Age-based preventive targeting of food assistance and behaviour change and communication for reduction of childhood undernutrition in Haiti: a cluster randomised trial

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Summary

Background **Food-assisted maternal and child health and nutrition programmes usually target underweight children younger than 5 years of age. Previous evidence suggests that targeting nutrition interventions earlier in life, before children become undernourished, might be more effective for reduction of childhood undernutrition.**

Methods **We used a cluster randomised trial to compare two World Vision programmes for maternal and child health and nutrition, which included a behaviour change and communication component: a preventive model, targeting all children aged 6–23 months; and a recuperative model, targeting underweight (weight-for-age *Z* score <–2) children aged 6–60 months. Both models also targeted pregnant and lactating women. Clusters of communities (n=20) were paired on access to services and other factors and were randomly assigned to each model. Using two cross-sectional surveys (at baseline and 3 years later), we tested differences in undernutrition in children aged 12–41 months (roughly 1500 children per survey). Analyses were by intention-to-treat, both by pair-wise community-level comparisons and by child-level analyses adjusting for the clustering effect and child age and sex. This study is registered with ClinicalTrials.gov, number NCT00210418.**

Findings **There were no differences between programme groups at baseline. At follow-up, stunting, underweight, and wasting (using WHO 2006 reference data) were 4–6 percentage points lower in preventive than in recuperative communities; and mean anthropometric indicators were higher by +0·14 *Z* scores (height for age; p=0·07), and +0·24 *Z* scores (weight for age and weight for height; p<0·0001). The effect was greater in children exposed to the preventive programme for the full span of 6 to 23 months of age than in children exposed for shorter durations during this period. The quality of implementation did not differ between the two programmes, nor did use of services for maternal and child health and nutrition.**

Interpretation **The preventive programme was more effective for the reduction of childhood undernutrition than the traditional recuperative model.**

Introduction

The United States Agency for International Development (USAID) spends nearly US$100 million a year on food-assisted child health and nutrition programmes, which aim to reduce food insecurity and childhood undernutrition. These programmes usually target services to families with children younger than 5 years who are identified through growth monitoring activities as underweight. Although widely implemented, these programmes and other large-scale government-sponsored programmes targeted to underweight children have shown limited effect in reducing childhood undernutrition.[1–5]

In this paper, targeting underweight children is called a recuperative approach. The term refers to targeting children with mild and moderate underweight (*Z* scores for weight-for-age of less than –1 [mild] or –2 [moderate]). We do not address severe acute undernutrition, which is defined as weight-for-height *Z* scores of less than –3, nor do we discuss related treatment approaches such as community therapeutic care.[6]

Research evidence suggests that a preventive approach based on targeting nutrition interventions as early as possible in children's lives might be more effective than recuperation to reduce childhood undernutrition. Published studies on the process and timing of growth faltering, and on the effectiveness of food supplementation, provide convincing evidence that the first 2 years of life (in addition to the prenatal period) is the window of opportunity for nutritional interventions. Research has shown that this period is not only the time of greatest vulnerability[7,8] and risk of possibly irreversible long-term physical and mental damage,[9–14] but is also the period of greatest benefits from nutrition interventions.[15–17] Consequently, there is increasing interest in developing, implementing, and assessing nutritional interventions to address childhood undernutrition based on a preventive approach.

This paper presents the results of an evaluation study based on a cluster randomised trial, which compared the effect on child growth of a preventive and a recuperative approach of targeting a food assisted maternal and child health and nutrition programme in Haiti. The hypothesis was that targeting all children 6–23 months of age (preventive) would be more effective

at reducing the community prevalence of stunting, underweight, and wasting than would targeting underweight children younger than 5 years (recuperative). A cluster randomised trial was used for the evaluation because the two programme models were delivered at the community level, rather than the individual level.

Methods

Setting and programmatic context

The research was undertaken in the context of a new 5-year programme implemented by World Vision-Haiti in the Central Plateau region of Haiti, where World Vision operates in all 12 communes and serves a population of roughly 600 000.

The programme offers a range of services for pregnant and lactating women and for children 0–59 months of age, and is based on five contact points between programme staff and beneficiaries: (a) rally posts, where beneficiary identification is done, and where health education, growth monitoring, and services for preventive maternal and child health and nutrition are provided; for children 0–5 years of age, these include immunisation, vitamin A supplementation, and the provision of oral rehydration salts and anthelmintic drugs; (b) mothers' clubs, where small groups of beneficiaries gather with programme health staff to discuss health, hygiene, and nutrition topics in the context of the programme's behaviour change and communication strategy; (c) food distribution points, where beneficiaries collect their monthly food rations; (d) prenatal and post-natal consultations; and (e) home visits for newborn infants or severely undernourished children.

The maternal and child health services offered at rally posts are open to all community members. Food assistance, however, is targeted only to pregnant and lactating women (up to 6 months post-partum) and to children identified as underweight (weight-for-age *Z* scores <–2). The monthly food ration for pregnant and lactating women consists of 5 kg of soy-fortified bulgur, 1·5 kg of vegetable oil, and 2 kg of lentils, and an indirect (family) ration of 5 kg of wheat-soy blend, 1·5 kg of oil, and 2 kg of lentils. The monthly food ration for children consists of 8 kg of micronutrient-fortified wheat soy blend and 2 kg of oil, and an indirect ration intended for general household consumption of 10 kg of wheat-soy blend and 2·5 kg of lentils. Food assistance is conditional on monthly participation in the rally posts and mothers' clubs. Pregnant and lactating women are eligible to receive food assistance for up to 6 months each, and underweight children for up to 9 months. According to World Vision management, the rationale for providing food supplements to undernourished children for 9 months is based on programmatic experience, which suggests that 9 months is sufficient for most children to recover from undernutrition. To our knowledge, this assumption is not supported by scientific research. Children are eligible for re-entry in the programme if they are still underweight 1 year after having exited the programme.

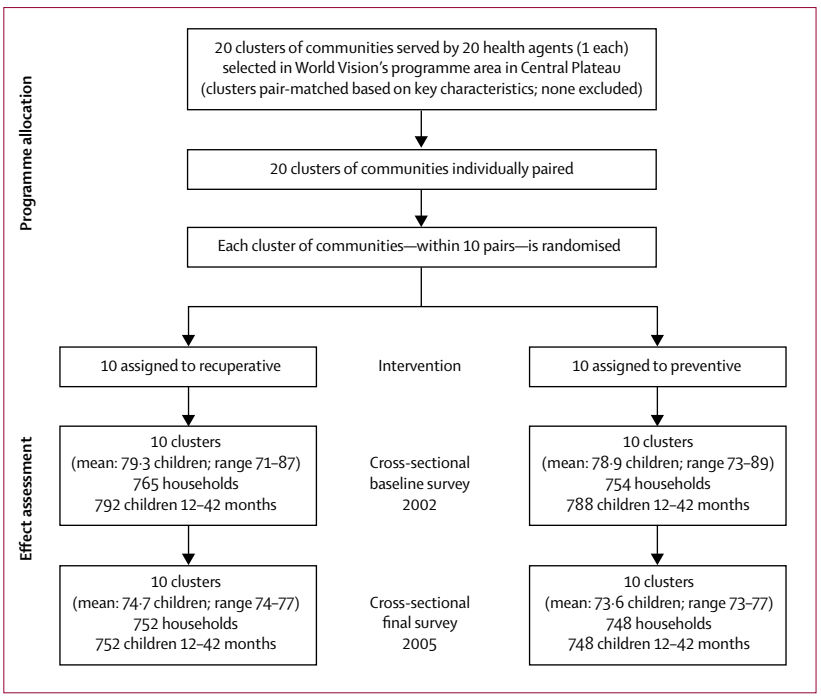

Figure 1: **Trial Profile**

Intervention packages

Our evaluation compared two different models of targeting food assistance to children and the behaviour change and communication intervention to their mothers at the mothers'clubs: the traditional, recuperative model described above, which targets underweight children (weight-for-age *Z* scores <–2) 6–59 months of age, and provides them with food assistance for 9 months; the preventive model, which targets all children 6–23 months and provides up to 18 months of food assistance to children. In this model, children 24–59 months of age with weight-for-age *Z* scores less than –3 are also eligible for programme benefits for 9 months (as in the recuperative model).

The two programme models offer exactly the same services to pregnant and lactating women and to children at the rally posts and in home visits, and provide the same monthly food ration conditional on monthly attendance at rally posts and mothers' clubs. The only three aspects that differ between the programmes are: (1) eligibility criterion (age 6–23 months or weight-for-age *Z* scores less than –3 for children aged 24–59 months in the preventive group *vs* weight-for-age *Z* scores less than –2 for children aged 6–59 months in the recuperative group); (2) the duration

	Recuperative [n=10 clusters] Mean (SE)	Preventive [n=10 clusters] Mean (SE)
Nutritional status indicators—cluster level *		
Height-for-age *Z* score (intracluster correlation (ICC=0·015)	–1·65 (0·10)	–1·69 (0·04)
Weight-for-age *Z* score (ICC=0·008)	–1·02 (0·06)	–0·97 (0·08)
Weight-for-height *Z* score (ICC=0·005)	–0·18 (0·03)	–0·18 (0·05)
Other child characteristics (individual level)†‡	N=792	N=788
Stunting prevalence (%)	37·4	36·7
Underweight prevalence (%)	17·8	17·6
Wasting prevalence (%)	4·3	5·2
Age (mean, SD)	29·4 (7·6)	29·3 (7·9)
Sex (% female)	48·0	51·4
Breastfed within 1 h (%)	19·3	16·2
Fed meals at least minimum recommended number of times (3 times a day) at 12–23 months (%) in previous 24 h	58·7	57·6
Mean number of food groups consumed by child (mean, SD) in previous 24 h	5·1 (1·5)	5·0 (1·5)
Consumed meat, fish, or eggs in previous 24 h (%)	87·3	89·2
Caregiver characteristics[4]	N=765	N=759
Age (mean, SD)	30·8 (7·0)	30·8 (8·0)
Maternal height at baseline (mean, SD)	157·9 (11·6)	157·6 (15·4)
Years of schooling (mean, SD)	1·4 (2·3)	1·6 (2·5)
Never attended school (%)	53·2	50·7
Occupation		
Unemployed (%)	16·1	16·5
Farming (%)	43·1	42·5
Trade/market (%)	32·7	32·0
Household characteristics[4]	N=765	N=755
Male head of housefold (%)	90·8	90·1
Occupation of head of household		
Unemployed (%)	2·0	1·4
Farming (%)	85·5	86·8
Household size (mean, SD)	6·8 (2·3)	6·7 (2·3)
Own house (%)	94·1	91·1
Have electricity (%)	2·1	1·9
Have sanitation facility (%)	57·3	56·0
Have tap water in the house (%)	1·6	0·9

*Differences in means were tested using cluster level pair-wise comparisons and paired *t* test. †Differences in the prevalence of stunting, underweight, and wasting were tested using a random effects logit model controlling for cluster effects. ‡Differences in other child, caregiver, and household characteristics were tested at the individual level, with *t* tests (for means) and χ^2 tests (for proportions). §None of the differences between the groups were significant.

Table 1: **Comparison of the programme communities at baseline§**

of eligibility to receive the intervention for food and behaviour change and communication (9 months in recuperative, up to 18 months for preventive); (3) the focus, timing, sequencing, and number of sessions of the intervention for behaviour change and communication at mothers' clubs.

Behaviour change and communication strategy

The behaviour change and communication strategy used mothers'clubs as the main venue for delivery. Extensive formative research informed the development of relevant messages and the translation of the Pan American Health Organization/WHO Guiding Principles for Feeding Breastfed Children[18] into feasible and locally acceptable child care and feeding practices.[19] A set of 13 learning sessions was developed on topics such as healthy pregnancy, breastfeeding, child development, child caring and feeding practices, hygiene in food handling and storage, and cooking demonstrations of nutrient-dense complementary foods. For the preventive model, a precise schedule was established to ensure that delivery of the information was age-specific and reached caregivers at the time when they most need the information. For the recuperative model, the learning sessions were designed to address topics of relevance for undernourished children, such as the causes of undernutrition, nutritious recipes, feeding during illness, and hygiene in food handling and storage. The mothers' club sessions lasted around an hour, and were facilitated by health workers trained in both technical content and adult education techniques; the health workers used various learning approaches (eg, demonstrations, food tasting, small group activities, and general discussions).

Food distribution and other components of the intervention packages were implemented in August–September, 2002, immediately after the baseline survey. The new behaviour change and communication package, however, was fully implemented only 8–9 months later, in May, 2003.

Study design and sample size

The evaluation was done in three communes of Central Plateau—Hinche, Thomonde, and Lascahobas—and used a cluster-randomised design. Two cross-sectional surveys were done to obtain information at baseline (May–September, 2002) and exactly 3 years later in the same communities (2005; figure 1). The main outcomes were mean *Z* scores for height for age, weight for age, and weight for height, and the prevalence of childhood stunting, underweight, and wasting.

20 clusters of communities, each attended by one health agent (World Vision local staff) were selected for the evaluation from programme areas in Central Plateau. These communities were new communities in which World Vision had planned to start their food-assisted programme. Each cluster was paired with another one selected to be similar in geographical and ecological conditions, access to a health care centre, and the existence of a World Vision private sponsorship programme. Within each pair of clusters, one was randomly assigned to the preventive model and the other one to the recuperative model. For each pair of matched clusters, we drew lots to determine which of the clusters would be assigned to the preventive group. The first cluster drawn from the pair was assigned to the preventive group and the one remaining was assigned to the recuperative. Thus, the unit of randomisation was the cluster of communities covered by one health agent.

For cost and logistical reasons, only ten pairs of clusters could be included in the study. We estimated a sample size of 75 children per cluster, for a total of 1500 children. This sample size provided the ability to detect differences between groups in the final survey of 7·5 percentage points or larger in the prevalence of stunting, assuming an average design effect of 1·5 (clustering of characteristics within cluster), an alpha of 0·05, and power of 0·90. This sample size also provided the ability to detect differences larger than 7·5 percentage points in underweight, 5 percentage points in wasting, and differences larger than –0·2 in mean *Z* scores for height for age, weight for age, and weight for height.

Age group selected for effect assessment and sample sizes

Children 12–41 months of age were selected for the effect assessment on the basis of available scientific evidence on the age of greatest nutritional vulnerability and largest potential for response to nutritional interventions.[7,8,15–17,20] Children regarded as most likely to benefit from the preventive model were those who were first exposed to the supplementation between 6 and 11 months of age, and for the whole duration of their period of greatest vulnerability (ie, up to 24 months of age). These children would be 24–41 months old at the final survey. Additionally, we also included children 12–23 months of age who were only partly exposed (ie, had not yet reached 24 months at final survey). For the recuperative model, the 12–41 months age range was also expected to include mostly children who had already been eligible for the programme (underweight and younger than 5 years), with some possible truncation (ie, still in the programme) in children in the younger age range, given that the peak prevalence of underweight children in Haiti is 12–17 months.[21]

Programme implementation started immediately after the baseline survey, except for the new behaviour change and communication strategy, which was implemented 9 months later. This delay meant that children who were 36–41 months at final survey were not fully exposed to all programme components. Thus, the sample at final survey includes children 24–35 months of age who were fully exposed to the programme, and two groups of partly exposed children (12–23 months, and 36–41 months).

Survey design and data collection

The baseline and final surveys used a community and a household questionnaire. The community questionnaire was administered using group interviews with key community members, and gathered information on access to the nearest major town, the main activity of the residents, key geographical characteristics, and access to services. The household questionnaire was administered to the mother of the index child, and collected data for household and maternal characteristics and on child caregiving practices (eg, feeding, health care seeking, hygiene, discipline). Anthropometric measurements (height and weight) were taken for children 6–41 months of age and their caregiver; only anthropometric data for children 12–41 months were used in the impact evaluation.

Households were selected for the survey if they had at least one child 12–41 months of age, based on census data collected by the research team before the surveys. The baseline survey included 792 children with anthropometric data in preventive group and 788 in the recuperative group, and the final survey included 749 children in preventive group and 751 in the recuperative group.

Field workers in charge of data collection for both surveys were unaware of the study objectives and were

	Recuperative			Preventive			Difference (preventive-recuperative)	
	N	Mean	SE	N	Mean	SE	Difference	p
Height-for-age *Z* scores								
Unadjusted (n clusters)* (Intra-cluster correlation [ICC]=0·016)	10	–1·68	0·05	10	–1·53	0·06	0·15	0·071
Adjusted for child age and sex† (n children)	746	–1·67	0·05	735	–1·53	0·05	0·14	0·018
Weight-for-age *Z* scores								
Unadjusted (n clusters) (ICC=0·021)	10	–1·21	0·04	10	–0·97	0·06	0·24	0·003
Adjusted for child age and sex (n children)	746	–1·20	0·05	735	–0·96	0·05	0·24	0·000
Weight-for-height *Z* scores								
Unadjusted (n clusters) (ICC=0·017)	10	–0·46	0·04	10	–0·23	0·06	0·23	0·001
Adjusted for child age and sex (n children)	746	–0·46	0·05	735	–0·22	0·05	0·24	0·000

*Statistical significance of differences in unadjusted means was tested using a paired *t* test of cluster level means. †Random effects regression models were used to analyse child-level data, controlling for child age and sex, and adjusting for clustering at the pair level.

Table 2: **Mean child anthropometric outcomes at final survey**

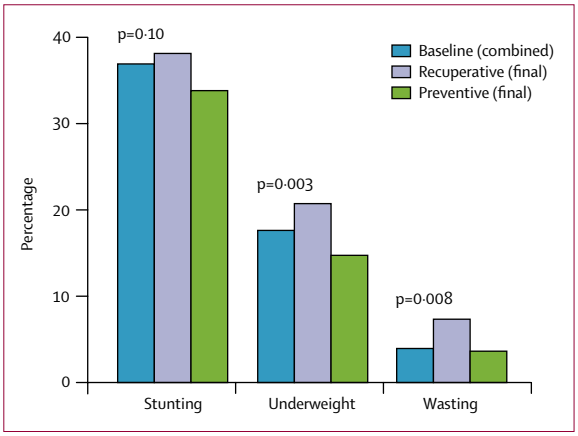

Figure 2: **Prevalence of stunting, underweight, and wasting at baseline and final survey, by programme group**

Groups were not different at baseline. Random effects logit models adjusting for cluster effects and controlling for child age and sex were used to assess the statistical significance of differences between programme communities. P values are for differences between preventive and recuperative at final survey.

unrelated to World Vision programmes. Likewise, World Vision staff were responsible for programme implementation and were not involved in data collection for the evaluation study.

Approval for the study was obtained from the Cornell University Committee on Human Subjects, the office of Coordination of the National Nutrition Programme (situated within the Ministry of Health) in Haiti, and World Vision-Haiti. All mothers of study children were provided with detailed information about the study in writing and verbally at recruitment, and all gave written or verbal informed consent.

Statistical analysis

All analyses examined the outcomes according to intention-to-treat analyses and included both programme participants and non participants. The correlation between the baseline and final values was too low (≤0·50) to warrant taking the baseline values into account[22] in the analyses. Differences between programme communities in the main outcomes of interest (mean *Z* scores for height for age, weight for age, and weight for height) were tested using a pair-wise comparison at the cluster level (and a paired *t*-test for statistical significance). Analyses were also done at the child-level using random effects regression modelling and adjusting for the clustering at the pair level[22] and controlling for child age and sex. Similarly, differences in the prevalence of stunting, underweight, and wasting at the cluster level were tested with random effects logit models (xtlogit in Stata 9) that adjusted for the clustering at the pair level and controlled for child age and sex. Anthropometric data were entered in Epi-Info 6 and *Z* scores were calculated using the WHO 2006 reference data.[23,24]

Role of the funding source

The evaluation was funded by multiple sources, including USAID through the Food and Nutrition Technical Assistance (FANTA) Project of the Academy for Educational Development (AED); USAID-Haiti; World Vision-Haiti; the Government of Germany; and the World Food Programme. FANTA/AED and World Vision participated in the study design; neither participated in the data collection, analysis, or writing of the manuscript, but both gave extensive feedback at all stages of the project. Freedom to publish the study findings was protected contractually in the agreement between the respective funding sources and the International Food Policy Research Institute.

Results

There were no differences between the groups at baseline in any of the child anthropometric measures or in other child, maternal, and household characteristics (table 1). At the end of the 3-year intervention, children from preventive communities had significantly higher mean *Z* scores for height for age (+0·14), weight for age (+0·24), and weight for height (+0·24) than the recuperative group (child-level means adjusted for cluster effect and for child age and sex; table 2). Differences in the prevalence of undernutrition (adjusted for child age and sex using logit models) confirm the greater effect of the preventive model: stunting, underweight, and wasting were 4, 6, and 4 percentage points lower, respectively, in preventive than recuperative communities (figure 2; p=0·10 for stunting; p=0·003 for underweight; p=0·008 for wasting). The prevalence of severe undernutrition (*Z* score <–3) was also lower in preventive than recuperative communities at final survey, but differences were significant only for underweight (5·7% in recuperative communities compared with 3·4% in preventive communities). Overall, the

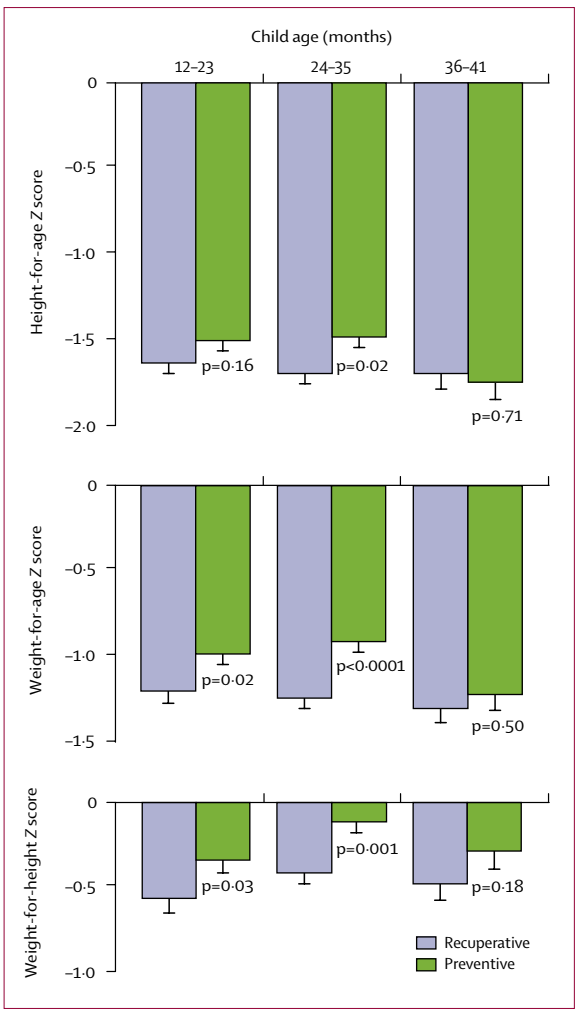

Figure 3: **Mean anthropometric outcomes by child age and programme group at final survey**

Groups were not different at baseline. Random effects regression models, adjusting for cluster effects, and controlling for child age and sex were used to assess significance of differences between groups. Error bars represent standard errors.

differences in favour of the preventive group were greatest (and significant) in children 24–35 months of age at final survey (figure 3). These children were exposed to the programme during their entire period of greatest nutritional vulnerability (ie, when they were between 6 and 23 months of age), whereas children in the two other age groups were only partly exposed.

Table 3 shows the use of programme services in preventive and recuperative communities. The percentage of pregnant and lactating women who received food assistance and who participated in mothers' clubs was high (57–70%) and similar between the two programme models, as expected by design. Use of programme services for children was also high: over 95% of mothers in both groups report having taken their children to the rally posts at least once (and on average 7 times) between baseline and final surveys, and 50% in the month preceding the survey. As expected given the different targeting criteria, receipt of food assistance by children 6 months or older differed markedly between programme models: about 73% of the children in preventive communities were ever enrolled in the programme (ie, received food assistance), compared with only 28% in recuperative communities. All children in the sample from preventive communities had at some point during the 3-year study period been between 6 and 24 months of age and were therefore eligible for the programme. By contrast, only children who had a weight-for-age *Z* score less than –2 at some point during the study period were eligible for the programme in recuperative communities. Thus, we did not expect 100% participation in recuperative communities. Consistent with programme design, children in the preventive model received food assistance on average for longer (12 months) than in the recuperative model (7·5 months), and entered the programme at a younger average age (8 months *vs* 14 months). This finding was expected because the peak prevalence of underweight in this population is in the first half of the second year.

	Programme communities		p*
	Recuperative (n=752)	Preventive (n=748)	
Mother			
Received food assistance when pregnant (%)	57·2	58·2	0·64
Received food assistance when lactating (%)	62·2	66·3	0·11
Participated in mothers' clubs when pregnant (%)	62·9	62·8	0·94
Participated in mothers' clubs when lactating (%)	64·8	69·8	0·04
Child			
Use of rally posts			
Ever taken to rally post between 2002–05 (%)	97·1	96·7	0·63
Taken to rally posts in month before survey	49·7	52·6	0·29
Number of times taken to rally posts in last year (mean [SD])	7·1 (3·2)	7·5 (3·2)	0·05
Receipt of food assistance			
Ever received food assistance (%)	28·2	73·1	0·0001
Number of times received wheat soy blend (among those who ever received food, mean [SD])	7·5 (4·3)	11·7 (3·7)	0·0001
Age first received food assistance (months, mean [SD])	13·6 (3·9)	7·7 (2·1)	0·0001

NS=not significant at p≤0·05 level. *P values are only presented for variables where p≤0·05 (using random effects regression models, adjusting for cluster effects).

Table 3: **Programme participation and use of services**

Discussion

This study shows, using a cluster-randomised trial, that an age-based preventive model for delivering a package of food assistance and maternal and child health and nutrition interventions was more effective at reducing childhood undernutrition than the traditional, recuperative model based on targeting underweight children. Results of our operational research done in 2004 also showed that the two programme models were operating equally well and that the organisational conditions were essentially identical (eg, with respect to staff characteristics, workload, logistics, incentive structure, supervision, and monitoring system). Use of programme services at rally posts and mothers' clubs was also similar between the groups. Overall, there were no differences between the two intervention groups in the programmes and services made available to the communities by World Vision over the period of the evaluation. Thus we rule out the possibility that the greater effect of the preventive model was due to organisational or implementation factors.

Various findings support the plausibility of our results. Children who were exposed to the programmes during the entire period of greatest nutritional vulnerability (ie, between 6 and 24 months of age) benefited more than children who were only partly exposed.

Sample sizes were not derived to estimate differences between groups in changes between baseline and post intervention. However, the data suggest a slight deterioration in prevalence of undernutrition in recuperative communities, especially in the two weight indicators (underweight and wasting). This finding is plausible in view of the severe political, economic, and climatic hardship experienced in Haiti during the 3 years of the study (2002–05).[25] Although the study did not include a control group, and therefore cannot assess the absolute effect of either model, results from the 2005 Demographic and Health Survey[26] suggest that undernutrition rates soared from 2000 to 2005 in the Central Department where the study was done: stunting increased by 5 percentage points in the region, whereas underweight prevalence almost doubled (17% to 32%) and wasting more than tripled (2·2% to 7·6%). Note that these prevalences are derived from the NCHS/CDC/WHO reference standards[27] and are therefore not comparable with our estimates, which used the new WHO reference standards.[23] Overall, our findings suggest that both programme models might

have mitigated the effect of the crisis on childhood undernutrition, but that the preventive model was more effective in doing so.

The magnitude of differences in favour of the preventive model in adjusted mean anthropometric indicators (0·14–0·24 *Z* scores) is in the range reported in effectiveness trials aimed at reducing childhood undernutrition through improved complementary feeding practices.[28] Similarly, a review of USAID food-assistance programmes documents an average reduction in underweight prevalence of 2 percentage point per year.[29] Although the studies included in these reviews, which used before-and-after or post-intervention designs with a control group, and the reference standards of NCHS/CDC/WHO, are not directly comparable to our study (which compared two programme models and used WHO standards), they are indicative of a range of effects that might be expected from this type of intervention. If we assume that our recuperative model had some effect on reducing undernutrition (as suggested by the review of USAID food-assisted maternal and child programmes),[30] then the larger effect of the preventive model must be viewed as additional to that of the recuperative model.

Our study did not include a control group because of cost and logistical constraints, and concerns about inequitable beneficence. A control group would have allowed an assessment of the effect of each programme model compared with no intervention. The evaluation also compared two packages of interventions, but not specific contributions of the different intervention components, which limits inferences about the effectiveness of models that have different design components.

We believe that the findings of the study are generalisable to similar resource-constrained populations, especially in view of the remarkably similar patterns of growth faltering that are seen worldwide.[7,8] Both programme models were implemented and functioning under high-quality operational standards. At the same time, they were facing normal programmatic constraints, in addition to the extraordinarily difficult conditions due to the country's severe climatic, political, and economic turmoil. Therefore, we suggest four conditions under which these results can be generalised: good programme design based on sound formative research; effective implementation, and service delivery monitored by operations research; good incentive structure and high staff motivation monitored and fostered by effective staff supervision; and similar or higher levels of undernutrition. Although the preventive model might still be effective in areas with lower levels of undernutrition than in Haiti, geographical or community-based targeting would probably result in better use of resources where undernutrition levels are fairly low.

Although this study has shown greater effectiveness of the preventive approach in the poor rural context of Haiti, more research is needed to refine the design and strengthen the implementation and targeting of preventive models of delivering nutrition interventions to accelerate progress in preventing childhood undernutrition in other programmatic and geographical contexts.

Contributors

MTR was principal investigator of the project, designed the study with PM, J-PH, GP, LM, and BH, and wrote the manuscript with PM; PM, CL, and MA coordinated and supervised data collection; PM, MA, JM, J-PH, and MTR analysed and interpreted the data; GB commissioned the research and provided critical support throughout the study; LM and BH ensured effective implementation of the programme and provided field support. All authors read and commented on the manuscript.

Conflict of interest statement

We declare that we have no conflict of interest.

Acknowledgments

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