Original Article

Combined intensive nutrition education and micronutrient powder supplementation improved nutritional status of mildly wasted children on Nias Island, Indonesia

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To assess the impact of intensive nutrition education (INE) with or without the provision of micronutrient powder (MNP) on the nutritional status of mildly wasted children in Nias, Indonesia, two groups of mildly wasted (≥-1.5 to <-1.0 WHZ) children aged ≥6 to <60 months in the Church World Service (CWS) project areas were assigned by village randomization to receive INE (n=64) or INE+MNP (n=51) in a weekly program. Another two groups of mildly wasted children who were living at a clear distance from INE and INE+MNP villages were selected to receive a monthly non-intensive nutrition education program (NNE) with or without MNP (n=50 both respectively). WHZ, weight, height, haemoglobin (Hb) level, and morbidity data were assessed at admission, during the study, and at individual discharge. Children's weight gain (g/kg body weight/day) was highest in INE+MNP group (2.2±2.1), followed by INE (1.1±0.9), NNE+MNP (0.3±0.5) and NNE (0.3±0.4) group. In both MNP intervention groups (INE+MNP, NNE+MNP), supplements significantly increased Hb value (g/L) of respective children (10.0±10.0; p<0.001 and 3.0±8.0; p<0.05 respectively). Proportion of children who reached discharge criterion was highest among the INE+MNP (70.6%; n=36), followed by INE (64.1%; n=41), NNE+MNP (26.0%; n=13), and NNE (20.0%; n=10) groups (p<0.001). Shortest length of stay until recovery was observed among children in the INE+MNP group (29.9 days), followed by INE (40.0 days), NNE+MNP (80.6 days), and NNE (86.2 days) respectively (p<0.001). Weekly intensive nutrition education supported by MNP supplementation produced the best results regarding weight gain and haemoglobin status of mildly wasted children.

Key Words: educational activities, micronutrients, fortified, weight gain, mildly wasted children

INTRODUCTION

The archipelago of Nias in North Sumatra is one of the poorest areas in Indonesia according to socio-economic indicators.[1] In 2005, a survey by UNICEF showed that every second child on Nias was stunted (50.7% on Nias district vs 36.8% in Indonesia).[2] Prevalence of underweight was 51.8% in Nias district vs. 18.4% in Indonesia, whereas the prevalence of global acute malnutrition (GAM) varied between 8.8% (Nias district) and 17.1% (Southern Nias district). One year later, the prevalence of GAM within CWS working area in Gunung Sitoli (Nias district) was 11.7%. The prevalence of stunting in the same area was 34.1% and underweight was 39.5% (unpublished report).

Anaemia in children was also highly prevalent on Nias Island. About half of the under-five children (51.7% in Nias district) suffered from anaemia while the country-wide data was 44.5% in the same year.[2,3]

Mildly wasted children who are not adequately treated may develop moderate or even severe forms of wasting in

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Manuscript received 4 August 2011. Initial review completed 21 February 2012. Revision accepted 3 April 2012.

the long run. They are in need of special nutritional support to improve their diets based on locally available foods. This can be achieved by making dietary recommendations and providing micronutrient powder which can add important nutrients that may not be present in sufficient amounts in locally available foods.[4]

To date there is limited information available about the impact of intensive/non-intensive nutrition education (INE/NNE), supported or not supported by the provision of micronutrient powder (MNP), on the nutritional status of mildly wasted children in Indonesia. In the absence of any ongoing interventions for mildly wasted children on Nias Island, this study was conducted to investigate the impact of the intensive nutrition education (INE) with or without MNP supplementation on weight gain (g/kgBW/d), haemoglobin (Hb) level, proportion of children who reached discharge criterion (RDC), and length of stay (days) among mildly wasted children aged ≥6 to <60 months in the study area. This weekly intervention was compared to the ongoing monthly non-intensive nutritional education (NNE). The study was undertaken in close cooperation with CWS and the local nutrition and public health activities of the Government of Indonesia (GOI).

METHODS

Population under study

The study took place from October 2007 to September 2008 with a Christmas and New Year interruption in the Church World Service (CWS) project area on Nias Island. The subjects of this study were mildly wasted children (<-1.0 to ≥-1.5 SD, according to NCHS reference data) aged ≥6 to <60 months.

Eligible children for this study were recruited in the project area from among children who attended the monthly growth monitoring activities (*Posyandu*) implemented by CWS and/or GOI. Children were individually discharged when they reached weight-for-height z-score (WHZ) ≥-1.0 or failed to achieve WHZ ≥-1.0 at the end of the intervention period. The term defaulter was used for a child who had left the program because of absence from at least two program activities, two home visits, or their caregivers refused to rejoin the program. The term relapse case was used to designate a child who had reached the discharge criterion of WHZ ≥-1.0 during the program, but had to be readmitted because his/her improved nutritional status could not be maintained. However, there were no cases of relapse during the intervention period.

Sample size

In order to be able to detect a mean difference of haemoglobin concentration 7.0 g/L or greater (that could be observed by SD of 12.7),[5] at least 40 children per group were needed using the power index of 0.8 with a type I error of 0.05.[6] Additionally, minimum sample size of 28 per program was calculated based on large size difference of weight increment of 0.75 with a type 1 error of 0.05 and a power of 0.8.[6]

Intensive/Non-intensive educational program, micronutrient supplementation

Culturally adapted interactive teaching material for intensive educational intervention (INE program) was developed with guidance from FAO and Hoffmann,[7,8] as well as based on the findings of qualitative research done prior to this study. Participants received information once a week on the importance of healthy family meals, food safety, feeding infants and young children, feeding sick children and prevention/treatment of malnutrition in a participatory manner by specially trained CWS health and nutrition officers and community workers (cadres). Detailed information of key messages used for intensive educational intervention is reported forthcoming in Food and Nutrition Bulletin vol 33(2), 2012.

Results of 24-hour dietary recall of mildly wasted children prior to the intervention showed that the average intake of most nutrients was much lower than the Indonesian Recommendation of Daily Dietary Intake (Table 4 and Figure 2). Therefore, in addition to the intensive educational programs, the mothers also learned through practical cooking exercises how to prepare a well balanced meal for their family by using the best combinations of locally and seasonally available food sources (Figure 3).

Non-intensive educational program (NNE program) was performed within an on-going monthly child growth monitoring program of the integrated health service center (*Posyandu*) activities. This program was conducted as a part of the routine services of the GOI and NGOs.

MNP “DSM Sprinkles” (under license from Ped-Med Ltd. Canada) were distributed on a weekly basis (for daily consumption) with instructions on how to use it. The ingredients of this micronutrient supplement are presented in Table 1.

Types of groups

Villages in the existing CWS project areas were randomly allocated to the INE and the INE+MNP groups. For the NNE and the NNE+MNP groups, CWS opened new project sites which were distanced out of daily communication range with the INE and the INE+MNP intervention villages to avoid spread of nutrition-related knowledge.

INE group

Mothers/caregivers in this group were assigned to attend weekly intensive educational programs (INE program). The children were weighed once a week, while height

Table 1. Nutrient content of MNP “DSM Sprinkles”

Nutrient per 1 g	DSM Sprinkles
Vitamin A (μg)	375.0
Vitamin D (μg)	5.0
Vitamin C (mg)	35.0
Thiamine (mg)	0.5
Riboflavin (mg)	0.5
Vitamin B-6 (mg)	0.5
Vitamin B-12 (mg)	0.9
Niacin (mg)	6.0
Folic acid (μg)	150.0
Vitamin E (mg)	4.0
Iron (mg)	10.0
Iodine (μg)	50.0
Zinc (mg)	5.0
Copper (mg)	0.6

was measured once a month. Morbidity recall of the previous week was assessed on a weekly basis.

INE+MNP group
Children admitted in this group received seven sachets of MNP per week in addition to intensive educational programs (INE program) on a weekly basis. Mothers/ caregivers were advised to add one sachet MNP per day into a small portion of the child's meal and feed it to the child. Weight, compliance with the take-home portion of MNP, and morbidity recall were recorded on a weekly basis. Height was measured once a month.

NNE group
Non-intensive educational programs (NNE program) were provided monthly through *Posyandu* activities in this group. Children were assessed once a month for weight, height, and morbidity.

NNE+MNP group
Children in this group received seven MNP sachets per week (for daily consumption). A weekly meeting was established solely for the purpose of distributing the MNP sachets. Important indicators such as weight gain, compliance issues, and morbidity recall were assessed weekly. Height was measured once a month. Mothers/caregivers attended, once a month, the non-intensive educational programs (NNE program).

Training prior to the intervention study
All health/nutrition officers of the implementing partner (CWS) and community workers were trained in anthropometric measurements, interview techniques, and morbidity assessment before the study began. Furthermore, those who were involved in the INE+MNP and NNE+MNP groups were trained on how to apply MNP for in-home use and how to offer it correctly to the children. Community workers and health/nutrition officers of CWS who were involved in the INE and INE+MNP groups were trained on how to conduct culturally appropriate intensive nutrition education sessions.

Collected data and information
Quantitative information during admission time was collected using a structured questionnaire to assess general background information, socio-economic characteristics of the family, and the child's characteristics.

Children's anthropometric measurements were taken at admission, during the study period and at individual discharge. Weight was assessed using a hanging spring scale (with an accuracy of 0.1 kg); height was examined by a length/height board with an accuracy of 0.1 cm and mid-upper arm circumference (MUAC) was determined using MUAC tape with an accuracy of 0.1 cm.

Morbidity data was collected by asking mothers to recall specific symptoms of diarrhoea, fever and respiratory illness at admission, during the program, and at discharge. Diarrhoea was defined as three or more liquid or semi liquid stools per day. Fever was defined on mother's report of elevation of the child's body temperature above normal. Respiratory illness was defined as the presence of purulent nasal discharge or cough. Home visits were performed when the child did not gain or lost weight and/or became seriously ill. The caregivers were encouraged to bring the respective child to a health centre/hospital for medical treatment.

Blood samples to examine Hb status of the children were collected at admission and during individual discharge. Hb level was assessed in the field using a HemoCue® 201^+ instrument.

Dietary data were collected using the 24-h dietary recall technique by trained interviewers. A quantitative 24-h recall of food intake of the previous day was made during admission. The respondent for the dietary assessment was the person in charge of feeding the child during the previous day. All foods eaten in the preceding 24 h were assessed by asking what the child had eaten including snacks in between, upon waking up, in the morning, at lunch, during the afternoon, at dinner, in the evening and during the night. Portion size was assessed by asking the respondents to describe in greater detail (in spoonfuls, cupfuls, etc) the amounts of food eaten. These amounts were later transformed into food weights.

The impact of the interventions was assessed by comparing data both at admission and after individual discharge of the children such as weight gain (g/kgBW/day), length of stay, nutritional status (WHZ, height-for-age *z* score /HAZ, Hb value), and morbidity status. The impact of intensive educational program (INE program) and non-intensive educational program (NNE program) on nutrition-related knowledge and practice of mothers/caregivers was also obtained.

Follow-up visits at home 5 months after discharge
Children who reached discharge criterion of WHZ ≥ -1.0 were followed-up at home five months after discharge to perform anthropometric measurements and to interview the caregivers regarding the current nutrition and health situation of the children. Children who did not reach discharge criterion until the closure of the study were transferred to the ongoing growth monitoring programs of the GOI.

Data analysis
All collected data were collated using PASW/SPSS version 18.0 for Windows software packages (SPSS Inc., Chicago, IL, USA). Data on weight and height were converted to z-scores of WHZ and HAZ according to NCHS reference data,[9] using the Emergency Nutrition Assessment software version 2007.[10] Because the harmonization of the growth reference used between involved institutions was very important for program implementation in the field, the NCHS growth chart was still used for admission and discharge criterion, as well as for the final analysis. The new WHO growth reference,[11] has not been widely used in Indonesia, especially among organizations and local health institutions working on Nias. If the new WHO growth reference data had been applied in this study a considerable proportion of the children (n=109) would no longer be defined as mildly wasted.

Nutrient intakes were calculated by NutriSurvey software version 2007,[12] using the Indonesian food database. The nutrient analysis from the 24-hour recall intakes were evaluated based on two sets of reference values, namely

"Recommended Nutrient Intake (RNI) of Indonesian children (2004)" for analyzing percentage fulfilment of energy, protein, vitamin A, iron, zinc, and "Recommended Dietary Intake, USA (1993)" was used to analyze fat intake adequacy.

Results of the 24-hour dietary recall method in Figure 2 were presented only for mildly wasted children aged ≥24 to < 36 months who were no longer breastfed at admission.

Weight gain (g/kgBW/d) was determined by calculating the weight change (g) per kg body weight (BW) per day during the study period of individual children. Length of stay of RDC children was defined as number of days until the child reached discharge criterion (WHZ ≥ -1.0). Length of stay of non-RDC children was defined as the number of days that a child stayed in the program. The length of stay of all eligible children included both RDC and non-RDC children. The formula used to measure the compliance of the respondents of MNP consumption was: [(total sachet consumed/total days needed to reach discharge criterion or program closure) x 100%].

Non categorical data were checked for normality using skewness value of the residuals and quantile-quantile plots (q-q plot). All variables were presented as means and standard deviation (SD). Continuous data were analysed by a mixed model using PASW/SPSS version 18.0 software and analysis of categorical data was done by generalized linear mixed model using GLIMMIX procedure of SAS 9.2 software. Based on examination of the residuals, we log-transformed several variables that were not normally distributed, such as: age of mother, number of children, income per capita, HAZ, weight gain per kgBW/d, height gain per day, MUAC gain per day, weight gain per day. The used mixed model included fixed and random effects. The type of program (INE, INE+MNP, NNE, and NNE+MNP) was used as fixed effect and the village as random factor. In addition, differences between children who reached the discharge criterion (RDC) and children who did not reach the discharge criterion (non-RDC), as well as differences of measurement values before admission and at discharge/ program closure within the groups, were also examined by a mixed model.

The effect of MNP supplement on the Hb level and anaemia was also investigated. For Hb, levels <110 g/L were used as a cut-off point for defining anaemia in children. The mean and SD of Hb and pre-post differences were calculated. Significant changes of Hb concentration within groups were reported based on a mixed model and significant change in the proportion of anaemia was done based on the McNemar test.

Linear mixed model was used to model the rate of WHZ at the final measure. Admission age, sex (male, female), maternal age (≥30, <30 y), maternal occupation (non farmer, farmer), maternal education (≥6, <6 y), paternal grandmother education (≥6 , <6 y), number of chil-

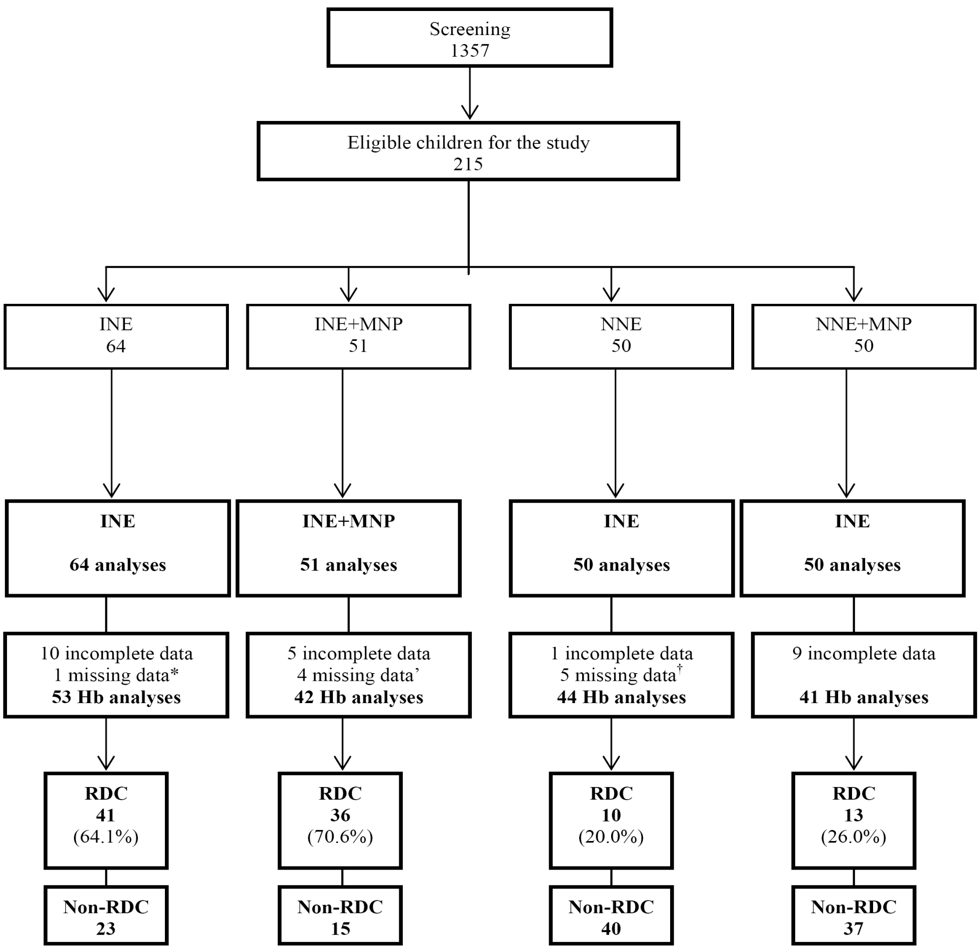

Figure 1. The study profile. † Parents who refused to let their children participate in the blood assessment

dren, episode of illness, income per capita per day using PPP (≥US $ 1.25, <US $ 1.25), compliance with the program (good compliance, poor compliance), types of programs (INE, INE+MNP, NNE, NNE+MNP) were fitted as fixed effect while villages were fitted as random effect.

Predictors of not reaching the discharge criterion of WHZ ≥-1.0 SD were identified via mixed-model logistic regression that allowed for modeling random effect (in this case, villages) as well as fixed effects. The potential predictors including age at admission, WHZ score at admission, sex (male, female), maternal age (≥30, <30 y), maternal occupation (non farmer, farmer), maternal education (≥6, <6 y), paternal grandmother education (≥6, <6 y), number of children, episode of illness, income per capita per day using PPP (≥US $ 1.25, <US $ 1.25), compliance with the program (good compliance, poor compliance), and types of programs (INE, INE+MNP, NNE, NNE+MNP).

Ethic approval

The study followed the ethical guidelines of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000) and was approved by the Ethical Committee of the Faculty of Medicine, University of Brawijaya, Malang, Indonesia. Informed consent was obtained from caregivers of eligible children.

RESULTS

As shown in Figure 1, 215 children in 29 villages were included in this study. At the time of admission important parental characteristics did not differ significantly among the groups (age, education level, family size). An exception was the fact that significantly more parents worked as farmers in the NNE groups (Table 2). Additionally, respondents in the NNE and the NNE+MNP groups had significantly more children than their counterparts in the INE and the INE+MNP groups.

Children enrolled in this study did not differ significantly in age, sex, and anthropometric characteristics (Table 2). However, significantly more children admitted in the NNE group had better WHZ scores than those admitted into the INE, the INE+MNP, and the NNE+MNP groups.

Generally, children admitted in the INE+MNP group showed the highest weight gain (2.2±2.1 g/kgBW/d), sig nificantly higher than those in the INE group (1.1±0.9

Table 2. Demographic and socio-economic characteristics of study population at admission, by group[†,‡]

	INE (*n*=64)	INE+MNP (*n*=51)	NNE (*n*=50)	NNE+MNP (*n*=50)	*p*-value
Age of parents, y					
Mothers	29.2±7.4	29.9±7.3	31.3±6.1	31.3±5.5	0.093
Fathers	33.2±8.1	32.5±6.5	34.8±7.4	35.0±6.1	0.197
Occupation of parents: farmer					
Mothers	33 (51.6) [¶,†]	31 (60.8) [¶,††]	42 (84.0)	43 (86.0)	0.000
Fathers	31 (48.4) [††]	24 (47.1) [††]	35 (70.0)	32 (64.0)	0.038
Maternal education, y					0.372
<6	35 (54.7)	32 (62.7)	35 (70.0)	33 (66.0)	
≥6	29 (45.3)	19 (37.3)	15 (30.0)	17 (34.0)	
Paternal grandmother education, y					0.058
<6	28 (43.8)	25 (49.0)	29 (58.0)	34 (68.0)	
≥6	36 (56.3)	26 (51.0)	21 (42.0)	16 (32.0)	
Number of children	3.1±1.4[††]	3.1±1.9[¶ ††]	4.0±2.0	3.7±1.5 [††]	0.010
Range (min, max)	(3; 12)	(3; 11)	(3; 12)	(4; 11)	
Income per month < US $ 63[§]	58 (90.6)	49 (96.1)	48 (92.3)	46 (92.0)	0.070
Income per capita per day, US $[§]					
Mean±SD	0.3±0.2	0.2±0.2	0.1±0.2	0.1±0.2	0.076
Range (min; max)	0.02;0.7	0.02;1.2	0.01;0.7	0.01;0.7	
<US $ 1.25/day	54 (85.7)	46 (92.0)	47 (94.0)	48 (96.0)	0.216
Female children	32 (50.0)	21 (41.2)	21 (42.0)	21 (42.0)	0.739
Age of children, mo	36.9±13.3	35.4±15.8	33.9±16.2	36.7±16.3	0.732
Age group, mo					
6 - <12	1 (1.6)	3 (5.9)	6 (12.0)	3(6.0)	-
≥12 - <24	10 (15.6)	13 (25.5)	7 (14.0)	10 (20.0)	
≥24 - <36	23 (35.9)	10 (19.6)	14 (28.0)	14 (28.0)	
≥36 - <48	14 (21.9)	13 (25.5)	9 (18.0)	6 (12.0)	
≥48 - 60	16 (25.0)	12 (23.5)	14 (28.0)	17 (34.0)	
Weight, kg	11.4±1.9	11.2±2.2	11.3±2.6	11.6±2.6	
Height/length, cm	88.8±8.7	87.4±10.4	87.4±11.8	89.1±11.7	0.730
WHZ	-1.3±0.1[¶,††]	-1.3±0.1[††]	-1.2±0.1	-1.3±0.14	0.004
HAZ	-1.6±1.1	-1.6±1.0	-1.1±2.1	-1.5±1.4	0.441
MUAC, mm	141±8	142±8	142±9	145±10	0.394

[†] Continuous variables written as mean ± SD, categorical variables as number (%).
[‡] Groups were analyzed by using a mixed model
[§] Income data was derived from average cash money earned every month, and did not include household valuable assets, agriculture production, savings or aids; US $ 1equal to ± Rp 9,230 using currency rates in 2007, monthly regional minimum wage in North Sumatra province was US $ 63 or equal to Rp 761,000, US $ 1.25 equal to ± Rp 4,918 using PPP (World Bank, 2008)
[¶] Significant different to the NNE+MNP group after post hoc test with *p<0.05*
[††] Significant different to the NNE group after post hoc test with *p<0.05*

Table 3. Selected important outcomes, by group[†,‡]

	INE (*n*=64)	INE+MNP (*n*=51)	NNE (*n*=50)	NNE+MNP (*n*=50)	*p*-value
Weight, kg					
Admission	11.4±1.9	11.2±2.2	11.3±2.6	11.6±2.6	0.713
Discharge	11.9±1.9[##]	11.8±2.2[##]	11.6±2.5[##]	11.9±2.6[##]	0.950
Difference per day	0.01±0.019[§,¶,††]	0.02±0.029[§,¶]	0.003±0.005	0.004±0.006	0.000
Weight gain, g/kg BW/d	1.1±0.9[§,¶,††]	2.2±2.1[§,¶]	0.3±0.4	0.3±0.5	0.000
Height/length, cm					
Admission	88.8±8.7	87.4±10.4	87.3±11.8	89.1±11.7	0.730
Discharge	89.6±8.9[##]	87.9±10.3[##]	88.9±11.6[#]	90.0±11.4[##]	0.592
Difference per day	0.013±0.012[¶]	0.014±0.017[¶]	0.019±0.015	0.011±0.01[¶]	0.100
WHZ					
Admission	-1.3±0.1[§,¶]	-1.3±0.1[¶]	-1.2±0.1	-1.3±0.1	0.004
Discharge	-1.0±0.2[†† ##]	-0.9±0.3[§,¶ ##]	-1.2±0.2	-1.2±0.2 [#]	0.000
Difference per day	(+)0.009±0.009[§,¶,††]	(+)0.015±0.015[§,¶]	(-)0.000±0.003	(+)0.001±0.003	0.000
HAZ					
Admission	-1.5±1.1	-1.6±1.0	-1.1±2.1	-1.5±1.4	0.441
Discharge	-1.6±1.2	-1.7±0.9	-1.3±1.9[#]	-1.7±1.4[##]	0.488
Difference per day	(-)0.001±0.015	(-)0.002±0.008	(-)0.002±0.006	(-)0.002±0.007	0.927
MUAC, mm					
Admission	141±8	142±8	142±9	145±10	0.293
Discharge	144±8[##]	145±8[##]	143±9[#]	147±10[##]	0.323
Difference per day	0.07±0.07[§,¶]	0.09±0.1[§,¶]	0.01±0.04	0.03±0.04	0.003
Haemoglobin, g/L					
Admission	114.0±14.0	114.0±10.0	114.0±13.0	115.0±11.0	0.946
Discharge	124.0±12.0[§,¶##]	124.0±14.0[§,¶##]	115.0±13.0	118.0±.10.0[#]	0.001
Difference	10.0±12.0[§,¶]	10.0±10.0[§,¶]	1.0±6.0	3.0±8.0	0.000
Hb < 110 g/L, n(%)					
Admission	33/53(62.3)	27/42(64.3)	28/44(63.6)	22/41(53.7)	0.523
Discharge	20/53(37.7)[#]	15/42(35.7)[#]	25/44(56.8)	21/41(51.2)	0.137
Improvement in %	13/53(24.5)	12/42(28.6)	3/44(6.8)	1/41 (2.4)	
Length of stay in the program, d	54.6±33.7[§,¶,††]	34.5±14.1[§,¶]	85.1±19.4	82.9±19.3	0.000
RDC children	41(64.1)[§,¶]	36(70.6.)[§,¶]	10(20.0)	13(26.0)	0.000
Non-RDC children	23(35.9)	15(29.4)	40(80.0)	37(74.0)	

† Continuous variables written as mean± SD, categorical/dichotomous variables as number (%).
‡ Groups were analyzed by using a mixed model; within group significant change from first measure to final value was analyzed by using a mixed model; # : p<0.05, ## : p<0.001
§ Significant different to the NNE+MNP group after post hoc test with p<0.05
¶ Significant different to the NNE group after post hic test with p<0.05
†† Significant different to the INE+MNP group after post hoc test with p<0.05

g/kgBW/d), the NNE group (0.3±0.5 g/kgBW/d), or the NNE+MNP group (0.3±0.4 g/kgBW/d) (Table 3). Height gain per day was similar for children receiving the INE, INE+MNP and NNE+MNP interventions (0.013±0.001; 0.014±0.017; and 0.011±0.010 cm/d), but higher within the NNE group (0.019±0.015 cm/d) during the intervention period. However, the HAZ scores of all eligible children decreased in all groups during the intervention period even though the difference was not significant. In contrast, the WHZ scores increased significantly from admission to final discharge in all groups (p<0.001 in the INE and INE+MNP groups, p<0.05 in the NNE+MNP group), except in the NNE group, where WHZ scores did not change.

During admission, there were no significant differences in Hb level among all eligible children. The increase in Hb concentration during the intervention period was highest in children who participated in the INE+MNP group (10.0±10.0 g/L; p<0.001) and the INE group (10.0±12.0 g/L; p<0.001). However, the difference between these two groups was not significant. The Hb increase was significantly lower in the NNE+MNP group (3.0±8.0 g/L; p<0.05) and even lower in the NNE group (1.0±6.0 g/L; NS) group. Additionally, the prevalence of anemia (Hb < 110 g/L) decreased significantly in the INE+MNP (64.3%; n=27 to 35.7%; n=15; p<0.001) and the INE groups (62.3%; n=33 to 37.7%; n=20; p<0.001) but not significantly in the NNE+MNP (53.7%; n=22 to 51.2%; n=21) and the NNE groups (63.6%; n=28 to 56.8%; n=25).

Length of stay of eligible children was significantly shorter (35±14 days) in children admitted in the INE+MNP group than in the INE group (55±34 days), followed by the NNE+MNP (83±19 days) and the NNE groups (85±19 days) (p<0.001).

Morbidity monitoring results showed that children in the INE and the INE+MNP groups suffered 1 to 2 times from illnesses (respiratory infection and/or diarrhea and/or fever) during study period. Children in the NNE and NNE+MNP groups suffered more frequently (4-5 times) from the same illness (data not shown).

The proportion of RDC children was highest in the INE+MNP group (70.6%; n=36), followed by the INE group (64.1%; n=41) and was significantly higher compared to children in the NNE+MNP (26.0%; n=13) and NNE groups (20.0%; n=10) respectively.

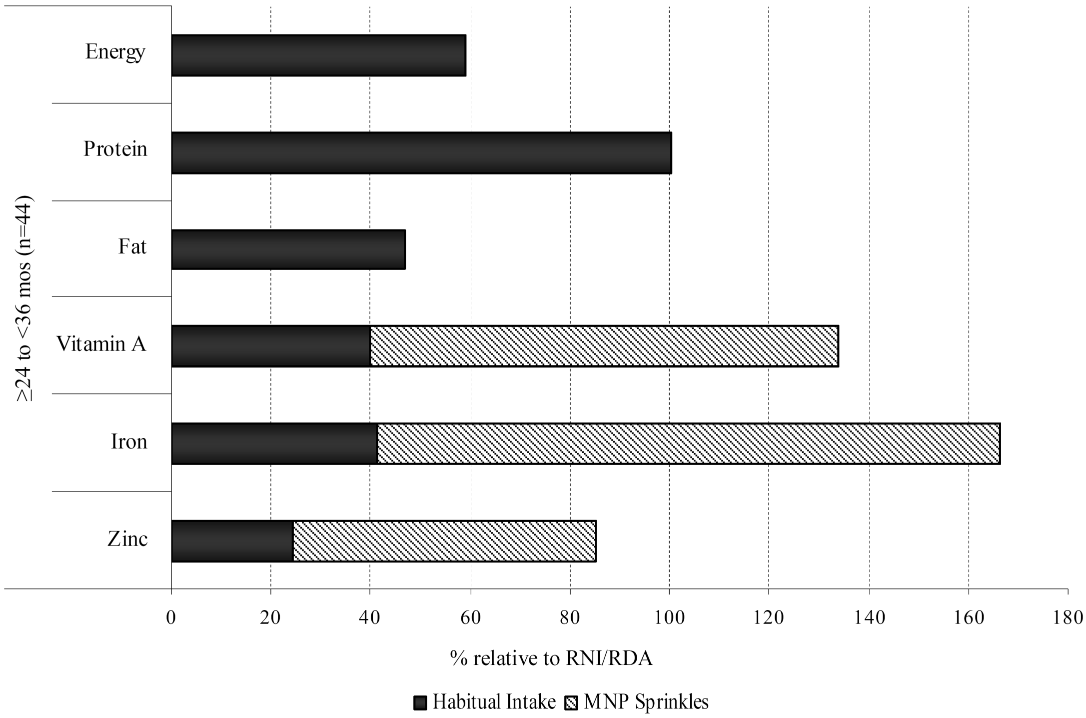

Figure 2. Selected nutrients of mean habitual dietary intake per day with provision of MNP to mildly wasted children who were no longer breastfed: an example in age group ≥24 to <36 months (*n*=43) in comparison to RNI/RDA†. † Recommended energy, protein, vitamin A, iron, zinc based on the Indonesian RNI (2004); recommended fat intake based on the RDA USA (1993).

Considering RDC children and non-RDC children within groups, no significant difference was found in demographic and socio-economic characteristics at admission (data not shown). RDC Children in the INE+MNP group showed significantly (p<0.001) higher weight gain (2.6±1.8 g/kg BW/d) compared to those in the INE group (1.5±0.9 g/kg BW/d). The NNE+MNP (0.6±0.3 g/kg BW/d) and NNE groups (0.5±0.2 g/kg BW/d) gained significantly less weight than those in the INE+MNP (p<0.001) and in the INE (p<0.05). RDC children in the INE+MNP group reached WHZ-score ≥-1.0 significantly earlier (p<0.001; with 30±11 days) than the INE (40±22 days), the NNE+MNP (81±16 days), and the NNE (86±20 days) groups (data not shown).

The compliance to the respective MNP intervention (defined if caregiver reported that a child consumed one given MNP sachet every day) was higher in the INE+MNP group than in the NNE+MNP group (83% vs 62%). The monitoring of MNP consumption revealed that non-RDC children in the INE+MNP group consumed on average 60% of MNP given, which was still better than the average MNP consumption among non-RDC children in the NNE+MNP group (31%) (data not shown).

A sub-sample of mothers of non-RDC children (n=16) was selected for in-depth interviews to explore the reasons why the children did not reach discharge criterion. Repeated illnesses (reported by all groups) and dislike of the taste of food mixed with MNP (INE+MNP and NNE+MNP groups) were mentioned as important perceived factors for lower weight gain of non-RDC children.

A frequent snacking habit of the child was considered to be an important factor that prohibited caregivers having complete control over the MNP intake of their child. A few respondents reported that the child who participated in the program was not the only child who consumed the MNP supplement because her/his siblings sometimes asked for it too.

The main reasons for not regularly consuming the MNP include perceived bitter taste of foods which are mixed with MNP, monotonous taste when consumed every day and occasionally overlooking adding MNP supplement to the lunch meal of the mildly wasted child. However, the majority of caregivers stated that they regularly added the MNP to the meal of the respective child, but the child several times refused to consume it.

Using mixed linear regression models (n=187), determinants of WHZ-score at individual discharge were developed. The following variables were not correlated with children's nutritional status at discharge: children sex, WHZ, maternal age, maternal occupation, maternal education, paternal grandmother education, number of children, income per capita based on PPP. Respondents' compliance with the programs, episode of illness, and types of programs were positively associated with the WHZ-score at discharge. Additionally, mixed model logistic regression identified that the predictors which correlated with co- reaching the discharge criterion (WHZ ≥1.0 SD) were WHZ at admission, respondents' compliance with the programs, episode of illness, and types of programs.

The result of 24-h recalls prior to the study showed that adding MNP to the daily diet of children aged ≥24 to <36 months increased micronutrient intake - including vitamin A, iron and zinc (Figure 2). Percentage fulfilment of iron, vitamin A, and folic acid were even above the RNI/RDA. Similar tendencies were also found among all age groups (Table 4).

Table 4. Nutrition composition of dietary intake per day of mildly wasted children who were no longer breastfed based on 24-h dietary recall on Nias Island, by age group†

Age group, mo	Habitual Intake and % Fulfillment	Energy (kcal)	Protein (g)	Fat (g)	Vitamin A (µg)	Iron (mg)	Zinc (mg)
≥12 - <24	Habitual	451±226	21.1±16.9	17.3±14.4	169±99.6	3.1±2.8	1.7±1.5
	RNI/RDA	1000	25.0	35.0	400	8.0	8.2
≥24 - <36	Habitual	585±231	24.9±13.5	18.5±12.8	157±121	3.2±2.6	1.9±1.1
	RNI/RDA	1000	25.0	35.0	400	8.0	8.2
≥36 - <48	Habitual	596±239	26.9±21.4	19.1±12.8	169±89.2	3.4±3.2	2.4±2.7
	RNI/RDA	1550	39.0	35.0	450	9.0	9.7
≥48 - <60	Habitual	569±248	24.7±12.7	22.2±16.4	203±141	4.3±3.0	1.9±1.1
	RNI/RDA	1550	39.0	35.0	450	9.0	9.7

† Recommended energy, protein, vitamin A, iron, zinc based on the Indonesian RNI (2004); recommended fat intake based on the RDA USA (1993)

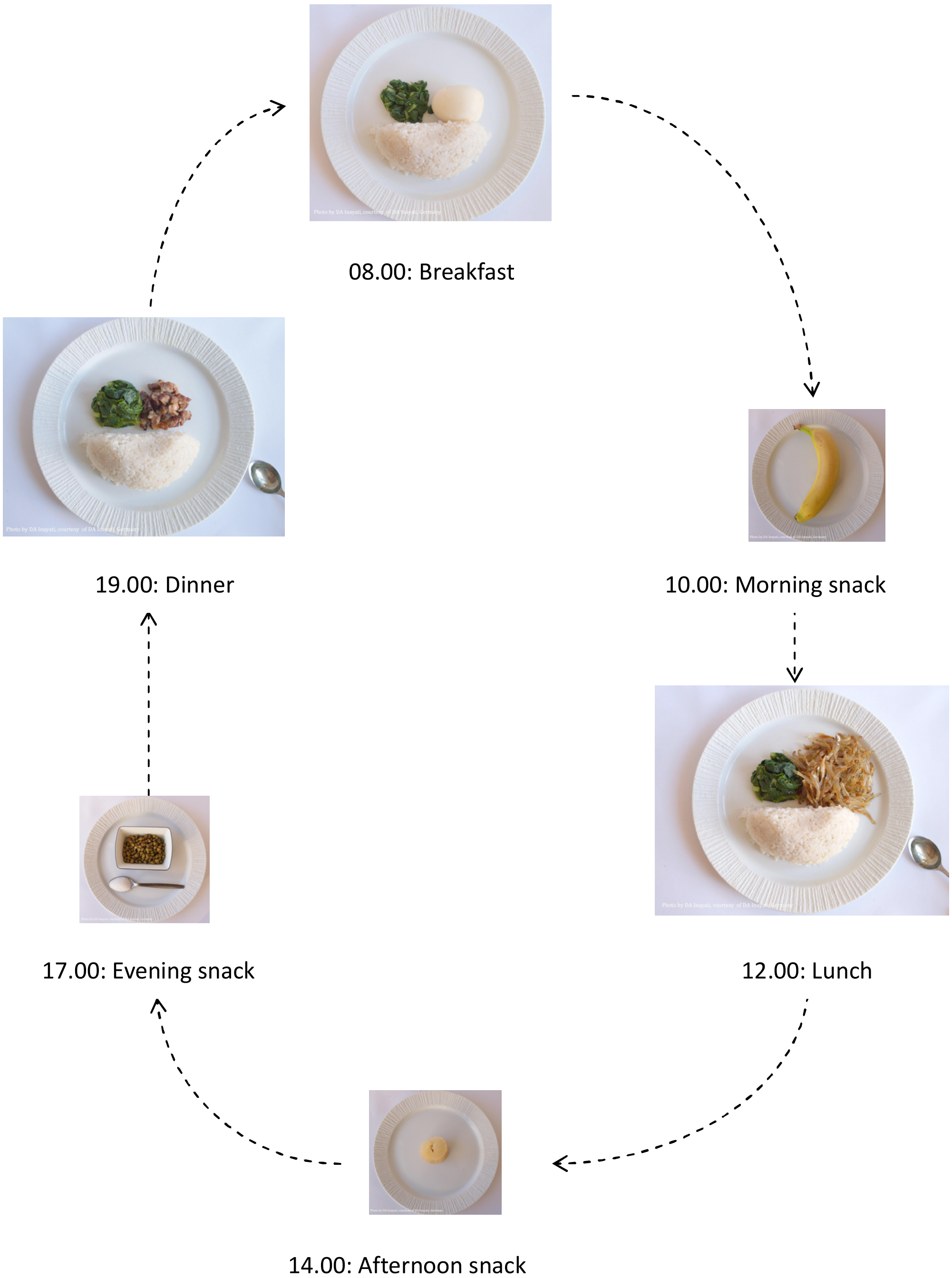

Figure 3. Example of feeding recommendation per day for children aged ≥24 to <36 months based on locally available food in Nias Island, Indonesia

Table 5. Nutrient composition of recommended dietary intake per day for children aged ≥24 to <36 months based on food locally available on Nias Island

		Energy (kcal)	Protein (g)	Fat (g)	Vitamin A (μg)	Iron (mg)	Zinc (mg)
Cooked rice	350 g	455	8.4	0.7	0.0	0.7	1.4
Anchovies	30 g	28.5	5.5	0.7	6.0	1.0	0.5
Cassava leaves	50 g	18.5	1.9	0.1	260	1.5	0.2
Cooked cassava	60 g	75.6	0.7	0.2	61.8	0.5	0.2
Mung bean	30 g	34.8	2.3	0.2	0.6	0.8	0.4
Meat	15 g	54.7	3.0	4.8	0.8	0.2	0.4
Egg	60 g	84.9	7.1	6.2	114	1.2	0.7
Oil	10 g	172	0.0	20.0	0.0	0.0	0.0
Sugar	5 g	19.3	0.0	0.0	0.0	0.0	0.0
Banana	150 g	143	1.7	0.3	57.0	0.8	0.3
Total		1009	29.3	32.9	500	6.5	3.9
% fulfillment from RNI/RDA†		101	117	94.0	125	81.3	47.6‡

†Recommended energy, protein, vitamin A, iron, zinc based on RNI Indonesia (2004); recommended fat intake based on RDA USA (1993)
‡ In order to increase the zinc intake, we recommend consuming additional food sources rich in zinc 2 to 3 times a week

Based on the result of the 24-h recall assessment, we modified some recipes to make them suitable to locally available ingredients which can be used as an alternative for healthy, nutritionally adequate family foods for children in the study area. Since the highest proportion of mildly wasted children in this Nias study was found in the age group ≥24 to <36 months, our daily recommended dietary intake is presented for young children in this respective age group (Figure 3). Energy, protein, fat, vitamin A, and iron needs are covered up to 80% of RNI/RDA in this recommended dietary intake (Table 5). However, zinc intake is still below RNI recommendation. Example of feeding advice of this recommended dietary intake is presented in Figure 3.

Of the RDC children (*n*=100), 98% (*n*=98)were followed-up at home on average 4.7 months after discharge (data not shown). One child from the NNE+MNP group relapsed below the WHZ-score ≤ -1.5. In general, the follow-up children in the INE and the INE+MNP groups showed better weight and height increment per day than the NNE and the NNE+MNP groups. While WHZ-score in the INE and the INE+MNP groups further increased, this decreased among children in the NNE and the NNE+MNP groups.

DISCUSSION

Demographic characteristics

More than 90% of the children in all groups came from families with low socioeconomic status that had a monthly income of less than minimum regional wage of US$ 63.40/month. Considering that a person is categorized as poor if she/he has an income of less than US$ 1.25 per day per person,[13] 92% of families in all groups lived under poverty conditions (range 86% to 96%).

Weight- and height gain outcomes of all eligible children

This study clearly demonstrated that children in the INE+MNP group achieved best results regarding weight gain, recovery rate, length of stay, and improvement of WHZ-score in comparison to those in the INE, the NNE, and the NNE+MNP groups. In addition, children in the INE group achieved significantly better results than those in the NNE or the NNE+MNP groups. On the contrary, a weekly provision of MNP with NNE program showed a marginal improvement on weight gain and anthropometric status of the study children as compared to those in the NNE group. This indicated that the MNP usage was largely insufficient if it was not supported by an intensive educational program.

The height gain per day during intervention period was comparable among the three groups, but was significantly higher in the NNE group. In contrast, during the follow-up assessment children in the NNE group showed the lowest height gain per day compared to the other three groups, though the difference was not significant. In conclusion, during the short period of this intervention there was no impact on height gain in this Nias study. Therefore, we suggest that the impact on height gain should be observed over a longer period of time and in a larger sample size.

Previous studies have demonstrated that micronutrient supplementation resulted in a positive effect on length/ height gain in young children,[14,15] whereas other studies found no influence on linear growth.[5,16-19] Similarly, our reported study demonstrated that MNP supplementation in the INE+MNP and the NNE+MNP groups could not significantly improve growth (HAZ-score) of mildly wasted children in the study area within the time frame of the current programs. Several factors might be responsible for the limited impact of micronutrient supplementation on linear growth in this Nias study, such as the amount of micronutrients consumed may have not been sufficient to adequately address the multiple micronutrient deficiencies of the respective children,[17] the relatively low prevalence of stunting during admission,[18] and the short duration of the supplementation period.[14,18] Additionally, iron supplementation in interaction with zinc is known to limit the absorption of zinc and both are included in the MNP.[18,21] Also stunting is regarded as difficult to treat, especially after 36 months of age,[22] and in our study almost half of the children were above 36 months of age.

One of the strengths of the intensive nutrition education program over the non-intensive education program was presumably related to the intensity of contact between community workers and/or CWS health officers and the caregivers. The frequency of personal contact in the INE+MNP group seemed to influence MNP usage. In addition, this likely motivated the caregivers in the INE and the INE+MNP groups to apply newly acquired nutrition knowledge. Key messages which were demonstrated in locally made pictures and a participatory method on the basis of group learning sessions likely increased active participation of caregivers in the discussions. Additionally, routine weekly INE meetings allowed community workers and health officers to supervise the program more intensively as compared to the once per month meeting in the NNE and the NNE+MNP groups.

In contrast, a monthly non-intensive educational program in the NNE and the NNE+MNP groups was not able to establish a sufficient dialog between caregivers and health educators (local health officers) to discuss important issues regarding daily health-, nutrition- and caring aspects. With respect to weekly contacts between caregivers and community workers/field officers in the NNE+MNP group, these meetings had a minor impact on the nutritional status of respective children. This was not surprising because these meetings were mainly used to distribute the micronutrient supplement, perform anthropometric measurements, and recall morbidity.

Based on studies in China and Peru,[23,24] Bhutta *et al* concluded that in food-insecure populations, educational interventions have been proven to be beneficial, especially when combined with food supplements.[22] In addition, the effectiveness of nutrition education is contingent upon relatively food-secure conditions in a population.[22] Several studies also found a positive impact of education intervention combined with food supplementation on the nutritional status of respective children.[25,26] Our study showed that children in the INE and the INE+MNP groups could sufficiently improve their nutritional status despite the fact that the majority of families came from lower socioeconomic status. It seemed that caregivers who received suitable educational intervention in the INE and the INE+MNP groups were highly motivated to learn how to make the best use of locally available foods. This resulted in better study outcomes than those in non-intensive educational programs.

According to Sheikholeslam *et al*, nutrition education alone may not be sufficient to improve the nutritional status of children.[27] However, several studies showed positive effects of educational intervention on the children's nutritional status.[23,24,26,28] In the study reported here, children in the INE group improved their nutritional status, even though they did not receive any supplementation. Weight gain was even significantly better than those in the NNE+MNP group ($p<0.001$). In a review, Ashworth *et al* suggested that counselling of caregivers about family foods is important to achieve good rates of weight gain among wasted children.[29] This might explain why the children in the INE group whose mothers received intensive educational intervention (including counseling activities) achieved a higher weight gain than the children in the NNE and the NNE+MNP groups.

Studies using MNP Sprinkles has previously been shown to be successful in treating and preventing anaemia.[19,30,31] In our study, the daily consumption of MNP increased Hb level of the respective children. We observed a significant improvement in Hb status in the INE ($p<0.001$) and the INE+MNP ($p<0.001$) groups, followed by the NNE+MNP group ($p<0.05$). The NNE group yielded lower and non-significant increase in Hb concentration. These findings suggest that supplementation of MNP in the community setting without appropriate educational messages may not result in an optimal increase of Hb level mainly due to the reported low rate of compliance in consuming micronutrient supplementation. In contrast, suitable intensive nutrition education sessions may motivate caregivers in the INE and the INE+MNP groups to practice what they learn (ie, offering locally available iron-rich food sources) despite the household being food-insecure.

Children who reached discharge criterion (RDC) and non-RDC children

The intensive educational program in both the INE and the INE+MNP groups was significantly associated with the high proportion of children who reached discharge criterion (RDC). The compliance with MNP usage was also higher in RDC children in the INE+MNP group than those in the NNE+MNP group. It suggested that caregivers who received intensive nutrition education were presumably more motivated to provide proper nutrition/ health care and comply with the instructions of MNP usage than those who were assigned in a non-intensive educational program. In addition, some studies found that micronutrient supplementation can improve the children's appetite.[31,32] This could also be the case in our study indicating that children who regularly consumed MNP within their daily lunch meal had improved appetites and associated weight gain. It was very likely that this explained the greater weight gain and higher percentage of RDC children in the INE+MNP group compared to the NNE+MNP group.

Predictors of WHZ at discharge and non-RDC status

In regression analysis, we found that socio-economic determinants had no significant relationship with either WHZ score of children at discharge or non-RDC status of the children.

Compliance with the program was an important predictor of the nutritional status at discharge, and non RDC status. Good compliance resulted in a 0.2 increased WHZ at discharge. In addition, respondents who complied with the program had a -3.9 decrease in the log-odds experiencing the non RDC status.

Type of program was significantly correlated with WHZ at discharge and with the status of non reaching discharge criterion (WHZ $\geq$-1.0 SD). Respondents in the INE+MNP program had a 0.31 increase in WHZ score at discharge and had a -3.0 decrease in the log-odds experiencing the non RDC condition than those in the NNE program. The INE program resulted in a 0.19 increase in WHZ score at discharge and produced a -2.9 decrease in the log-odds of having the non RDC status than those in the NNE program. The NNE+MNP program had a 0.18 increase of WHZ score at discharge and had a -1.55 decrease in the log-odds experiencing the non RDC condition than those in the NNE program.

Episode of illness was also an important factor for the nutritional status at discharge, and non RDC status. One unit increase of illness episode resulted in a -0.04 decrease WHZ at discharge. In addition, for every one-unit increase in episode of illness, we expect a 0.80 increase in the log-odds of non RDC status.

Therefore, it was presumed that the improvement in nutritional status of the respective children was more strongly influenced by improved knowledge, beliefs, and practices of the caregivers in terms of health and nutrition practices than by socio-economic family factors that could influence food access.

Follow-up assessment

The majority of the children from the INE and the INE+MNP groups could maintain or even further improve their nutritional status. In contrast, most children who experienced a decrease in their nutritional status came from the NNE and the NNE+MNP groups. It appeared that a long-term improvement of nutritional status of mildly wasted children in the INE and the INE+MNP groups might be explained by sustainable behavioural changes of mothers/caregivers.

Role of MNP and educational programs in improving children's daily diet

MNP supplement which are mixed into foods will enrich the micronutrients content of the daily diet of the children. Thus, we conclude that MNP supplementation will likely improve micronutrients intake of daily consumed foods but cannot increase the content of macronutrients like energy, fat and protein intake. Unfortunately, adequate micronutrients alone without sufficient macronutrients intake cannot optimize children's health and growth. Therefore, an appropriate educational intervention (NE) is needed to accompany MNP supplementation programs. Such a suitable NE is important to improve the quality of child feeding practices and caring practice of caregivers. In addition, appropriate educational intervention can increase the knowledge of caregivers in using the best combination of locally available food sources. Adding MNP Sprinkles to a daily family meal of respective children should be seen as a short term intervention to improve micronutrients status, but not as a long term solution to improve nutritional status of the children.

Recommended dietary intake for Nias children

To date recommendation for improved dietary intake for mildly wasted children on Nias Island is not available. In our recommended dietary intake, energy, protein, fat, vitamin A, and iron needs are covered up to 80% of RNI/RDA. However, zinc intake is still below RNI recommendation. Food sources rich in zinc like red meat, or eggs is beneficial for improving children's plasma zinc status since zinc is required for essential processes like growth and immunity. [33] Providing information about foods rich in zinc and making these foods available for children is essential for prevention of malnutrition in this area.

Limitations and strengths

We are aware that the influence of media or other nutrition-related programs of other NGOs in neighbourhood villages could not be controlled for. In addition, data on height and weight of the mothers and the children from pregnancy/birth to the time of admission was not available. Therefore we could not investigate possible influence of low birth weight or genetic factors on the children's long-term growth patterns.

Despite a number of limitations, the study benefited from some of its important strengths. These include low dropout rate, lack of important difference in children's characteristics among treatment groups at the time of admission, repeated measurements taken by well-trained field officers, and careful attention paid to data cleaning and analysis.

Conclusion and recommendation

Both INE supported by the provision of MNP for in-home use and INE alone were highly effective in improving nutritional - and Hb status of mildly wasted children in the CWS project area. The INE+MNP intervention was more effective in improving WHZ and required a shorter length of stay compared to the INE, but Hb improvement was the same in both groups. In contrast, the NNE with or without MNP was not highly effective. This finding is most likely related to the fact that the mothers in these groups had much less intense personal contact within the programs. However, because these findings were obtained from a relatively small sample size, the effectiveness of the INE+MNP intervention should be confirmed in studies with larger sample sizes in a similar age group and a matched cohort study design.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge in kind and financial support from Neys-van Hoogstraten Foundation, Eiselen Foundation, DSM Nutritional Products, and CWS Indonesia. We are also greatly obliged to the cooperation of all voluntary workers, women and their children in the intervention area on Nias. We would also like to show our deep appreciation to Prof. Hans-Peter Piepho for statistical advice as well as Dr. Saskia de Pee for reviewing earlier an draft of manuscript.

AUTHOR DISCLOSURES

The authors declared no conflict of interest in regard to this paper and the funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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Original Article

Combined intensive nutrition education and micronutrient powder supplementation improved nutritional status of mildly wasted children on Nias Island, Indonesia

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合併密集營養教育及補充微量營養素粉以改善印尼 Nias 島輕度消瘦兒童的營養狀況

本研究評估密集營養教育(INE)與是否補充微量營養素粉(MNP)對於印尼 Nias 島輕度消瘦兒童營養狀況之影響。在世界教會服務計劃區域，年齡在≥6 到<60 個月輕度消瘦(體重-身高比 Z 分數，WHZ ≥-1.5 至<-1.0)的兒童以村落隨機分派成兩組，INE 組(64 位)或是 INE+MNP 組(51 位)，照顧者每週接受一次營養教育，另給予 INE+MNP 組兒童微量營養素粉。另外選取兩組居住相當遠的輕度消瘦兒童，實施每個月一次的非密集營養教育(NNE)及有或無補充 MNP (兩組各有 50 位)。在納入、研究期間及釋出時，各評估 WHZ、體重、身高、血紅素(Hb)及罹病率。INE+MNP 組的兒童體重增加(公克/公斤體重/天)最多，再來是 INE 組(1.1±0.9)、NNE+MNP 組(0.3±0.5)和 NNE 組(0.3±0.4)。在 MNP 介入組(INE+MNP 及 NNE+MNP)，兒童的血紅素(g/L)顯著提高(分別是 10.0±10.0，$p<0.001$ 及 3.0±8.0，$p<0.05$)。INE+MNP 組的兒童達到釋出標準的比例最高(70.6%；36 位)，再來是 INE 組(64.1%；41 位)、NNE+MNP 組(26.0%；13 位)和 NNE 組(20.0%；10 位) ($p<0.001$)。INE+MNP 組被留置到復原為止的天數最短(29.9 天)，再來分別是 INE 組(40.0 天)、NNE+MNP 組(80.6 天)和 NNE 組(86.2 天) ($p<0.001$)。每週密集營養教育佐以 MNP 補充，對於輕度消瘦兒童的體重增加及血紅素狀況有最佳的結果。

關鍵字：教育活動、微量營養素、強化、體重增加、輕度消瘦兒童