

Table S1: Clinical data of children in urban and rural locations in each intervention arm at 3 monthly intervals

Parameter	Intervention Group			p-value	Residence		p-value
	A	B	C		Urban	Rural	
	n = 20	n = 20	n = 20		n = 30	n = 30	
Gender							
Male	7 (35.0)	6 (30.0)	10 (50.0)	0.502	10 (33.3)	13 (43.3)	0.596
Female	13 (65.0)	14 (70.0)	10 (50.0)		20 (66.7)	17 (56.7)	
At Recruitment (3 months)							
Height (cm)	61.0 (58.3,63.0)	59.0 (56.5,63.5)	59.0 (55.8,61.0)	0.190	61.2 (59.5,64.0)	58.3 (56.0,59.5)	<0.001
Weight (kg)	5.3 (4.3,5.6)	5.3 (4.5,5.9)	5.2 (4.5,5.6)	0.880	5.5 (5.1,6.0)	4.6 (4.2,5.3)	<0.001
HAZ	0.2 (-0.4,1.2)	-0.9 (-1.9,0.7)	-1.2 (-1.8,-0.1)	0.036	0.4 (-1.2,1.4)	-1.1 (-1.8,-0.2)	0.006
WHZ	-2.5 (-3.2,-1.4)	-1.3 (-2.3,-0.1)	-1.2 (-1.9,-0.3)	0.027	-1.9 (-2.6,-0.6)	-1.3 (-2.4,-0.9)	0.730
WAZ	-1.2 (-2.7,-0.4)	-1.4 (-2.2,-0.4)	-1.5 (-2.1,-1.1)	0.900	-1.1 (-1.7,-0.2)	-1.9 (-2.6,-1.3)	0.002
Stunted (HAZ<-2SD)	2 (10.0)	7 (35.0)	4 (21.1)	0.160	6 (20.7)	7 (23.3)	1.000
Wasted (WHZ<-2SD)	13 (65.0)	6 (30.0)	4 (21.1)	0.013	12 (41.4)	11 (36.7)	0.790
Underweight (WAZ<-2SD)	8 (40.0)	5 (25.0)	8 (40.0)	0.560	7 (23.3)	14 (46.7)	0.100
Diarrhea	3 (15.0)	5 (25.0)	8 (40.0)	0.240	4 (13.3)	12 (40.0)	0.039
Micronutrient status							
Anemia (HB<11 g/dL)	13 (68.4)	12 (66.7)	10 (50.0)	0.440	20 (71.4)	15 (51.7)	0.180
Vitamin A deficiency (Retinol<0.7 mmol/L)	3 (15.8)	4 (25.0)	7 (41.2)	0.260	7 (26.9)	7 (26.9)	1.000
Iron deficiency (Ferritin<12 ng/mL)	0 (0.0)	0 (0.0)	0 (0.0)	--	0 (0.0)	0 (0.0)	--
Zinc deficiency (zinc<60 µg/dL)	2 (10.5)	2 (12.5)	6 (35.3)	0.150	3 (11.5)	7 (26.9)	0.290
At 6 months							
Height (cm)	65.5 (63.5,67.3)	64.0 (61.2,68.0)	65.5 (62.0,68.0)	0.480	65.9 (64.0,68.0)	63.8 (61.1,67.0)	0.043
Weight (kg)	6.4 (5.7,7.7)	6.6 (6.0,7.2)	6.2 (5.6,6.8)	0.620	6.6 (5.9,7.5)	6.2 (5.4,6.9)	0.079
HAZ	-0.1 (-1.0,0.5)	-1.0 (-2.1,0.7)	-0.8 (-1.7,0.1)	0.430	0.0 (-1.0,0.5)	-1.2 (-2.1,0.3)	0.060
WHZ	-1.8 (-2.4,-0.3)	-1.1 (-1.7,-0.3)	-1.8 (-2.2,-1.0)	0.230	-1.2 (-2.0,-0.7)	-1.4 (-2.2,-0.5)	0.500
WAZ	-1.2 (-2.1,-0.0)	-1.0 (-2.0,-0.2)	-1.9 (-2.4,-1.2)	0.330	-1.1 (-2.0,-0.1)	-2.0 (-2.6,-0.8)	0.021
Stunted (HAZ<-2SD)	3 (15.8)	5 (26.3)	4 (21.1)	0.920	2 (6.9)	10 (35.7)	0.010
Wasted (WHZ<-2SD)	7 (36.8)	2 (10.5)	7 (36.8)	0.140	6 (20.7)	10 (35.7)	0.250
Underweight (WAZ<-2SD)	8 (40.0)	4 (20.0)	12 (63.2)	0.026	10 (33.3)	14 (48.3)	0.290

Diarrhea	8 (40.0)	5 (25.0)	7 (35.0)	0.700	10 (33.3)	10 (33.3)	1.000
Micronutrient status							
Anemia (HB<11 g/dL)	11 (64.7)	10 (71.4)	6 (40.0)	0.250	11 (57.9)	16 (59.3)	1.000
Vitamin A deficiency (Retinol<0.7 mmol/L)	3 (18.8)	4 (30.8)	3 (17.6)	0.740	3 (15.8)	7 (25.9)	0.490
Iron deficiency (Ferritin<12 ng/mL)	7 (53.8)	7 (58.3)	8 (50.0)	0.930	9 (56.3)	13 (52.0)	1.000
Zinc deficiency (zinc<60 µg/dL)	3 (18.8)	3 (23.1)	1 (5.9)	0.350	1 (5.3)	6 (22.2)	0.210
At 9 months							
Height (cm)	69.2 (67.5,70.5)	69.5 (67.0,72.0)	68.6 (67.5,71.0)	0.680	69.8 (68.5,71.9)	68.3 (65.0,71.0)	0.024
Weight (kg)	7.5 (6.2,8.0)	7.4 (6.3,7.9)	7.1 (6.3,8.0)	0.920	7.4 (6.7,7.9)	7.2 (6.1,7.9)	0.430
HAZ	-0.6 (-1.5,-0.1)	-0.3 (-1.7,0.6)	-0.9 (-1.7,-0.1)	0.470	-0.2 (-1.0,0.4)	-0.9 (-2.3,-0.4)	0.012
WHZ	-0.9 (-2.0,-0.6)	-1.3 (-2.6,-0.4)	-1.0 (-2.4,-0.2)	0.570	-1.1 (-1.9,-0.5)	-1.1 (-2.2,-0.3)	0.910
WAZ	-1.4 (-2.5,-0.4)	-0.9 (-2.2,-0.6)	-1.4 (-2.6,-0.8)	0.820	-1.3 (-2.0,-0.5)	-1.5 (-2.9,-0.8)	0.25
Stunted (HAZ<-2SD)	2 (12.5)	3 (20.0)	3 (20.0)	0.790	0 (0.0)	8 (30.8)	0.006
Wasted (WHZ<-2SD)	4 (25.0)	4 (26.7)	4 (26.7)	1.000	4 (20.0)	8 (30.8)	0.510
Underweight (WAZ<-2SD)	6 (30.0)	6 (31.6)	10 (52.6)	0.290	9 (32.1)	13 (43.3)	0.430
Diarrhea	5 (25.0)	8 (40.0)	11 (55.0)	0.170	8 (26.7)	16 (53.3)	0.064
At 12 months							
Height (cm)	70.0 (67.5,74.0)	71.3 (69.0,73.0)	71.5 (68.0,73.0)	0.990	71.5 (69.0,74.0)	70.0 (66.0,73.0)	0.180
Weight (kg)	7.9 (6.6,8.6)	7.8 (7.2,8.5)	7.7 (7.0,8.0)	0.760	7.9 (7.1,8.5)	7.6 (6.5,8.4)	0.430
HAZ	-1.7 (-3.0,0.0)	-1.5 (-2.8,-0.7)	-1.6 (-2.5,-0.7)	0.940	-1.4 (-2.0,-0.4)	-2.0 (-3.1,-0.7)	0.210
WHZ	-1.0 (-2.3,-0.6)	-0.6 (-1.7,-0.2)	-1.2 (-2.2,-0.2)	0.630	-0.7 (-1.5,-0.4)	-1.7 (-2.3,-0.2)	0.210
WAZ	-1.6 (-2.6,-0.4)	-1.2 (-2.2,-0.7)	-1.8 (-2.8,-0.9)	0.430	-1.2 (-2.3,-0.6)	-1.8 (-2.6,-0.9)	0.270
Stunted (HAZ<-2SD)	5 (35.7)	4 (30.8)	4 (40.0)	0.910	5 (27.8)	8 (42.1)	0.500
Wasted (WHZ<-2SD)	6 (42.9)	3 (23.1)	3 (30.0)	0.620	3 (16.7)	9 (47.4)	0.079
Underweight (WAZ<-2SD)	7 (35.0)	5 (25.0)	9 (47.4)	0.360	10 (34.5)	11 (36.7)	1.000
Diarrhea	8 (40.0)	4 (20.0)	8 (40.0)	0.340	5 (16.7)	15 (50.0)	0.013
At 18 months							
Height (cm)	76.5 (73.0,78.0)	77.0 (75.0,79.0)	79.0 (75.0,79.0)	0.480	78.5 (76.5,79.0)	75.9 (73.0,78.5)	0.150
Weight (kg)	9.0 (7.7,9.7)	8.8 (8.3,9.8)	8.4 (7.6,9.9)	0.830	9.8 (8.6,10.1)	8.4 (7.5,9.3)	0.013
HAZ	-1.6 (-3.4,-0.9)	-1.3 (-2.6,-0.6)	-1.2 (-2.3,-1.0)	0.750	-1.2 (-1.6,-0.7)	-1.9 (-3.2,-1.2)	0.120
WHZ	-0.5 (-1.1,0.7)	-0.5 (-1.3,0.1)	-0.7 (-1.9,-0.2)	0.630	-0.1 (-1.1,0.3)	-0.9 (-1.7,-0.4)	0.026
WAZ	-1.1 (-2.4,-0.4)	-1.2 (-2.2,-0.3)	-1.7 (-2.5,-0.4)	0.640	-0.6 (-1.7,-0.3)	-2.0 (-2.7,-1.1)	0.004
Stunted (HAZ<-2SD)	2 (22.2)	3 (27.3)	4 (28.6)	1.000	4 (23.5)	5 (29.4)	1.000

Wasted (WHZ<-2SD)	1 (11.1)	1 (9.1)	3 (21.4)	0.840	2 (11.8)	3 (17.6)	1.000
Underweight (WAZ<-2SD)	6 (35.3)	6 (30.0)	12 (63.2)	0.093	9 (34.6)	15 (50.0)	0.290
Diarrhea	8 (40.0)	4 (20.0)	7 (35.0)	0.470	9 (30.0)	10 (33.3)	1.000
Micronutrient status							
Anemia (HB<11 g/dL)	18 (94.7)	11 (57.9)	13 (68.4)	0.025	19 (67.9)	23 (79.3)	0.38
Vitamin A deficiency (Retinol<0.7 mmol/L)	6 (35.3)	8 (47.1)	9 (50.0)	0.690	16 (64.0)	7 (25.9)	0.011
Iron deficiency (Ferritin<12 ng/mL)	6 (75.0)	1 (6.3)	5 (33.3)	0.002	3 (17.6)	9 (40.9)	0.17
Zinc deficiency (zinc<60 µg/dL)	7 (38.9)	4 (21.1)	5 (27.8)	0.500	0 (0.0)	16 (53.3)	<0.001
At 24 months							
Height (cm)	79.0 (77.0,82.0)	79.8 (77.5,82.5)	80.0 (77.5,82.7)	0.850	81.0 (78.0,82.7)	79.0 (76.8,82.0)	0.200
Weight (kg)	9.4 (8.0,10.6)	9.1 (8.4,10.3)	9.4 (8.3,9.8)	0.990	9.6 (9.0,10.8)	8.8 (7.8,9.8)	0.043
HAZ	-2.3 (-3.1,-1.7)	-2.1 (-2.9,-1.3)	-2.1 (-2.8,-1.2)	0.950	-1.8 (-2.8,-1.1)	-2.4 (-3.2,-1.7)	0.140
WHZ	-1.2 (-1.9,-0.9)	-0.7 (-1.8,-0.4)	-1.1 (-1.8,-0.7)	0.810	-0.9 (-1.1,-0.5)	-1.5 (-1.9,-0.6)	0.120
WAZ	-2.0 (-3.2,-0.7)	-1.9 (-3.1,-1.3)	-1.9 (-3.1,-1.4)	0.910	-1.6 (-2.1,-0.8)	-2.4 (-3.3,-1.6)	0.013
Stunted (HAZ<-2SD)	8 (57.1)	9 (56.3)	9 (52.9)	1.000	8 (42.1)	18 (64.3)	0.150
Wasted (WHZ<-2SD)	3 (21.4)	2 (12.5)	3 (17.6)	0.890	2 (10.5)	6 (21.4)	0.440
Underweight (WAZ<-2SD)	11 (57.9)	9 (47.4)	10 (52.6)	0.940	11 (40.7)	19 (63.3)	0.110
Diarrhea³	1 (5.0)	1 (5.0)	4 (20.0)	0.340	2 (6.7)	4 (13.3)	0.670

¹ For categorical variables summary statistics reflect the count and percent in parenthesis; the difference was assessed with Fishers exact test

² For continuous variables summary statistics are presented as median and IQR; the difference was assessed with the Mann-Whitney test

³ Diarrhea was defined as three or more loose stools per day. A diarrheal episode was defined as a minimum of 2 days with diarrhea followed by at least 2 diarrhea-free days.

Table S2: Differences in alpha diversity indices between children in urban and rural locations at each 3-monthly time point

Index	Location	Month					
		3	6	9	12	18	24
Chao	Rural ¹	349.2 (293.0, 469.0)	443.2 (376.5, 514.8)	478.8 (411.7, 579.8)	462.2 (388.6, 599.3)	736.0 (589.6, 974.7)	767.8 (589.5, 973.9)
	Urban ¹	444.9 (345.9, 520.9)	458.6 (369.1, 573.4)	429.8 (361.6, 533.2)	521.3 (438.4, 677.8)	634.9 (408.6, 894.0)	811.0 (660.3, 1113.7)
	P-value ²	0.1421	0.7117	0.2665	0.2488	0.1462	0.4581
Shannon	Rural	2.75 (2.20, 3.31)	3.14 (2.82, 3.57)	3.58 (3.21, 3.98)	3.62 (3.14, 3.92)	4.51 (3.63, 4.89)	4.85 (4.02, 5.30)
	Urban	3.25 (2.39, 3.71)	3.39 (3.03, 4.04)	3.26 (2.58, 3.82)	3.72 (3.20, 4.24)	4.13 (2.96, 4.93)	5.00 (4.25, 5.45)
	P-value	0.1153	0.1296	0.2009	0.1433	0.3671	0.3554
Equitability	Rural	0.374 (0.324, 0.440)	0.424 (0.383, 0.472)	0.472 (0.423, 0.511)	0.478 (0.423, 0.503)	0.552 (0.469, 0.583)	0.589 (0.510, 0.618)
	Urban	0.433 (0.354, 0.488)	0.454 (0.418, 0.509)	0.432 (0.363, 0.510)	0.484 (0.434, 0.531)	0.523 (0.401, 0.588)	0.596 (0.527, 0.639)
	P-value	0.0713	0.1188	0.1785	0.1205	0.3632	0.3671
PD	Rural	20.00 (15.29, 24.36)	22.74 (20.27, 25.15)	24.34 (21.96, 29.98)	26.91 (21.91, 30.75)	37.69 (30.86, 42.82)	39.52 (33.97, 47.34)
	Urban	22.50 (18.02, 30.26)	24.75 (19.86, 30.49)	24.95 (21.97, 28.85)	28.38 (24.17, 34.18)	32.58 (25.14, 41.80)	40.49 (35.74, 45.36)
	P-value	0.0850	0.3898	0.8891	0.1984	0.1882	0.9176
Observed	Rural	149.5 (119.2, 187.8)	165.5 (152.0, 192.5)	192.0 (174.2, 232.5)	190.5 (155.5, 230.5)	271.0 (212.0, 331.8)	292.5 (242.5, 378.5)
	Urban	172.5 (113.8, 200.8)	187.5 (145.8, 229.8)	181.5 (148.2, 226.5)	201.5 (178.5, 263.2)	248.0 (163.2, 320.2)	317.0 (271.5, 388.0)
	P-value	0.3750	0.2169	0.2642	0.09477	0.2549	0.4917

¹median (interquartile range), ²Mann-Whitney

Table S3: Differentially abundant taxa in the microbiota of children residing in urban and rural locations identified by LEfSe analysis at 3-monthly intervals

Urban	Rural
3 months	
Clostridiaceae	None
Clostridiaceae_1	
Clostridium	
Lachnospiraceae	
Lachnospiraceae (subfamily)	
Lachnospira	
Lachnospiraceae_Incertae_Sedis	
Lactococcus	
Corynebacteriaceae	
Corynebacterium	
Alphaproteobacteria	
6 months	
Firmicutes	Actinobacteria
Clostridiaceae_1	Actinobacteria (class)
Clostridiaceae	Actinobacteridae
Clostridium	Bifidobacteriales
Enhydrobacter	Bifidobacteriaceae
Incertae_Sedis_6	Bifiobacterium
Peptoniphilus	
9 months	
None	Actinobacillus
	Pasteurellaceae
	Pasteurellales
12 months	
Veillonellaceae	
18 months	
Enterococcaceae	Catenibacterium
Enterococcus	Erysipelotrichi
Ruminococcaceae	Erysipelotrichales
Ruminococcaceae_Incertae_Sedis	Erysipelotrichaceae
24 months	
Sporobacter	Clostridiaceae
	Clostridiaceae_1
	Clostridium
	Cyanobacteria
	Streptophyta
	Chloroplast
	Cyanobacteria (class)
	Leuconostoc
	Sarcina

Table S4: Differentially abundant taxa in the microbiota of children receiving different interventions identified by LEfSe analysis at 3-monthly intervals

Intervention Group	A	B	C
3 months			
6 months	None	None	None
9 months	None	None	Actinomyces Actinomycetaceae Actinomycineae Atopobium
12 months	None	None	Dialister
18 months	None	None	Weisella
24 months	None	None	None

Supplementary Figures

Figure S1

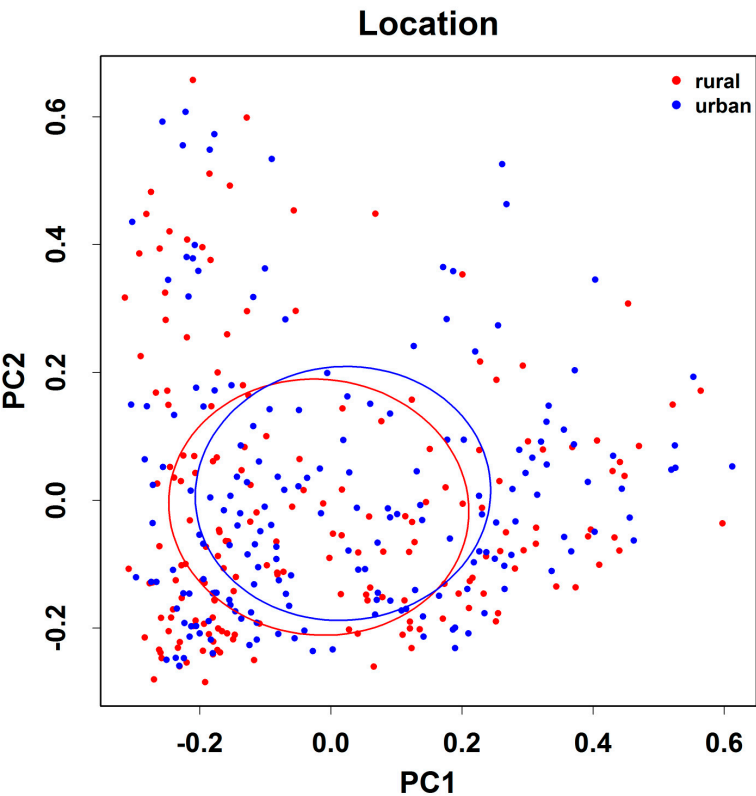


Figure S2

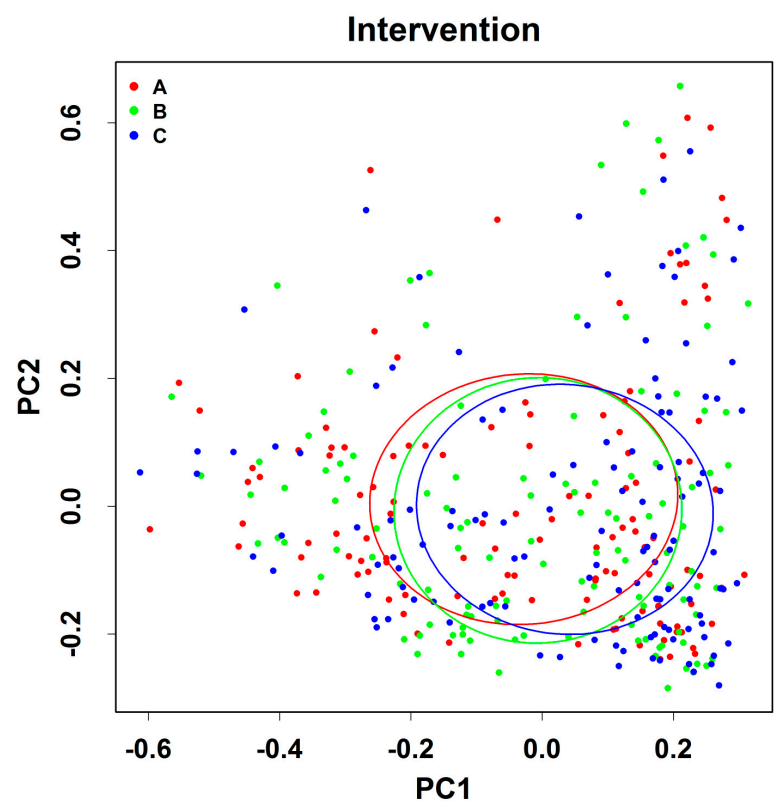


Figure S3

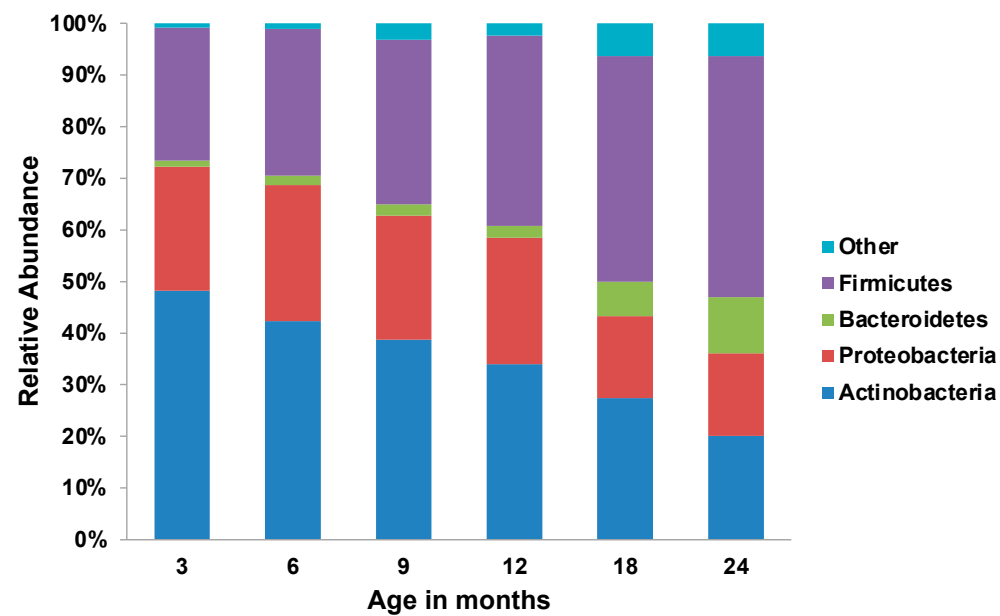


Figure S4

