

Supplementary materials

Personalized Prediction of Glycemic Responses to Food in Women with Gestational Diabetes: Gut Microbiota Matters

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Supplementary table 1. Feature description.

Feature name	Feature description	Feature group
BMI	prepregnancy body mass index, kg/m2	anthropometric
Height	height, cm	
Weight	prepregnancy weight, kg	
GLUb240	glucose level 240 minutes before meal start (mmol/L)	cgm_data
GLUb120	glucose level 120 minutes before meal start (mmol/L)	
GLUb60	glucose level 60 minutes before meal start (mmol/L)	
GLUb50	glucose level 50 minutes before meal start (mmol/L)	
GLUb40	glucose level 40 minutes before meal start (mmol/L)	
GLUb30	glucose level 30 minutes before meal start (mmol/L)	
GLUb25	glucose level 25 minutes before meal start (mmol/L)	
GLUb20	glucose level 20 minutes before meal start (mmol/L)	
GLUb15	glucose level 15 minutes before meal start (mmol/L)	
GLUb10	glucose level 10 minutes before meal start (mmol/L)	
GLUb5	glucose level 5 minutes before meal start (mmol/L)	
GLU0	glucose level at the beginning of the meal according to the CGM signal (mmol/L)	
GLURiseb240	glucose level rise from 240 minutes before the meal to meal start (mmol/L)	
GLURiseb120	glucose level rise from 120 minutes before the meal to meal start (mmol/L)	
GLURiseb60	glucose level rise from 60 minutes before the meal to meal start (mmol/L)	
iAUCb240	incremental AUC 240 minutes before the meal start (mmol/L*hour)	
iAUCb120	incremental AUC 120 minutes before the meal start (mmol/L*hour)	

iAUCb60	incremental AUC 60 minutes before the meal start (mmol/L*hour)	
rs10830963_MTNR1B_N	rs10830963 variant in MTNR1B gene	genetics
rs1387153_MTNR1B_N	rs1387153 variant in MTNR1B gene	
Gestational age 1	gestational age at the time of inclusion in the study, weeks	gynecological_data
Cervical insufficiency	cervical insufficiency (1 – yes, 2 – no)	
COC	combined oral contraceptive use any time before pregnancy (1 – yes, 0 – no)	
Edema 1	edema at the time of inclusion in the study (0 – no, 1 – yes)	
Menses	the presence of a regular menstrual cycle before pregnancy (1 – yes, 0 – no)	
Abortions	the number of abortions in history	
Deliveries	the number of deliveries in history	
Pregnancies	the number of pregnancies in history, including the index pregnancy	
Pregnancy losses	the number of pregnancy loss episodes in history	
PCOS	the presence of polycystic ovary syndrome (0 – no, 1 – yes)	
Weight gain	gestational weight gain by the time of inclusion in the study, kg	
Fasting plasma glucose V1	fasting plasma glucose level at the time of inclusion in the study (mmol/L)	laboratory_glycemic_markers
Fasting plasma glucose OGTT	fasting plasma glucose level in OGTT, mmol/L	
Fructosamine 1	serum fructosamine level (mcmol/l) at the time of inclusion in the study	
HbA1C 1	glycosylated hemoglobin level at the time of inclusion in the study, %	
Climbing stairs 2	number of flights of stairs climbed during pregnancy (1 – less than 4 flights per day, 2 – 4–16 flights of stairs per day, 3 – more than 16 flights of stairs per day)	lifestyle_survey
Dairy 1	frequency of eating dairy products before pregnancy (1 – less than 3 times per week, 2 – 3–6 times a week, 3 – more than 6 times a week)	
Fruits 1	frequency of eating fruits before pregnancy (1 – less than 6 per week, 2 – 6–12 per week, 3 – more than 12 per week)	
Legumes 2	frequency of eating legumes during pregnancy (1 – less than 1 time per week, 2 – 1–3 times a week, 3 – more than 3 times a week)	
Sausages 1	frequency of consuming sausage products before pregnancy (1 - less than 1 time a week, 2 - 1–3 times a week, 3 -more than 3 times a week)	
Sausages 2	frequency of consuming sausage products during pregnancy (1 – less than 1 time per week, 2 – 1–3 times a week, 3 – more than 3 times a week)	
Vegetables 2	frequency of eating vegetables during pregnancy (1 – less than 6 per week, 2 – 6–12 times a week, 3 – more than 12 times a week)	
Carbohydrates	the amount of carbohydrates in the meal, g	meal_composition
Fats	the amount of fats in the meal, g	
Glycemic index	glycemic index of the meal	
Glycemic load	glycemic load of the meal	
Kcal	the energy value of the meal	
Starch	the amount of starch in the meal, g	

Mono-, di-saccharides	the amount of monosaccharides and disaccharides in the meal, g	meal_context
Proteins	the amount of proteins in the meal, g	
Fiber	the amount of alimentary fiber in the meal, g	
Diurnal interval	time of the day (1=0-4, 2=4-8, 3=8-12, 4=12-16, 5=16-20, 6=20-24)	
Hour	time of the day (hour)	
Meal type	meal type (1 – breakfast, 2 – lunch, 3 – dinner, 4 – snack)	
Carbohydrates before 3h	carbohydrates consumed within 3 hours before the meal, g	
Carbohydrates before 6h	carbohydrates consumed within 6 hours before the meal, g	
Carbohydrates before 12h	carbohydrates consumed within 12 hours before the meal, g	
Fats before 3h	fats consumed within 3 hours before the meal, g	
Fats before 6h	fats consumed within 6 hours before the meal, g	
Fats before 12h	fats consumed within 12 hours before the meal, g	
Glycemic load before 3h	glycemic load of the foods consumed within 3 hours before the meal	
Glycemic load before 6h	glycemic load of the foods consumed within 6 hours before the meal	
Glycemic load before 12h	glycemic load of the foods consumed within 12 hours before the meal	
Kcal before 3h	energy value of the foods consumed within 3 hours before the meal (kcal)	
Kcal before 6h	energy value of the foods consumed within 6 hours before the meal (kcal)	
Kcal before 12h	energy value of the foods consumed within 12 hours before the meal (kcal)	
Preceding meal GI	glycemic index of the preceding meal	
Preceding meal GL	glycemic load of the preceding meal	
Preceding meal Carbo	the amount of carbohydrates in the preceding meal, g	
Preceding meal protein	the amount of proteins in the preceding meal, g	
Preceding meal fat	the amount of fats in the preceding meal, g	
Preceding meal fiber	the amount of alimentary fiber in the meal, g	
Proteins before 3h	proteins consumed within 3 hours before the meal, g	
Proteins before 6h	proteins consumed within 6 hours before the meal, g	
Proteins before 12h	proteins consumed within 12 hours before the meal, g	
Fiber before 3h	alimentary fibers consumed 3 hours before the meal, g	
Fiber before 6h	alimentary fibers consumed 6 hours before the meal, g	
Fiber before 12h	alimentary fibers consumed 12 hours before the meal, g	
Lachnospiraceae/Marvinbryantia/NA/OTU_110	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Marvinbryantia NA	microbiome
Lachnospiraceae/FCS020 group/NA/OTU_123	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Lachnospiraceae FCS020 group NA	
Oscillospiraceae/UCG-002/NA/OTU_124	Bacteria Firmicutes Clostridia Oscillospirales Oscillospiraceae UCG-002 NA	

Lachnospiraceae/Dorea/NA/OTU_13	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Dorea NA
Oscillospirales/Ruminococcaceae Incertae Sedis/NA/OTU_132	Bacteria Firmicutes Clostridia Oscillospirales Ruminococcaceae Incertae Sedis NA
Lachnospiraceae/Fusicatenibacter/NA/OTU_15	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Fusicatenibacter NA
Lachnoclostridium edouardi	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Lachnoclostridium edouardi
NA/NA/NA/OTU_153	Bacteria Firmicutes Clostridia Clostridia UCG-014 NA NA NA
Oscillospiraceae/NA/NA/OTU_187	Bacteria Firmicutes Clostridia Oscillospirales Oscillospiraceae NA NA
Prevotellaceae/Prevotella_9/NA/OTU_190	Bacteria Bacteroidota Bacteroidia Bacteroidales Prevotellaceae Prevotella_9 NA
Anaerovoracaceae Family XIII/AD3011 group/NA/OTU_193	Bacteria Firmicutes Clostridia Peptostreptococcales-Tissierellales Anaerovoracaceae Family XIII AD3011 group NA
Ruminococcus champanellensis	Bacteria Firmicutes Clostridia Oscillospirales Ruminococcaceae Ruminococcus champanellensis
Prevotellaceae/NA/NA/OTU_196	Bacteria Bacteroidota Bacteroidia Bacteroidales Prevotellaceae NA NA
Oscillospirales [Eubacterium] coprostanoligenes group/NA/NA/OTU_197	Bacteria Firmicutes Clostridia Oscillospirales [Eubacterium] coprostanoligenes group NA NA
Oscillospiraceae UCG-002/NA/OTU_20	Bacteria Firmicutes Clostridia Oscillospirales Oscillospiraceae UCG-002 NA
Coriobacteriales Incertae Sedis/NA/NA/OTU_210	Bacteria Actinobacteriota Coriobacteriia Coriobacteriales Coriobacteriales Incertae Sedis NA NA
Oscillospirales [Eubacterium] coprostanoligenes group/NA/NA/OTU_230	Bacteria Firmicutes Clostridia Oscillospirales [Eubacterium] coprostanoligenes group NA NA
Lachnospiraceae/Marvinbryantia/NA/OTU_239	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Marvinbryantia NA
NA/NA/NA/OTU_241	Bacteria Firmicutes Clostridia Clostridia UCG-014 NA NA NA
Lachnospiraceae [Ruminococcus]/torques group/NA/OTU_25	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae [Ruminococcus] torques group NA
Christensenellaceae/R-7 group/NA/OTU_256	Bacteria Firmicutes Clostridia Christensenellales Christensenellaceae Christensenellaceae R-7 group NA
Desulfovibrionaceae/Bilophila/wadsworthia/OTU_257	Bacteria Desulfobacterota Desulfovibrionia Desulfovibrionales Desulfovibrionaceae Bilophila wadsworthia
Tannerellaceae/Parabacteroides/distasonis/OTU_305	Bacteria Bacteroidota Bacteroidia Bacteroidales Tannerellaceae Parabacteroides distasonis
Lachnospiraceae/Blautia/NA/OTU_312	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Blautia NA
Muribaculaceae/NA/NA/OTU_33	Bacteria Bacteroidota Bacteroidia Bacteroidales Muribaculaceae NA NA
Christensenellaceae/R-7 group/NA/OTU_337	Bacteria Firmicutes Clostridia Christensenellales Christensenellaceae Christensenellaceae R-7 group NA
NA/NA/NA/OTU_338	Bacteria Firmicutes Clostridia NA NA NA NA
Lachnospiraceae/Coprococcus comes/OTU_34	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Coprococcus comes
Lachnospiraceae [Eubacterium]/hallii group/NA/OTU_354	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae [Eubacterium] hallii group NA
Lachnospiraceae/NA/NA/OTU_359	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae NA NA

Lachnospiraceae/NA/NA/OTU_396	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae NA NA	
Lachnospiraceae/Eisenbergiella/tayi/OTU_399	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Eisenbergiella tayi	
Anaerovoracaceae Family XIII/AD3011 group/NA/OTU_402	Bacteria Firmicutes Clostridia Peptostreptococcales-Tissierellales Anaerovoracaceae Family XIII AD3011 group NA	
Lachnospiraceae/Sellimonas/NA/OTU_420	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Sellimonas NA	
Lachnospiraceae/Lachnoclostridium/NA/OTU_439	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Lachnoclostridium NA	
Lachnospiraceae/Dorea/NA/OTU_44	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Dorea NA	
Lachnospiraceae/UC5-1-2E3/NA/OTU_454	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae UC5-1-2E3 NA	
Lactobacillaceae/Lactobacillus/NA/OTU_459	Bacteria Firmicutes Bacilli Lactobacillales Lactobacillaceae Lactobacillus NA	
NA/NA/NA/OTU_496	Bacteria Firmicutes Clostridia Clostridia UCG-014 NA NA NA	
Methanobacteriaceae/Methanosphaera/NA/OTU_51	Archaea Euryarchaeota Methanobacteria Methanobacteriales Methanobacteriaceae Methanosphaera NA	
Anaerovoracaceae Family XIII/AD3011 group/NA/OTU_529	Bacteria Firmicutes Clostridia Peptostreptococcales-Tissierellales Anaerovoracaceae Family XIII AD3011 group NA	
Prevotellaceae/NA/NA/OTU_587	Bacteria Bacteroidota Bacteroidia Bacteroidales Prevotellaceae NA NA	
NA/NA/NA/OTU_609	Bacteria Firmicutes Bacilli RF39 NA NA NA	
Oscillospiraceae/Colidextribacter/NA/OTU_677	Bacteria Firmicutes Clostridia Oscillospirales Oscillospiraceae Colidextribacter NA	
Lachnospira eligens	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae [Eubacterium] eligens group NA	
Christensenellaceae/Christensenellaceae R-7 group/NA/OTU_712	Bacteria Firmicutes Clostridia Christensenellales Christensenellaceae Christensenellaceae R-7 group NA	
Oscillospirales [Eubacterium] coprostanoligenes group/NA/NA/OTU_76	Bacteria Firmicutes Clostridia Oscillospirales [Eubacterium] coprostanoligenes group NA NA	
Intestinibacter bartlettii	Bacteria Firmicutes Clostridia Peptostreptococcales-Tissierellales Peptostreptococcaceae Intestinibacter bartlettii	
Butyricicoccus faecihominis	Bacteria Firmicutes Clostridia Oscillospirales Butyricicoccaceae Butyricicoccus faecihominis	
Lachnospiraceae/Roseburia/NA/OTU_84	Bacteria Firmicutes Clostridia Lachnospirales Lachnospiraceae Roseburia NA	
Christensenellaceae/NA/NA/OTU_98	Bacteria Firmicutes Clostridia Christensenellales Christensenellaceae NA NA	
Group	group number (1 – GDM, 2 – healthy)	other
Arterial hypertension	arterial hypertension in history	
Diastolic blood pressure 1	diastolic blood pressure at the time of inclusion in the study, mm Hg	
Systolic blood pressure 1	systolic blood pressure at the time of inclusion in the study, mm Hg	
Diabetes in family	the presence of diabetes mellitus in the family history (1 – yes, 0 - no)	
Gestational age 1	gestational age at the time of inclusion in the study, weeks	
Smoking 1	smoking before pregnancy (0 – no, 1 – yes)	
Smoking 2	smoking during pregnancy (0 – no, 1 – yes)	

CGMS GA	gestational age at the moment of CGMS installation, weeks	
Antibiotics	antibiotics use any time during pregnancy	
Diet before	dieting before the time of inclusion in the study (1 - yes, 0 - no)	
Diet duration	duration of dieting before the time of inclusion in the study, weeks	
Beta-hydroxybutyrate 1	beta-hydroxybutyrate level at the time of inclusion in the study	other_laboratory_data
Plasma insulin level 1	plasma insulin level at the time of inclusion in the study,	
Urinary ketones 1	urinary ketones level at the time of inclusion in the study	
Leptin 1	serum leptin level at the time of inclusion in the study, ng/ml	
Cholesterol level 1	cholesterol level (mmol/L) at the time of inclusion in the study	serum_lipid_markers
HDLC 1	high-density lipoprotein cholesterol level at the time of inclusion in the study, mmol/L	
LDLC 1	low-density lipoprotein cholesterol level at the time of inclusion in the study, mmol/L	
Triglyceride 1	serum triglyceride level at the time of inclusion in the study, mmol/L	
VLDLC 1	very low density lipoprotein cholesterol at the time of inclusion in the study	

Supplementary table 2. Lifestyle parameters with significant Spearman correlations with iAUC120 and/or GLUmax

	GLUmax		iAUC120	
	R	P	R	P
Climbing stairs during pregnancy	-0.196	0.023	-0.147	0.092
Frequency of eating dairy products before pregnancy	-0.167	0.055	-0.203	0.019
Frequency of eating fruits before pregnancy	0.138	0.113	0.211	0.015
Frequency of eating legumes during pregnancy	0.178	0.04	0.110	0.206
Frequency of consuming sausage products before pregnancy	0.182	0.036	0.138	0.113
Frequency of eating vegetables during pregnancy	-0.140	0.107	-0.190	0.028

Notes: R- Spearman correlation coefficient; P - P-value, 2-sided

For detailed scoring of features listed in Supplementary table 2 please refer to Supplementary table 1.

Supplementary table 3. Additional baseline characteristics of the participants

	GDM N=77	Healthy pregnant women N=28	p-value
	N (%)		
Arterial hypertension in history	4 (5.2)	1 (3.6)	1.0
Combined oral contraceptive use any time before pregnancy	33 (42.9)	13 (46.4)	0.825

The presence of diabetes mellitus in the family history	37 (48.1)	11 (39.3)	0.509
Edema	12 (15.6)	5 (17.9)	0.770
Irregular menstrual cycle before pregnancy	11 (14.3)	3 (10.7)	0.755
Polycystic ovary syndrome	3 (3.9)	1 (3.6)	1.0
	mean±SD		
Serum leptin level, ng/ml	32.5±29.2	32.1±23.7	0.960
Serum fructosamine level (mcmol/l)	207.8±16.7	202.2 ± 19.0	0.146
Serum cholesterol level (mmol/L)	6.4 ± 1.3	6.3 ±1.3	0.847
Serum high-density lipoprotein cholesterol level, mmol/L	1.9 ± 0.4	2.0 ± 0.5	0.419
Serum Low-density lipoprotein cholesterol level, mmol/L	3.3 ± 0.8	3.5 ± 1.5	0.417
Serum very low density lipoprotein cholesterol at the time of inclusion in the study	0.9 ± 0.3	0.8 ± 0.3	0.151
Serum triglyceride level, mmol/L	2.1 ± 0.7	11.8 ± 0.8	0.164
Fasting plasma glucose level at the time of inclusion in the study (mmol/L)	4.9 ± 0.5	4.4 ± 0.3	<0.001
Serum beta-hydroxybutyrate level	0.17 ± 0.14	0.14 ± 0.1	0.202
Urinary ketones level at the time of inclusion in the study	0.4 ± 1.1	0.04 ± 0.18	0.005
Diastolic blood pressure at the time of inclusion in the study, mm Hg	74.7 ± 7.5	73.2 ± 12.9	0.562
Systolic blood pressure at the time of inclusion in the study, mm Hg	119.9 ± 10.4	114.5 ± 12.1	0.024
Number of pregnancies in history, including the index pregnancy	2.2 ± 1.4	1.9 ± 1.0	0.323
Number of abortions in history	0.3 ± 0.6	0.2 ± 0.4	0.246
Number of deliveries in history	0.7 ± 0.7	0.5 ± 0.8	0.321
Number of pregnancy loss episodes in history	0.2 ± 0.5	0.2 ± 0.5	0.852

Notes: Comparisons of scale variables were performed using the bootstrap hypothesis test.

To compare the distribution of binary or ordinary characteristics the χ^2 criterion or Fisher's exact test was used.