015 (0.011;0.021)	0.012 (0.009;0.017)	0.018 (0.013;0.025)	0.0074	0.0065	0.6808	0.6305
	Rye	0.011 (0.008;0.015)	0.006 (0.005;0.009)	0.009 (0.006;0.012)				
<i>Blautia</i>	Wheat	2.166 (1.879;2.496)	2.126 (1.843;2.452)	2.073 (1.821;2.359)	0.0741	0.0015	0.9958	0.1575
	Rye	1.941 (1.694;2.224)	1.72 (1.501;1.972)	1.54 (1.361;1.743)				
<i>Collinsella</i>	Wheat	0.289 (0.24;0.348)	0.303 (0.256;0.358)	0.464 (0.396;0.543)	0.0065	0.0076	0.6175	0.7296
	Rye	0.241 (0.202;0.289)	0.211 (0.179;0.247)	0.332 (0.286;0.386)				

<i>Shuttleworthia</i>	Wheat	0.011 (0.007;0.015)	0.008 (0.006;0.011)	0.005 (0.003;0.006)	0.0248	0.0031	0.9958	0.3193
	Rye	0.009 (0.006;0.013)	0.004 (0.003;0.006)	0.002 (0.002;0.003)				
<i>Monoglobus</i>	Wheat	0.321 (0.289;0.357)	0.35 (0.314;0.39)	0.307 (0.277;0.34)	0.0027	0.4912	0.2754	0.9854
	Rye	0.314 (0.284;0.347)	0.281 (0.253;0.311)	0.29 (0.263;0.32)				
<i>Coprococcus</i>	Wheat	1.308 (1.166;1.468)	1.527 (1.345;1.733)	1.322 (1.195;1.463)	0.0028	0.0353	0.2828	0.9854
	Rye	1.248 (1.118;1.393)	1.192 (1.056;1.345)	1.14 (1.035;1.256)				
<i>Lactococcus</i>	Wheat	0.003 (0.002;0.004)	0.002 (0.002;0.003)	0.003 (0.002;0.004)	0.0313	0.0086	0.9958	0.7998
	Rye	0.003 (0.002;0.003)	0.002 (0.001;0.002)	0.002 (0.002;0.002)				
<i>Veillonella</i>	Wheat	0.018 (0.013;0.024)	0.015 (0.012;0.02)	0.024 (0.019;0.031)	0.0071	0.0206	0.6674	0.9854
	Rye	0.023 (0.018;0.03)	0.028 (0.021;0.036)	0.039 (0.03;0.05)				
<i>Eisenbergiella</i>	Wheat	0.013 (0.009;0.019)	0.01 (0.007;0.014)	0.006 (0.005;0.009)	0.0221	0.0077	0.9958	0.7315
	Rye	0.016 (0.011;0.022)	0.006 (0.004;0.008)	0.004 (0.003;0.005)				
CAG_56	Wheat	0.145 (0.116;0.181)	0.203 (0.167;0.248)	0.144 (0.116;0.179)	0.0035	0.1831	0.3500	0.9854
	Rye	0.111 (0.089;0.137)	0.127 (0.105;0.153)	0.109 (0.089;0.134)				
<i>Paludicola</i>	Wheat	0.011 (0.008;0.015)	0.007 (0.005;0.01)	0.006 (0.005;0.009)	0.0049	0.5007	0.4753	0.9854
	Rye	0.01 (0.008;0.014)	0.004 (0.003;0.005)	0.005 (0.004;0.007)				
<i>Bifidobacterium</i>	Wheat	0.396 (0.319;0.492)	0.498 (0.406;0.612)	0.700 (0.582;0.842)	0.0186	0.0152	0.9958	0.9854
	Rye	0.331 (0.269;0.408)	0.606 (0.498;0.738)	0.844 (0.707;1.007)				
<i>[Eubacterium] eligens group</i>	Wheat	0.662 (0.558;0.785)	0.63 (0.532;0.747)	0.498 (0.434;0.571)	0.0073	0.0709	0.6789	0.9854
	Rye	0.648 (0.55;0.762)	0.473 (0.401;0.556)	0.421 (0.369;0.48)				
<i>Adlercreutzia</i>	Wheat	0.063 (0.051;0.079)	0.061 (0.048;0.078)	0.072 (0.061;0.086)	0.0115	0.1325	0.9890	0.9854
	Rye	0.054 (0.044;0.067)	0.039 (0.031;0.048)	0.059 (0.05;0.069)				
<i>Streptococcus</i>	Wheat	0.087 (0.072;0.106)	0.067 (0.055;0.081)	0.082 (0.069;0.099)	0.0127	0.2400	0.9958	0.9854
	Rye	0.087 (0.072;0.104)	0.049 (0.04;0.059)	0.071 (0.06;0.085)				
<i>Sutterella</i>	Wheat	0.789 (0.645;0.965)	0.779 (0.637;0.952)	0.927 (0.759;1.133)	0.0108	0.5359	0.9720	0.9854
	Rye	0.788 (0.65;0.955)	1.043 (0.86;1.264)	0.996 (0.822;1.206)				
<i>Lachnospiraceae AC2044 group</i>	Wheat	0.087 (0.065;0.116)	0.12 (0.088;0.164)	0.094 (0.07;0.127)	0.0309	0.0231	0.9958	0.9854
	Rye	0.088 (0.067;0.117)	0.188 (0.14;0.254)	0.151 (0.113;0.201)				
	Wheat	0.133 (0.113;0.157)	0.148 (0.126;0.172)	0.127 (0.11;0.146)	0.0111	0.1559	0.9768	0.9854

<i>Lachnospiraceae</i> UCG 004	Rye	0.142 (0.121;0.166)	0.194 (0.168;0.226)	0.147 (0.129;0.169)				
<i>Colidextribacter</i>	Wheat	0.151 (0.135;0.17)	0.142 (0.127;0.158)	0.165 (0.151;0.181)	0.1379	0.0106	0.9958	0.9646
	Rye	0.163 (0.146;0.182)	0.13 (0.117;0.144)	0.145 (0.133;0.158)				
<i>Butyrivibrio</i>	Wheat	0.070 (0.044;0.11)	0.044 (0.027;0.071)	0.024 (0.015;0.039)	0.0114	0.1673	0.9890	0.9854
	Rye	0.071 (0.046;0.111)	0.020 (0.013;0.032)	0.016 (0.01;0.025)				
<i>Roseburia</i>	Wheat	1.719 (1.529;1.931)	1.801 (1.587;2.044)	1.897 (1.687;2.132)	0.1122	0.024	0.9958	0.9854
	Rye	1.780 (1.592;1.99)	1.607 (1.424;1.814)	1.620 (1.448;1.813)				
<i>Candidatus Soleaferrea</i>	Wheat	0.008 (0.007;0.011)	0.005 (0.004;0.006)	0.006 (0.005;0.008)	0.2326	0.0171	0.9958	0.9854
	Rye	0.007 (0.005;0.008)	0.004 (0.003;0.005)	0.004 (0.003;0.005)				
<i>Merdibacter</i>	Wheat	0.008 (0.006;0.011)	0.006 (0.005;0.009)	0.008 (0.006;0.012)	0.0147	0.2419	0.9958	0.9854
	Rye	0.010 (0.007;0.014)	0.004 (0.003;0.006)	0.007 (0.005;0.01)				
<i>Lachnospiraceae</i> UCG 001	Wheat	0.209 (0.171;0.255)	0.224 (0.187;0.268)	0.167 (0.137;0.203)	0.017	0.2158	0.9958	0.9854
	Rye	0.185 (0.153;0.224)	0.163 (0.137;0.193)	0.135 (0.111;0.163)				
<i>Incertae Sedis</i>	Wheat	0.18 (0.16;0.202)	0.24 (0.209;0.276)	0.288 (0.253;0.328)	0.0325	0.1129	0.9958	0.9854
	Rye	0.178 (0.159;0.2)	0.195 (0.171;0.223)	0.249 (0.22;0.282)				
<i>Howardella</i>	Wheat	0.004 (0.003;0.005)	0.005 (0.004;0.006)	0.006 (0.005;0.008)	0.021	0.4056	0.9958	0.9854
	Rye	0.004 (0.003;0.006)	0.003 (0.003;0.004)	0.006 (0.004;0.007)				
<i>Phascolarctobacterium</i>	Wheat	0.124 (0.094;0.164)	0.118 (0.088;0.158)	0.166 (0.124;0.224)	0.1849	0.0258	0.9958	0.9854
	Rye	0.101 (0.077;0.132)	0.083 (0.063;0.11)	0.099 (0.074;0.132)				
<i>Intestinimonas</i>	Wheat	0.238 (0.213;0.265)	0.202 (0.18;0.227)	0.229 (0.205;0.256)	0.0378	0.1196	0.9958	0.9854
	Rye	0.22 (0.198;0.245)	0.167 (0.149;0.187)	0.199 (0.179;0.221)				
<i>Oscillibacter</i>	Wheat	0.211 (0.186;0.239)	0.191 (0.168;0.216)	0.2 (0.173;0.23)	0.0299	0.2037	0.9958	0.9854
	Rye	0.191 (0.169;0.215)	0.153 (0.136;0.173)	0.17 (0.149;0.195)				
<i>Anaerostipes</i>	Wheat	0.552 (0.478;0.637)	0.662 (0.573;0.765)	0.639 (0.562;0.726)	0.0412	0.2104	0.9958	0.9854
	Rye	0.498 (0.435;0.571)	0.764 (0.666;0.877)	0.684 (0.606;0.773)				
<i>Lachnospira</i>	Wheat	0.465 (0.409;0.528)	0.423 (0.362;0.494)	0.479 (0.42;0.547)	0.3593	0.0432	0.9958	0.9854
	Rye	0.425 (0.376;0.48)	0.37 (0.319;0.429)	0.388 (0.342;0.441)				

*Relative abundance in % as geometric mean and 95% CI (raw unadjusted data, back transformed from log scale). **Linear mixed model, adjusted for baseline abundance, data was log transformed before analysis. n(rye/wheat) =108/99.

Supplemental table S4: Correlations between changes in plasma short chain fatty acid concentration and changes in clinical outcomes. Data is Spearman's rho (p-value), significant correlations are highlighted in bold font.

	Δ Formic acid	Δ Acetic acid	Δ Propionic acid	Δ Butyric acid	Δ Isobutyric acid	Δ Succinic acid	Δ Valeric acid	Δ Isovaleric acid	Δ Capronic acid
Rye group (n=108)									
Δ weight	0.073 (0.450)	-0.076 (0.437)	-0.061 (0.535)	-0.113 (0.252)	-0.040 (0.684)	-0.078 (0.421)	0.077 (0.432)	0.048 (0.626)	-0.095 (0.329)
Δ Fat mass	0.010 (0.922)	-0.049 (0.612)	-0.149 (0.126)	-0.188 (0.055)	-0.044 (0.650)	-0.049 (0.615)	0.110 (0.260)	0.063 (0.519)	-0.125 (0.198)
Δ Fat%	-0.040 (0.680)	-0.041 (0.671)	-0.206 (0.034)	-0.193 (0.049)	-0.061 (0.533)	-0.013 (0.897)	0.145 (0.136)	0.032 (0.740)	-0.095 (0.328)
Δ CRP	-0.168 (0.082)	0.107 (0.272)	0.024 (0.807)	-0.015 (0.877)	0.024 (0.805)	-0.211 (0.028)	0.034 (0.728)	0.052 (0.592)	-0.072 (0.458)
Δ Glucose	-0.013 (0.894)	-0.046 (0.640)	0.239 (0.013)	0.245 (0.012)	-0.071 (0.465)	-0.031 (0.748)	0.183 (0.060)	-0.128 (0.188)	-0.057 (0.556)
Δ Insulin	0.005 (0.959)	-0.043 (0.655)	0.142 (0.144)	0.080 (0.416)	-0.037 (0.704)	0.017 (0.860)	0.054 (0.582)	-0.190 (0.049)	-0.031 (0.749)
Δ total chol.	-0.078 (0.423)	-0.177 (0.067)	-0.1412 (0.145)	-0.155 (0.114)	0.020 (0.835)	0.113 (0.243)	0.045 (0.642)	0.063 (0.518)	-0.012 (0.900)
Δ LDL chol.	0.135 (0.165)	-0.078 (0.421)	-0.133 (0.171)	-0.181 (0.065)	0.060 (0.543)	0.099 (0.307)	0.013 (0.892)	0.119 (0.221)	0.082 (0.398)
Δ HDL chol.	-0.105 (0.278)	-0.100 (0.302)	-0.124 (0.204)	-0.097 (0.327)	0.010 (0.915)	0.071 (0.466)	0.077 (0.428)	0.054 (0.580)	-0.019 (0.841)
Δ Triglyceride	0.027 (0.779)	-0.221 (0.022)	0.055 (0.572)	0.030 (0.763)	0.004 (0.965)	0.030 (0.755)	-0.057 (0.558)	-0.147 (0.130)	-0.051 (0.603)
Wheat group (n=99)									
Δ weight	-0.037 (0.716)	-0.065 (0.523)	-0.015 (0.880)	0.130 (0.210)	-0.202 (0.045)	-0.213 (0.035)	-0.120 (0.237)	-0.080 (0.431)	-0.050 (0.624)

ΔFat mass	-0.056 (0.580)	-0.066 (0.518)	-0.060 (0.558)	0.107 (0.302)	-0.197 (0.051)	-0.266 (0.008)	-0.029 (0.775)	-0.078 (0.440)	-0.063 (0.534)
ΔFat%	-0.018 (0.86)	-0.069 (0.497)	-0.082 (0.422)	0.067 (0.516)	-0.148 (0.145)	-0.239 (0.017)	0.025 (0.807)	-0.072 (0.479)	-0.081 (0.426)
ΔCRP	-0.159 (0.116)	-0.112 (0.269)	-0.173 (0.088)	-0.043 (0.682)	0.049 (0.632)	0.007 (0.948)	-0.147 (0.147)	0.183 (0.070)	-0.011 (0.910)
ΔGlucose	0.065 (0.524)	-0.140 (0.166)	0.149 (0.143)	0.202 (0.049)	-0.003 (0.980)	0.0273 (0.789)	-0.079 (0.434)	-0.209 (0.038)	0.054 (0.596)
ΔInsulin	0.142 (0.160)	0.1763 (0.081)	0.224 (0.027)	0.173 (0.094)	-0.070 (0.490)	0.061 (0.548)	-0.064 (0.529)	-0.291 (0.004)	0.059 (0.560)
Δtotal chol.	0.145 (0.153)	0.0359 (0.724)	0.176 (0.0835)	0.132 (0.204)	-0.048 (0.639)	-0.224 (0.026)	0.135 (0.182)	-0.059 (0.560)	0.094 (0.355)
ΔLDL chol.	-0.015 (0.886)	0.0743 (0.465)	0.016 (0.874)	0.045 (0.664)	0.037 (0.719)	-0.100 (0.324)	0.017 (0.866)	0.115 (0.259)	0.057 (0.575)
ΔHDL chol.	-0.037 (0.716)	-0.065 (0.523)	-0.015 (0.880)	0.130 (0.210)	-0.202 (0.045)	-0.213 (0.035)	-0.120 (0.237)	-0.080 (0.431)	-0.050 (0.624)
ΔTriglyceride	-0.056 (0.580)	-0.066 (0.518)	-0.060 (0.558)	0.107 (0.302)	-0.197 (0.051)	-0.266 (0.008)	-0.029 (0.775)	-0.078 (0.440)	-0.063 (0.534)

Abbreviations: CRP, C-reactive protein; chol, cholesterol; LDL chol, low density lipoprotein cholesterol; HDL chol, high density lipoprotein cholesterol.