Short Communication

Supplementary feeding with locally-produced Ready-to-Use Food (RUF) for mildly wasted children on Nias Island, Indonesia: comparison of daily and weekly program outcomes

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Ready-to-Use Foods (RUFs) in the form of fortified cereal/nut/legume-based biscuits (±500 kcal and 8-10% protein per 100 g) were tested among mildly wasted children from October 2007 to June 2008, and were labelled as RUF-Nias biscuits. This study reports on a comparison of supplementary feeding program outcomes of mildly wasted children with weight-for-height z-score (WHZ) ≥-2 to <-1.5 SD aged ≥6 to <60 months old given locally produced RUF-Nias biscuits within daily (in semi-urban areas) and weekly (in rural remote regions) distribution and supervision program settings. In the Church World Service project area, all eligible children were recruited continuously from monthly community-based screening programs and admitted into existing nutrition centers managed by the community on Nias Island, Indonesia. Individual discharge criterion of the programs was WHZ ≥-1.5 SD. Of the index children admitted in daily programs (n=51), 80.4% reached target WHZ, which was higher than in weekly programs (72.9%; n=48) by a similar length of stay of about 6 weeks. Weight gain of the children in daily programs was higher (3.1±3.6 g/kg body weight/day) than in weekly programs (2.0±2.1 g/kg body weight/day), and they achieved significantly higher WHZ at discharge. However, the majority of caretakers preferred weekly programs due to lower time constraints. Locally produced RUF in the form of biscuits for treatment of mild wasting among children demonstrated promising results both in daily and weekly community-based intervention programs.

Key Words: ready-to-use foods, fortified, supplementary feeding, mildly wasted children, weight gain

INTRODUCTION

Fortified peanut/milk paste Ready-to-Use Food (RUF), which was also called peanut/milk paste Ready-to-Use Therapeutic Food (RUTF) provides all nutrients for promoting growth and health of children suffering from severe acute malnutrition (SAM).[1] RUTF/RUF had been proven to be effective in treating severely, moderately and mildly wasted children without medical complications mainly in community-based program settings in Malawi.[2-4]

More recently, RUF in the form of fortified cereal/nut/legume-based biscuits, which were originally designed for SAM children at University of Hohenheim, Germany,[5] were locally produced and tested for children suffering from moderate and mild forms of wasting in Nias, Indonesia. This study reports on a comparison of rehabilitation program outcomes of mildly wasted children given locally produced RUF-Nias biscuits within daily (in semi-urban areas) and weekly (in rural remote regions) distribution and supervision programs.

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METHODS

A longitudinal food-based intervention study was carried out on Nias Island, Indonesia from October 2007 to June 2008. To detect a weight increment difference of 1.7 g/kg body weight/day (g/kg/day)[4] and standard deviation (SD) 2.6, with a confidence level of 95% and a power of 0.8, a minimum sample size of 37 children per program was calculated.[6]

In semi-urban areas, 51 children aged ≥6 to <60 months old, with weight-for-height (WHZ) ≥-2 to <-1.5 SD WHO 2006 standard reference data[7] and no birth defect or disease that could limit the *ad libitum* food intake were continuously recruited from the existing community-based screening programs in the Church World Service project area, and assigned to the daily programs. Forty-eight children in rural remote regions were allocated to weekly programs. Individual discharge criterion was WHZ ≥-1.5 SD.

In daily programs, the consumption of about one-third of the daily portion of RUF-Nias biscuits was supervised on site; the current health status (diarrhea, fever and respiratory infection) of the children was also assessed. Compliance with the take-home ration of RUF-Nias biscuits and morbidity of the children at home were asked the following day. The index children were weighed 2-3 times per week, while height was measured once a month. In weekly programs, all basic activities were performed once a week (see Table 1). Furthermore, at admission into the programs, during the intervention period and at discharge, WHZ, height-for-age z-score (HAZ), as well as duration of stay in the respective programs were collected for each index child. The weight of the child was assessed by a hanging scale, whereas the height was measured using height/length board (for children above/below 2 years of age). General background information, 24-hour recall dietary intake of the children during admission time and socio-economic characteristics of their families were provided by the mothers/caregivers on the basis of a standardized questionnaire.

The study conformed to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000) and was approved by the Ethics Committee of the Faculty of Medicine, University Brawijaya, Malang, Indonesia. The purpose of this study was explained to parents of eligible children, and their children were included only on the basis of informed consent.

Locally produced RUF-Nias biscuit

Based on an acceptance trial with wasted children, two RUF-Nias biscuits recipes (Table 2) were locally produced at village level with simple technology and utilizing available ingredients such as wheat flour, peanut flour, refined sugar, palm oil, egg yolk and white, soy bean or mungbean flour and micronutrient powder donated from DSM-Basel. Soy bean/mungbean flour was used interchangeably, and was roasted prior to biscuit production. Macro- and micronutrient content of RUF-Nias biscuits was developed for rehabilitation of SAM children.[1,5] Children in daily and weekly programs received a daily RUF portion which was based on the weight of the individual child[5], calculated to fulfill about 60% of daily energy requirements of Indonesian children,[8] and to be offered as a snack.

Data analysis

Differences in nutritional indicators were transformed into log (variable x + minimum value in variable x + 1), tested with Independent t-test, and presented as mean±SD to allow for comparison with other published studies. Differences in proportion were tested with Fisher's exact test. Nutritional indicators before admission and after discharge were tested for each group with paired t test. Independent predictors of not reaching the target WHZ ≥-1.5 SD were analyzed using logistic regression with a forward stepwise approach. The following covariates were included in the initial model: children's age and WHZ at admission, compliance on RUF consumption, type of program, and morbidity of the children during program period. Additionally, linear regression analysis with stepwise approach for identifying the contribution of similar covariates as in logistic regression to weight gain (in g/kg/day) of the children at program discharge was also carried out. Statistical analysis was performed using PASW/SPSS version 18.0 for Windows software packages (SPSS Inc, Chicago, IL, USA).

RESULTS

In total 1357 children were screened during the Nias study period. Approximately 45% of girls vs. 55% of boys were admitted in daily and weekly programs. As presented in Table 3, mildly wasted children admitted in daily programs were slightly younger, more wasted, more stunted, and less likely to be breastfed than those in weekly RUF-Nias biscuit intervention programs. However, the differences were not significant. About 20% of the children in both groups were below 2 years of age.

Table 1. Type and frequency of activities within daily and weekly programs

Type of regular activities	Frequency of implementation	
	Daily programs	Weekly programs
Measures regarding RUF biscuits:		
local production	1-2x per week	1x per week
distribution of RUF biscuits	1x per day	1x per week
on-site RUF biscuit'intake supervision	1x per day	1x per week
Recall and monitoring on:		
take-home ration of RUF biscuit'intake	1x per day	1x per week
child morbidity	1x per day	1x per week
Monitoring on child anthropometry:		
weight	2-3x per week	1x per week
height	1x per month	1x per month

Table 2. Macro and micronutrients in 100 g RUF-Nias biscuits in relation to reference data

Micronutrients	WHO/WFP/UN-SCN/UNICEF for SAM[†]		Soybean-based RUF-Nias+premix[‡]	Mungbean-based RUF-Nias+premix[‡]
Macronutrients	Min	Max		
Energy, kcal	520	550	536	523
Protein, %	10	12	10	8
Fat, %	45	60	58	60
Micronutrients				
Vitamin A, µg	800	1,100	979	971
Vitamin D, µg	15.0	20.0	16.5	16.4
Vitamin C, mg	50.0	-	54.3	54.0
Thiamine B1, mg	0.5	-	0.9	0.9
Riboflavin, mg	1.6	-	1.9	1.9
Vitamin B6, mg	0.6	-	0.7	0.7
Vitamin B12, µg	1.6	-	1.9	1.9
Niacin, mg	5.0	-	11.7	11.2
Biotin, µg	60.0	-	66.0	65.5
Folic acid, µg	200	-	256	257
Vitamin K, µg	15.0	30.0	28.3	27.2
Vitamin E, mg	20.0	-	20.1	19.4
Panthotenate, mg	3.0	-	4.0	3.9
Calcium, mg	300	600	346	320
Iron, mg	10.0	14.0	13.9	12.6
Iodine, µg	70.0	140	121	121
Zinc, mg	11.0	14.0	14.9	14.4
Sodium, mg	-	290	16.0	14.8
Potassium, mg	1,110	1,400	954	803
Magnesium, mg	80.0	140	91.6	67.0
Phosphorus, mg	300	600	351	287
Copper, mg	1.4	1.8	2.3	2.1
Selenium, µg	20.0	40.0	30.6	30.6

[†]Source of reference data[1]
[‡]modified from Scherbaum *et al.* (2009)[5]

Table 3. Selected characteristics and family socio-economic background of all eligible mildly wasted children during admission, by daily and weekly programs[†]

Child characteristics	Daily programs	Weekly programs	*p* value
n	51	48	
Female children	45.1 (23)	45.8 (22)	0.100
Age of children, months	33.7±12.6	34.4±14.7	0.790
Children still breastfed	27.5 (14)	37.5 (18)	0.197
Weight, kg	9.8±1.5	10.0±1.9	0.429
Height/length, cm	83.7±9.0	84.8±9.0	0.512
WHZ	-1.75±0.15	-1.72±0.15	0.366
HAZ	-2.62±1.07	-2.35±1.25	0.258
Family socio-economic conditions			
Age of parents, years			
Mothers	30.5±6.5	29.2±5.5	0.284
Fathers	34.5±7.3	32.9±6.7	0.243
Education of caregivers			
Maternal education	35.3 (18)	37.5 (18)	0.837
Father education	60.8 (31)	70.8 (34)	0.397
Occupation of parents (farmer)			
Mothers	60.8 (31)	68.8 (33)	0.528
Fathers	56.9 (29)	70.8 (34)	0.210
Income per capita per day (US$)[‡]	0.32±0.23	0.25±0.19	0.125
< US$ 1.25/day	84.3 (43)	95.8 (46)	0.093

WHZ: weight-for-height z-score; HAZ: height-for-age z-score
[†]Continuous variables written as mean±SD, categorical variables presented as % (n)
[‡]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, US$1.25 PPP equal to ±Rp 4,918 [9]

Table 4. Anthropometric indices during admission and before discharge/program closure of mildly wasted children, by daily and weekly programs(including those children who did not reach discharge criterion, excluding 3 default children)[†]

Indicators	Daily programs	Weekly programs	*p* value[††]
n	48	48	
Length of stay[‡], day	42.7±36.5	43.5±31.3	0.909
RUF intake, g/day	83.3±23.6	82.2±30.2	0.849
Poor compliance[§]	4 (8.3)	10 (20.8)	0.073
Weight			
Admission, kg	9.8±1.5	10.0±1.9	0.411
Discharge, kg	10.4±1.5	10.5±1.9	0.905
Difference, kg	0.7±0.5	0.4±0.4	0.007
Weight gain, g/kg/day	3.1±3.6	2.0±2.1	0.114
Height/Length			
Admission, cm	83.6±7.4	84.8±9.0	0.485
Discharge, cm	84.3±7.3	85.3±9.1	0.530
Difference, cm	0.1±0.2	0.1±0.2	0.863
WHZ			
Admission	-1.74±0.15	-1.72±0.15	0.556
Discharge	-1.13±0.57	-1.35±0.43	0.035
Change in *z*-score	0.61±0.56	0.37±0.41	0.016
HAZ			
Admission	-2.62±1.10	-2.35±1.25	0.278
Discharge	-2.71±1.0	-2.47±1.11	0.291
Change in *z*-score	-0.09±0.21	-0.12±0.55	0.120

WHZ: weight-for-height z-score; HAZ: height-for-age z-score, RUF: Ready-to-Use Food
[†]Continuous variables written as mean±SD, categorical variables presented as % (n)
[‡]Length of stay for children who reached discharge criterion was defined as number of days until reaching WHZ ≥-1.5 SD; for length of stay for those who did not reach discharge criterion was defined as number of days until program closure
[§]Poor compliance was defined as reported inadequate RUF-Nias biscuit consumption (<80% of daily portion) during program period
[††] Independent t-test (continuous data) or Fisher`s exact test (percentages) for comparing daily and weekly programs

Mothers of the index children in daily programs were slightly older, less likely to be engaged in on-farm activities, and had almost similar education level as those in weekly programs. Family income in semi-urban areas was only slightly higher than those in the rural remote regions. A high proportion of respondents (84.3 and 95.8%) in daily and weekly programs were categorized as poor families by earning less than US$1.25/day of Purchasing Parity Power (PPP);[9] however the difference was not significant (Table 3). Income data was derived from average cash money earned per month, and did not include household valuable assets, agriculture production, savings or aids.

As shown in Table 4, children assigned in daily programs demonstrated better weight gain than those in weekly intervention groups (3.1 and 2.0 g/kg/day respectively) although the average duration of stay was similar for both programs (42.7 and 43.5 days). As many as 80.4% (41/51) of the children in daily and 72.9% (35/48) of those in weekly programs reached discharge criterion.

Within program period, the children in both programs suffered from mild diarrhea, respiratory infection and fever with mostly 1-2 episodes (data not shown). Weight gain (in g/kg/day) of children at program discharge showed significant positive correlation with good compliance in consuming RUF biscuits (ß=0.337, p=0.031). Furthermore, based on logistic regression analysis, children who did not comply with RUF-Nias biscuit consumption had about 30 fold higher risk of not reaching discharge criterion. Other risk factors were not shown to be significant predictors for not reaching discharge criterion in this study setting.

DISCUSSION

All eligible mildly wasted children participating in the daily programs gained more weight than those in weekly programs (3.1 and 2.0 g/kg/day, respectively) within a similar duration of stay (±6 weeks) (Table 4). The results are comparable to weight gain and proportion of recovered observed in Malawian mildly wasted children consuming RUTF (3.1 g/kg/day, 58% recovered children) and higher than the children who consumed corn-soy blend (1.4 g/kg/day, 22% recovered children) in community-based programs.[4] As nearly all macro and micronutrients (based on a 24-h dietary recall) were below the recommended nutrient intake for Indonesian well-nourished children (data not shown), the role of RUF-Nias biscuits was to fill the gap and rehabilitate mild cases of wasting.[10]

Height-for-age z-score and height gain of our study children during individual discharge was not clearly affected by the RUF-Nias biscuit intervention, similar to the study result in Malawi.[3] This could possibly be due to the shorter duration of stay (about 37 days) of children who reached discharge criterion in the respective programs (data not shown).

In this study, randomization could not be applied in our distinctive study areas because it was often impossible to perform daily programs in rural remote regions, where the nutrition center was far away from the respondent's

houses. Daily programs were performed in semi-urban areas, that are relatively densely populated and near public facilities (including health facilities), enabling daily meeting for supervision and evaluation of RUF-Nias biscuits consumption. In more rural villages, only a weekly program was possible; supervision and home visits were found more difficult to carry out.

The daily programs also recorded a slightly higher compliance rate and RUF biscuit's intake among mildly wasted children than in weekly programs (see Table 4). One explanation is that daily programs enabled supervision and monitoring on-site consumption of 30-40% of the daily portion of RUF-Nias biscuits, in contrast to only about 5-10% portion in the weekly programs. Additionally, the analysis of consumed take-home ration of RUF-Nias biscuits relied on the accuracy of mothers'/caregivers' recall of children's RUF intake. Daily recall of RUF-Nias biscuits consumption could be assessed more precisely than in the weekly programs, wherein the past seven days were harder to recapture. Similarly, the health status of the children, which was not significantly different between the two programs, was also more closely monitored in the daily than in weekly programs. Despite a slightly more wasted and stunted condition at the start of the programs, the children assigned in daily programs produced better weight gain; more children reached WHZ ≥-1.5 SD and had significantly higher WHZ at individual discharge than in weekly programs. Thus, an improved weight gain and WHZ-score at discharge in daily programs can be related to adequate consumption of RUF-Nias biscuits.

A few caretakers complained that the children became bored by the taste of the RUF-Nias biscuits, particularly children from better-off families. Consequently, their mothers/caretakers bought commercial snacks to replace RUF-Nias biscuits and shared the RUF-Nias biscuits with siblings and other family members. The fact that the children who did not comply to prescribed consumption of RUF-Nias biscuit had about 30 times greater risk of not reaching discharge criterion, highlights the importance of improving the biscuits' appeal by adding spices and increasing their nutrient density (eg, less calories but full range of micronutrients) to reduce the required RUF quantities for the children.

Of the 76 children who reached discharge criterion, 47 (27 children in daily and 20 children in weekly program) were followed-up on average after 4.9 months (data not shown). Two children who were already discharged from the daily, and two other children from the weekly programs were found again below with WHZ <-1.5 SD, but none were below WHZ <-2 SD. On average, at follow-up children showed on-going and significantly increased weight and height as compared to that at discharge from the programs. Among those discharged from the daily program, the WHZ-score also improved, while children from the weekly program maintained their WHZ-score.

Daily programs also provided more opportunities to educate and motivate the caregivers on health and nutrition related knowledge and practices targeted for children, than in weekly programs. However, the majority of caretakers preferred weekly programs (once a week rather than every day attendance) due to lower time demands.

Despite the differences in socio-cultural, as well as geographical settings, the vast majority of mildly wasted children in daily and weekly programs achieved acceptable weight gain, and a high proportion in both programs reached discharge criterion within a relatively short period of intervention (about 6 weeks). Thus, treatment of mild wasting with RUF-Nias biscuits seems to be feasible even in the less supervised weekly programs.

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AUTHOR DISCLOSURES

The authors declared no conflict of interest in regard to this paper.

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以在地產的即食品供給印尼 Nias 島的輕度消瘦兒童：每日或每週補充餵食的結果比較

以強化穀類/堅果類/豆類為主製成的餅乾(每 100 公克含±500 大卡及 8-10%蛋白質)做為即食補充品(RUFs)，並標示為 RUF-Nias 餅乾。從 2007 年 10 月至 2008 年 6 月，以當地輕度消瘦兒童作為測試。這個研究針對體重-身高比 Z 分數(WHZ)為≥-2 至<-1.5 標準差，年齡介於≥6 至<60 個月的輕度消瘦兒童，給予在地產的 RUF-Nias 餅乾，比較以每日(半都會區)或每週(鄉村偏遠地區)發給及監督食用補充品方案的結果。在世界教會服務計劃區域內，每月由社區篩選的所有符合條件的兒童陸續納入營養中心，並由印尼 Nias 島社區管理。受試者離開這個計劃的準則是 WHZ≥-1.5 標準差。在相似的約 6 週餵食補充期間，每日方案的兒童(51 位)顯示有 80.4%達到 WHZ 目標，高於每週方案的兒童(48 位中的 72.9%)。每日方案的兒童體重增加(平均每天 3.1±3.6 g/kg 體重)也較每週方案(每天 2.0±2.1 g/kg 體重)高，且在離開時達到顯著性較高的 WHZ。然而，大多數的兒童照顧者傾向於每週方案，因為有較低程度的時間約束。在地產的即食補充品以餅乾的形式治療輕度消瘦的兒童，證實不論是每日或每週社區基礎介入方案都是大有可為的。

關鍵字：即食補充品、強化、補充餵食、輕度消瘦兒童、體重增加