Supplementary Appendix

Nutrition, hygiene and stimulation education to improve growth, cognitive, language and motor development among infants in Uganda: A cluster-randomized trial

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Supplementary Methodology

Below follows a detailed description of the methods used, to compliment the description of methods in the main text.

1. Procedures

A village health team (VHT) leader (i.e. a volunteer health worker in the community) was selected by consensus among the individual groups. If a VHT leader could not be selected, a mother was selected by consensus to lead the group. The VHT leaders/mother leaders were all female. There were no requirements with regard to the education levels for them, but they had to be able to read and write well. The VHT leader/mother leader was instructed by the first author (GM) on how to administer the group. In addition they attended the three main sessions with the mothers to learn about the intervention and therefore plan appropriately for home visits and monthly group meetings. The VHT leader/mother leader was responsible for two main activities: (i) organize monthly group meetings to practice preparation of dishes demonstrated to the groups, feed the children, review and discuss the theoretical knowledge about feeding and hygiene emphasized in the intervention; and (ii) conduct monthly follow-up visits to mothers in their homes to assist and encourage them to adhere to the intervention.

Three types of meetings were thus organized with the mothers. First, the education team had three main sessions with each mother group during the intervention period of six months. These three sessions were delivered in similar format following strict guidelines agreed upon

by the education team prior to implementation. The quality of these main sessions was monitored on site by the first and second author (GM and PA) who attended all of them. Second, each VHT leader/mother leader organized a monthly group meeting where all the mothers would attend, to review the information from the three main sessions, cook the recommended dishes, feed babies and engage in stimulation of the children and socialization. Third, the VHT leader/mother leader visited each mother at home at least once in the period between the three main sessions. All VHT leaders/mother leaders were given an allowance to enable them to organize these monthly group meetings and facilitate their movement in the communities.

1.1. The main education sessions

Prior to the three main sessions, the education team would inform the VHT leader/mother leader and a date would be agreed upon after consultation with the group members. On the appointed date, mothers would gather in a home of one the group members where the education team would meet them. The mothers were responsible for contributing the foods to be cooked for the children on the appointed day. In addition, as an incentive for the mothers to keep in the group and attend these main sessions, we paid for their transportation and provided all the ingredients to make the enriched porridges for the children on each of the three meeting days. For the first meeting in all the groups we provided 'special'[1] ingredients which were to be used in the demonstration and these included: silver fish, eggs, milk, soy beans, meat, ground nut paste, carrots, tomatoes cooking oil, and sugar.

Each main session lasted 6-8 hours. The first main session in each of the groups involved the display and classification of the most common foods in their localities into the various classes according to their functions in the body. Specifically:

- The sessions began with preparation of enriched porridges (millet and maize flours being the main ingredients) for the infants and feeding them (1 hour).
- The VHT leader/mother leader would report on the activities of the group since the previous main session to the education team in presence of all mothers (10 minutes).
- Then the mothers together with the education team would reflect on the theoretical knowledge (both in nutrition and child stimulation) including a "Question and answer session" (30-40 minutes).

[1] These were 'special' in that they were not commonly consumed and we were recommending them now for use in the children's diet.

- The next session would be for cooking demonstrations followed by feeding of the infants (3-4 hours).
- The education team then demonstrated how to make play materials using local materials and stimulation activities. The mothers would be given time with their infants engaging them in play and stimulation while the education team would be counselling individual mothers (30 minutes).
- In the final part of the day, the mothers would organize themselves and interact through a traditional dance (10-20 minutes).

2. The intervention

2.1. Nutrition education

The education team started by reviewing the importance of breast feeding an infant and demonstrated how to position and attach the infant to the breast. Further on, they clarified the need to allow the infant to empty one breast before changing to the other breast because fore and hind breast milk had different nutrient contents. Mothers were informed to always breast feed the infant on demand (eight or more times in a day including at night). Since all infants were between 6 and 8 eight months, their mothers were advised to start feeding them on nutrient rich foods. Mother were advised to continue breast feeding as the food was slowly being introduced to infant's diet; to start with soft foods in small amounts at a time and gradually increase the portion and the thickness of the food. The education team emphasized that the food should be rich in variety of nutrients, and explained the importance of combining a variety of foods in one dish. The mothers were encouraged to start giving foods 2-3 times a day and increase to 3-4 times a day as the child grew. The education team asked the mothers to provide nutritious healthy snacks (such as fruit) to the infant in between the main meals and continue breastfeeding.

The mothers were encouraged to interact and be responsive to their infants during feeding by talking to them, smiling and encouraging them to eat more without forcing them to eat the food; to exercise patience and make feeding session a time for joy and bonding with the infant. They were reminded at a later age (8 months and beyond) that they needed to allow the infants to eat finger foods which they could hold with their hands, and that such food should be wholesome in nutrient (not a potato, piece of cassava or plantain). Examples of whole-

some snacks included a fruit, and *Kitobero*[2], that the children could hold in their hands and eat by themselves. Furthermore, the mothers were advised to breast feed more frequently, provide more fluids during illness of the infant, and give more nutritious foods after recovery. Special emphasis was given to feeding in diarrhea and/or fever episodes.

2.2. Cookery demonstrations

On diversifying meals the education team explained the importance of mixing foods to be fed to the infants and demonstrated dishes which could combine up to 13 different foods obtained in their local environments (see below the list of commonly available foods in the study area). The recipes were formulated using locally available foods with emphasis on animal protein obtained from e.g. silverfish *(Rastrineobola argentea)* locally known as *Mukene* and bearing cost constraints in mind. The nutrient content per 100 g of dry matter of silver fish is: protein 53-58%, fat 12.5-13.2%, calcium 1711 mg, iron 10 mg, zinc 10 mg, EPA+ DHA 1650 mg (1). The education team demonstrated how to make milk from soy beans, scraping meat (muscle), preparation of pumpkin seeds and silverfish powder to incorporate in the infant's food, addition of oil/fat and sugar to porridges to increase the energy content. The following dishes were also demonstrated:

- Kitobero1 and 2[3]
- Enriched porridge 1 and 2[4]; the following ingredients were used to enrich the porridges in combinations of two or more: cooking oil, sugar, silver fish powder, milk, pumpkin seed powder and eggs.
- Scrambled eggs (previously the mothers would either boil the eggs of make omelet which was rather hard for the infants to consume)

[2] Kitobero is a dish that combines up to 13 (may be less) different ingredients and when steamed together, it is solid and can be eaten with fingers and at the same time, soft enough for that age of children

[3] Kitobero 1 has about 13 different foods all combined and steamed and the result is solid, whereas Kitobero 2, combined foods are cooked on direct heat and the result is thick and can be fed to the child with a spoon

[4] Enriched porridge 1 had millet or sorghum flour as the main ingredient and enriched porridge 2 had maize flour as the main ingredient. Other ingredients were added to increase both macro and micronutrients.

List of foods commonly consumed in the study area and the foods recommended during the intervention:

Foods commonly consumed	**Recommended foods**
Irish potatoes	Beef
Sweet potatoes	Chicken
Green bananas	Goat meat
Sorghum (for food and porridge)	Eggs*
Millet (for food and porridge)	Fish (people close to the lake)
Maize (food and porridge)	Ground nuts*
Pumpkins	Ripe bananas*
Beans	Pineapples
Peas	Carrots*
Amaranthus	Milk*
Cabbage	Sugar*
Chayote	Pumkin seeds*
Bitter tomatoes	Silver fish (*Mukene*)*
Avocado	Soy milk*
Tomatoes	
Tomato passion fruit	
Goose berries	
Paw-paws	

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*These were affordable foods

2.3. Hygiene and sanitation

The education team stressed the importance of living in a clean home environment for the good health of all the family members, especially the young children. They emphasized the need to always have their hands and utensils clean during preparation and feeding the infant, and that the food to be prepared should also be clean, free of soil and other contaminants. It was also emphasized to always wash hands with clean water and soap, and the mothers were specifically encouraged to carry water and a piece of soap to the field to wash hands before feeding the infants. The mothers were cautioned about giving left-over foods to the infants as it is difficult to keep it safe for the infants to consume later. It was noted that the mothers had a habit of licking spoons as they fed the babies (sometimes to test the temperature of the food before giving it to the baby) and this practice was discouraged to avoid transmission of infections from the mother to the infant.

2.4. Oral hygiene

The education team demonstrated the cleaning of the oral cavity of the infant with clean, boiled water and a soft tooth brush which we had supplied to the infant. They gave the mothers clear instructions to:

- Brush with clean water at least twice a day, especially before going to bed
- Clean the brushes after use before storing them safely in a clean container, preferably with a cover
- Not to share the tooth brushes

3. Child stimulation

Mothers were educated about the importance of play to promote a healthy development of the child. The education team emphasized that the mothers and other members of the family had roles to play in order for the child to grow well physically, cognitively, and in other developmental domains at every age. Furthermore, emphasis was on the three development domains: cognitive, language and motor development. Together with the mothers, specific play activities and toys that could be useful in developing each of the development domains were identified. The mothers were encouraged to engage in play activities and make "easy-to-make" toys.

Cognitive development was simply defined as the child's ability to understand and interact with the surroundings through construction of thought, remembering, problem solving and decision making. The education team explained that the aim of play was to develop imagination, creativity and social development. The mothers were encouraged to use "name and identify" child's body parts to facilitate the child to understand his/her daily routine related to his body (2). The education team encouraged mothers to engage children by hiding favourite items for children to find; demonstrate screwing and unscrewing bottles and imaginary play. The recommended toys that mothers could make included: shakers, empty transparent bottles with screws and food pellets inside, baby dolls made from cloth or banana fibres.

Language development was defined as verbal and non-verbal communication (expressive and receptive language). The 'We Talk' slogan was used to show mothers how important it is to talk to the child so that they learn to talk back and in the process develop language skills. The education team emphasized the use of communication development aides such as imitation, role-playing games, songs and music, which help to develop the child's ability to communicate emotions, thoughts, needs and interests (3). The mothers were encouraged to set aside time to talk to the children, call them by their name and to respond to them in word and

by gesturing as well; mention household and personal items and point at them, naming domestic animals, imitating their words and actions.

For motor development activities, "Learn while playing' slogan was incorporated. In this, the education team explained the concept of gross motor skills using examples of coordination and control of the body which would facilitate the development of security, speed, and accuracy in daily performance of tasks in a child's life. Fine motor skills were defined as the ability to perform complex skills for more proficient tasks of daily living (3). In addition the two aspects of gross motor (involving the large movements like walking and kicking) and fine motor (involving smaller movements like writing, unbuttoning clothes, tying shoelaces) were explained. Motor development activities encouraged were: giving child items to hold with their fingers, handing a pencil and paper for them to scribble, holding them by hand to try out walking the infant, ball throwing, crawling or walking upstairs or ladders, and kicking the ball. The recommended toys included balls, ropes, shakers, pencils and paper.

The mothers were encouraged to socialize more and empower each other in their groups for their social well-being. They were also encouraged to formalize their groups and register with the sub-county for easy identification by government programs targeting women. This would involve having a group name, forming an executive committee, keeping records of their meetings, developing plans for income generating activities and raising money for registration of their group.

4. Time-line of activities

	2013	**2014**											**2015**
Activity	**Oct**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan-May**
Recruitment and baseline assessments													
Intervention													
Assessment at 12-16 months													
Follow-up in the intervention group													
Final assessment at 20-24 months. Administration of knowledge assessment questionnaire													

5. References

1. Kabahenda MK, Amega EO, S, Husken MC, Heck S. Protein and micronutrient composition of low-value fish products commonly marketed in the Lake Victoria region. *World J Agric Sci* 2011;7:521-6.
2. Chang SM, Grantham-McGregor SM, Powell CA, Vera-Hernandez M, Lopez-Boo F, Baker-Henningham H, et al. Integrating a parenting intervention with routine primary health care: a cluster randomized trial. *Pediatrics* 2015;136:272-80.
3. Hartinger SM, Lanata CF, Hattendorf J, Wolf J, Gil AI, Obando MO, et al. Impact of a child stimulation intervention on early child development in rural Peru: a cluster randomised trial using a reciprocal control design. *J Epidemiol Commun Health* 2016 doi: 10.1136/jech-2015-206536. Epub ahead of print.

Follow-up assessment form for mothers in the intervention group

	Score (points)
1. Attendance of the mothers at group meetings (availed by the VHT leaders/mother leaders)	2
2. Proportion of mothers who were able to correctly answer nutrition knowledge questions in the group (≥ 50% of mothers answered correctly)	2
3. Other activities/projects that the group is engaged (at least 1)	0.5
4. Number of meetings held since the study team last met the group (minimum 2)	1
5. The level of interest/enthusiasm observed in the group	0.5
6. Individual report on brushing children's teeth and oral hygiene (≥ 50% of mothers doing it regularly)	1
7. Practical skills in cooking the dishes that were demonstrated to the group	
• The number of dishes (at least 2)	1
• How well they prepare the dishes	2
Total score	10

Supplemental Table 1: Assessment of knowledge and practices in the two study groups after the study period

Assessed	Intervention (*n* = 181)	Control (*n* = 167)
Nutrition and infant feeding		
Mention best food for infant as		
Breast milk	105 (64.8)	100 (63.7)
Other food	57 (35.2)	57 (36.3)
Named major functions of food in the body		
2-3	113 (62.4)	62 (37.1)**
0-1	68 (37.6)	105 (62.9)
Food sources linked to functions in the body		
Well done	74 (40.9)	36 (21.6)**
Mixed them up	67 (37.0)	105 (62.9)
Poor/failed	40 (22.1)	26 (15.6)
Know the importance of varied diet	150 (92.0)	130 (83.0)*
Gives variety of food to infant	152 (93.3)	134 (85.4)*
Preparation of meat for infant described		
Very well	79 (43.6)	4 (2.4)**
Tried	31 (17.1)	30 (18.0)
Failed	71 (39.2)	133 (79.6)
Preparation of silverfish described		
Very well	92 (50.8)	10 (6.0)**
Fairly done	42 (23.2)	32 (19.2)
Poorly done	25 (13.8)	35 (21.0)
Failed	22 (12.3)	90 (53.9)
Feeding baby with silver fish	157 (87.6)	86 (51.5)**
Child play and stimulation		
Identification of development domains		
2-3 domains	137 (76.1)	31 (18.8)**
0-1 domains	43 (23.9)	134 (81.2)
Described activity for development		
Cognitive	105 (58.3)	68 (41.2)**
Language	134 (76.6)	114 (69.9)
Motor	92 (51.4)	57 (34.1)**
Know the importance of play	173 (95.6)	160 (95.8)
Mothers made at least one play material	117 (64.4)	100 (59.9)
Mothers took time to play with infant	154 (85.1)	141 (84.4)
Hygiene		
Reported cleaning oral cavity	152 (84.0)	84 (50.3)**
Frequency of cleaning teeth		
At least once/day	135 (74.6)	73 (43.7)**
At least once/ week	18 (9.9)	10 (6.0)
Rarely/Never	28 (15.5)	84 (50.3)
Hygiene practices mentioned		
$\geq$ 4	44 (24.3)	39 (23.4)
2-3	110 (60.8)	100 (59.9)
0-1	27 (14.9)	28 (16.8)
Hand washing practices mentioned		
$\geq$ 4	43 (23.8)	39 (23.4)
2-3	110 (60.8)	100 (59.9)
0-1	28 (15.5)	28 (16.8)

We randomly selected a sub-sample to assess basic knowledge and practices among groups at the end of the study period. Values are *n* (%). *$P < 0.05$; **$P < 0.001$.

Supplemental Table 2: Growth changes within the intervention and control groups

	Mean slope in intervention group (*n* = 240-263)[1]	*P*-value[2]	Mean slope in control group (*n* = 212-248)	*P*-value[2]	Difference between mean slopes (*n*=452-511)	*P*-value[3]	ICC
Change in growth							
LAZ	-0.53 (-0.63 to -0.43)	0.0001	-0.53 (-0.63 to -0.43)	0.0001	0.00 (-0.14 to 0.14)	1.00	0.01
WAZ	-0.11 (-1.00 to -0.03)	0.008	-0.08 (-0.17 to -0.002)	0.058	-0.03 (-0.15 to 0.09)	0.63	0.02
WLZ	0.09 (-0.01 to 0.18)	0.035	0.10 (0.01 to 0.19)	0.031	-0.01 (-0.12 to 0.11)	0.93	0.01
MUACZ	-0.23 (-0.29 to -0.16)	0.0001	-0.21 (-0.28 to -0.14)	0.0001	-0.02 (-0.11 to 0.08)	0.79	0.01
HCZ	-0.14 (-0.22 to -0.06)	0.001	-0.14 (-0.22 to -0.05)	0.001	0.00 (-0.11 to 0.11)	0.99	0.005

[1]The variation in *n* is due to missing data.
[2]*P*-value for mean slopes within group, [3]*P*-value for difference between mean slopes.
Values are mean (95% CI) coefficients for slopes within the groups based on the data obtained at baseline and 12-16 months; 12-16 months and 20-24 months. ICC - intra-class correlation, LAZ – length-for- age z-score, WAZ – weight-for-age z-score, WLZ – weight-for-length z-score, MUACZ - mid-upper arm circumference z-score, HCZ - head circumference z-score.

Supplemental Table 3: Intervention effect sizes of the various outcomes at the end of study

Child growth	*n*	Effect size	Child development domains	*n*	Effect size
Nutritional status indicator			**BSID-III**		
LAZ	472	0.10	Cognitive	495	0.98
WAZ	472	0.01	Language	494	0.57
WLZ	472	0.04	Motor	477	0.78
MUACZ	472	0.01	**ASQ**		
HCZ	472	0.05	Communication	474	0.33
			Gross motor	474	0.26
			Fine motor	474	0.33
			Problem solving	474	0.51
			Personal social	474	0.21

Cohen's d effect size was calculated as the difference in means between the intervention and control groups divided by the pooled SD of the two study groups.

Supplemental Table 4: Developmental changes within the intervention and control groups

	Mean slope in intervention group (*n* = 243-245)[1]	*P*-value[2]	Mean slope in control group (*n* = 212-220)	*P*-value[2]	Difference between the mean slopes (*n* = 455-465)	*P*-value[3]	ICC
Change in BSID-III scores							
Cognitive	6.26 (4.96 to 7.55)	0.0001	-1.94 (-3.30 to -0.58)	0.005	8.20 (6.40 to 10.00)	0.0001	0.07
Language	-2.45 (-3.49 to -1.40)	0·0001	-6.02 (-7.11 to -4.92)	0.0001	3.57 (2.13 to 5.00)	0.0001	0.06
Motor	4.45 (3.22 to 5.69)	0.0001	-2.69 (-3.98 to -1.40)	0.0001	7.14 (5.47 to 8.82)	0.0001	0.07
Change in ASQ scores							
Communication	-3.30 (-4.41 to -2.19)	0.0001	-6.51 (-7.66 to -5.35)	0.0001	3.21 (1.67 to 4.75)	0.0001	0.03
Gross motor	2.66 (1.57 to 3.75)	0.0001	0.14 (-0.99 to 1.28)	0.81	2.52 (0.98 to 4.05)	0.001	0.05
Fine motor	-4.65 (-5.54 to -3.77)	0.0001	-7.01 (-7.93 to -6.09)	0.0001	2.36 (1.19 to 3.52)	0.0001	0.01
Problem solving	-1.41 (-2.42 to -0.40)	0.006	-5.66 (-6.70 to -4.61)	0.0001	4.25 (2.86 to 5.63)	0.0001	0.05
Personal social	-4.63 (-5.73 to -3.54)	0.0001	-6.70 (-7.84 to -5.56)	0.0001	2.07 (0.56 to 3.58)	0.007	0.04

[1]The variation in *n* is due to missing data as some children would not complete all tests.
[2]*P*-value for mean slopes within group, [3]*P*-value for difference between mean slopes.
Values are mean (95% CI) coefficients for slopes within the groups based on the data obtained at baseline and 12-16 months; 12-16 months and 20-24 months.
ICC - intra-class correlation.