Original Article

Sustainability of market-based community distribution of Sprinkles in western Kenya

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Abstract

To evaluate the sustainability of market-based community distribution of micronutrient powders (Sprinkles®, Hexagon Nutrition, Mumbai, India.) among pre-school children in Kenya, we conducted in August 2010 a follow-up survey, 18 months after study-related marketing and household monitoring ended. We surveyed 849 children aged 6–35 months randomly selected from 60 study villages. Nutritional biomarkers were measured by fingerstick; demographic characteristics, Sprinkles purchases and use were assessed through household questionnaires. We compared Sprinkles use, marketing efforts and biomarker levels with the data from surveys conducted in March 2007, March 2008 and March 2009. We used logistic regression to evaluate associations between marketing activities and Sprinkles use in the 2010 survey. At the 2010 follow-up, 21.9% of children used Sprinkles in the previous 7 days, compared with 64.9% in 2008 ($P < 0.001$). Average intake was 3.2 sachets week^{-1} in 2008, 1.6 sachets week^{-1} in 2009 and 1.1 sachets week^{-1} in 2010 ($P < 0.001$). Factors associated with recent Sprinkles use in 2010 included young age [6–23 months vs. 24–35 months, adjusted odds ratio (aOR) = 1.5, $P = 0.02$], lowest 2 quintiles of socio-economic status (aOR = 1.7, $P = 0.004$), household attendance at trainings or launches (aOR = 2.8, $P < 0.001$) and ever receiving promotional items including free Sprinkles, calendars, cups and t-shirts (aOR = 1.7, $P = 0.04$). In 2010, there was increased prevalence of anaemia and malaria ($P < 0.001$), but not iron deficiency ($P = 0.44$), compared with that in 2008. Sprinkles use in 2010 was associated with decreased iron deficiency ($P = 0.03$). Sprinkles coverage reduced after stopping household monitoring and reducing marketing activities. Continued promotion and monitoring of Sprinkles usage may be important components to sustain the programme.

Keywords: Sprinkles, micronutrient powders, anaemia, sustainability, marketing.

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Introduction

Effective evidence-based interventions can improve child undernutrition and nutrition-related outcomes, including stunting, micronutrient deficiencies and child mortality, thereby reducing child deaths by 25% in the short-term and averting over 60 million disability-adjusted life-years (Bhutta *et al.* 2008). The benefit : cost ratio of programmes to improve micronutrient status is unmatched by other large-scale health or economic interventions (Horton *et al.* 2008). Despite their efficacy, there is limited documented long-term success of large-scale programmes. In particular, there is lack of evidence on sustainability. A recent review found only 24 studies of sustainability of health programmes from low- and middle-income countries (Gruen *et al.* 2008). The Africa Bureau's Office of Sustainable Development of the United States Agency for International Development defines sustainability as 'the ability of host country entities

(community, public and/or private) to assume responsibility for programs and/or outcomes without adversely affecting the ability to maintain or continue program objectives or outcomes' (Mehdi 1999).

Micronutrient powders (MNPs; e.g. Sprinkles®) are powdered preparations of vitamins and minerals that are mixed into food before consumption (Zlotkin *et al.* 2005; HFTAG 2011). Despite established efficacy for both treating and preventing anaemia in young children, few studies have reported operational and cost considerations of MNP programmes, and limited information is available on which distribution mechanisms are the most effective (Dewey *et al.* 2009; De-Regil *et al.* 2011). We previously reported the success of market-based community distribution of Sprinkles in western Kenya, which achieved high acceptability and coverage among children 6–35 months of age and demonstrated significant reductions in iron and vitamin A deficiency and recovery rates from anaemia (Suchdev *et al.* 2010, 2012). The effectiveness study formally ended in March 2009, at which time the monitoring and marketing of Sprinkles became the responsibility of the implementing organisation. A behaviour change communication strategy, which includes promotion of MNPs, is needed to create demand and support coverage, adherence and appropriate use (HFTAG 2011); however, there is virtually no information available on the minimum levels of intensity of these strategies needed to carry-out effective MNP programmes.

As the government of Kenya and implementing agencies plan to scale-up distribution of Sprinkles, evidence on the sustainability of market-based distribution is needed to inform stakeholders. Therefore, we aimed to evaluate the sustainability of market-based community distribution of Sprinkles 18 months after the end of household monitoring and research-subsidised marketing activities.

Materials and methods

Participants

We conducted a follow-up cross-sectional survey among 60 villages that had previously participated in the Nyando Integrated Child Health and Education Project (NICHE), which involved the promotion and sale of evidence-based health products, including Sprinkles, in western Kenya. NICHE was a community-based, cluster-randomised trial with two primary objectives: (1) to measure the effectiveness of Sprinkles distribution through an integrated health promotion and income-generating programme and (2) to measure the impact of Sprinkles sales on anaemia, iron deficiency and vitamin A deficiency among young children.

The intervention was implemented by the Safe Water and AIDS Project (SWAP), which utilises an innovative approach to increase access to evidence-based health products in rural Kenya, mainly by supporting community vendor groups who sell health products to their neighbours. Sprinkles were sold alone or with other SWAP products, including water disinfectant, soap, insecticide-treated bed nets (ITNs) and condoms. Sachets of Sprinkles were purchased wholesale by SWAP vendors for 1 Kenya shilling (KES) ($\approx$ 1.3¢). Vendors were instructed to resell them at a retail price in their village and surrounding areas for 2 KES ($\approx$ 2.7¢) per sachet. Sprinkles were marketed for daily use (at least 1–2 sachets week^{-1} to

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Key messages

- Despite the established efficacy of micronutrient powders (MNPs) (e.g. Sprinkles®) for both treating and preventing anaemia in young children, limited information is available on the sustainability of distribution.
- Follow-up evaluation of market-based community distribution of Sprinkles in western Kenya found reduced Sprinkles coverage and a decline in nutritional status after reducing marketing activities.
- Household attendance at trainings or launches and receipt of promotional items were associated with Sprinkles use at follow-up.
- Appropriate promotion and ongoing monitoring of MNPs usage may be important components for sustaining the programme.
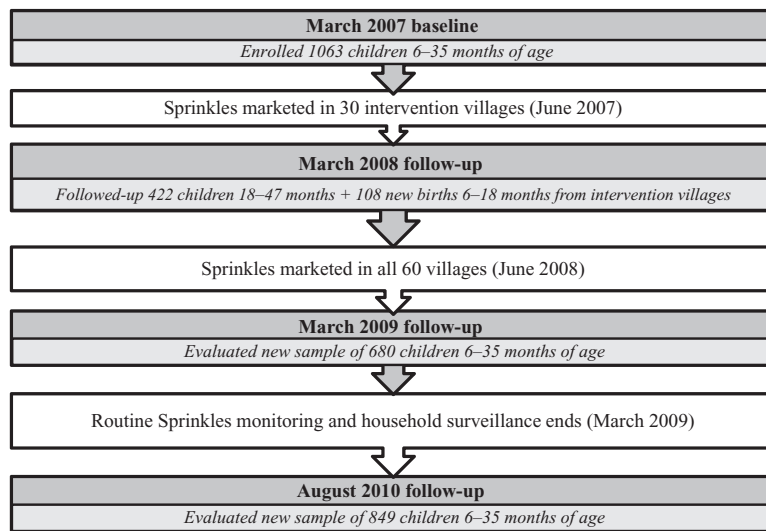
| **March 2007 baseline** |
| *Enrolled 1063 children 6–35 months of age* |

| Sprinkles marketed in 30 intervention villages (June 2007) |

| **March 2008 follow-up** |
| *Followed-up 422 children 18–47 months + 108 new births 6–18 months from intervention villages* |

| Sprinkles marketed in all 60 villages (June 2008) |

| **March 2009 follow-up** |
| *Evaluated new sample of 680 children 6–35 months of age* |

| Routine Sprinkles monitoring and household surveillance ends (March 2009) |

| **August 2010 follow-up** |
| *Evaluated new sample of 849 children 6–35 months of age* |

Fig. 1. Timeline of Sprinkles distribution and programme evaluation in Nyando Division, Kenya.

achieve health benefits) to families with children aged 6–59 months living in Nyando Division, a largely rural region within Nyanza Province in western Kenya that has approximately 80 000 people and 15 000 households. Details of the study are described elsewhere (CDC 2007; Suchdev *et al.* 2010, 2012).

Data collection and processing

Figure 1 shows the timeline of Sprinkles distribution in the study area and follow-up evaluations that were conducted in all 60 study villages as part of NICHE from 2007 to 2010. Sprinkles were first distributed by SWAP in July 2007, 3 months after a baseline survey of 1063 children aged 6–35 months that was conducted in both the intervention and the comparison communities. Extensive qualitative research was conducted prior to and during initial Sprinkles implementation (Jefferds *et al.* 2010). During the first year of the study, Sprinkles were only marketed and distributed in the 30 intervention villages as part of the cluster-randomised trial design. In March 2008, we measured the effects of Sprinkles sales on anaemia, iron deficiency and vitamin A deficiency. In addition to enrolling children aged 18–47 months followed from baseline, to account for ageing effects, we also enrolled new births aged 6–18 months from study households. In June 2008, Sprinkles sales were scaled-up to all 60 villages, and a repeat survey of

newly sampled children aged 6–35 months was conducted in March 2009. Between 2007 and 2009, NICHE study staff visited households every 2 weeks to monitor Sprinkles purchases and use. Following the March 2009 survey, SWAP assumed programmatic and monitoring and evaluation activities of Sprinkles that included ongoing promotion and marketing of Sprinkles in the study villages as well as monitoring of Sprinkles sales to vendors. External financial and technical support for the Sprinkles programme was no longer provided by the Centers for Disease Control and Prevention (CDC) or other international partners.

In August 2010, 18 months after programmatic activities by the outside agencies ended, and 42 months after the initial Sprinkles distribution in the intervention study area, a cross-sectional survey was conducted in the 60 study villages. Because we hypothesised that Sprinkles use had decreased and anaemia prevalence would have increased, sample size estimates were based on an estimated change in anaemia prevalence from 45% (March 2009) to 53% (August 2010). At a confidence level of 95%, power of 80%, design effect of 1.5 and non-response rate of 20%, the estimated sample size was 1150 children. Using a household census conducted in March 2009, 19 compounds were randomly selected per village. Lists of selected compounds were provided to the field team, and all children aged 6–35 months

living in these compounds were approached for enrolment.

Trained fieldworkers administered questionnaires to study participants' mothers to collect demographic and socio-economic data, exposure to Sprinkles marketing activities (at any point during the study period) and information on Sprinkles purchases and use. They also collected anthropometric measurements and capillary blood samples from a fingerstick for use in haemoglobin (Hb) measurements, malaria smear preparations and Microtainer® (Becton Dickinson, Franklin Lakes, NJ, USA) blood collection to assess iron and vitamin A status and the presence of inflammation among enrolled children. Details of the laboratory analysis are described elsewhere (Grant *et al.* 2012). Hb levels were measured in the field using HemoCue® (HemoCue, Inc. Cypress, CA, USA) photometers; children with $Hb < 11.0\,g\,dL^{-1}$ were classified as anaemic (McLean *et al.* 2009). Testing for the presence of malaria parasites and the level of parasitaemia was performed by the CDC laboratory in Kisian, Kenya. Frozen plasma samples were transported to a laboratory in Germany, which measured levels of ferritin, retinol-binding protein (RBP) and C-reactive protein (CRP) using a sandwich enzyme-linked immunosorbent assay technique (Erhardt *et al.* 2004). The following thresholds were used to define abnormal values for these biochemical indicators: $ferritin < 12\,\mu g\,L^{-1}$; $RBP < 0.7\,\mu mol\,L^{-1}$ and $CRP > 10\,mg\,l^{-1}$ (Erhardt *et al.* 2004). Approaches to account for the effect of infection or inflammation on ferritin and RBP levels include exclusion of individuals with inflammation based on elevated values of one or more acute-phase proteins (e.g. CRP) (WHO/CDC 2004), or use of correction factors to adjust for the effects of inflammation (Thurnham *et al.* 2003, 2010). In line with the current World Health Organization (WHO)/CDC recommendations, we excluded subjects with elevated CRP levels from analyses of the relationship between Sprinkles intake and levels of ferritin and RBP ($n = 146$, 63, 102 and 242 from each survey, respectively) (WHO/CDC 2004). For the purposes of this analysis, we used low ferritin as the indicator of choice for iron deficiency (WHO/CDC 2004).

In addition to the four cross-sectional surveys (Fig. 1), we also reviewed SWAP office records to calculate the number of distributed promotional items and the number of Sprinkles sachets that were sold wholesale to vendors.

Data management and analysis

Data cleaning and analyses were performed with SAS software (version 9.2; SAS Institute Inc., Cary, NC, USA) and SPSS (version 19; SPSS Inc., Chicago, IL, USA). We used the WHO Child Growth Standards (WHO Anthro, Geneva, Switzerland) to calculate z-scores and categorised underweight as weight-for-age z-score < -2, stunting as height/length-for-age z-score < -2 and wasting as weight-for-height/length z-score < -2. We divided participants into socio-economic quintiles on the basis of household asset scores calculated by assigning values to housing materials and household possessions (Gwatkin *et al.* 2007).

To evaluate the sustainability of the Sprinkles intervention, we compared the main findings from cross-sectional surveys in 2008, 2009 and 2010 using analysis of variance (ANOVA) for continuous variables and the Mantel–Haenszel chi-square test for linear trend for categorical variables. Primary outcomes included individual Sprinkles use and nutritional biomarkers. Covariates included both individual (age, gender) and household-level (attendance at promotional launches or trainings, receipt of promotional items, socio-economic status, maternal education and whether or not the household was part of the prior NICHE study) measures. We used logistic regression to identify factors associated with Sprinkles use. We also developed a model to determine variables that were associated with anaemia with primary exposures of interest including study year (to measure changes over time) and Sprinkles use. Models were adjusted for the following covariates using backward regression: age, gender, height-for-age z-score, inflammation, iron deficiency, vitamin A deficiency and malaria. Analyses were adjusted for clustering at the village-level. We considered P-values <0.05 to be indicative of significant differences between groups.

Ethical review

Ethical approval was obtained from the institutional review boards of the Kenya Medical Research Insti-

tute and the US CDC. This trial is registered at http://clinicaltrials.gov, identifier NCT01088958.

Results

August 2010 follow-up survey

A total of 1348 children were assessed for eligibility, and 882 were enrolled. Of the 466 children not enrolled, 57.7% were outside of the age range, 26.6% were not encountered on three attempted household visits, 7.1% did not receive parental consent and 8.6% were classified as other. An additional 33 children were excluded due to missing laboratory data, which led to a total of 849 children included in the final analysis. Demographic and health characteristics of children and households are depicted in Table 1. The mean age of children was 21.4 months, 50.4% were

Table 1. Characteristics of study population at August 2010 follow-up (*n* = 849)

Variable	*n*	Mean or %
Households		
No electricity (%)	834	98.2
Dung or mud walls (%)	808	95.2
Participated in NICHE study (%)	388	46.6
Mothers		
Age (years) (mean ± SD)	845	26.9 ± 7.8
Less than complete primary school education (%)	404	47.8
Children		
Male (%)	428	50.4
Age (months) (mean ± SD)	849	21.4 ± 8.3
Ever breastfed (%)	767	91.0
Currently breastfeeding (%)	425	54.6
Consumed tea in the last 24 h (%)	692	82.3
Hb (g dL^{-1}) (mean ± SD)	830	9.6 ± 1.9
Anaemic (Hb < 11.0 g dL^{-1}) (%)	595	71.7
Iron deficient (ferritin < 12 μg L^{-1})* (%)	150	25.9
Vitamin A deficient (RBP < 0.7 μg L^{-1})* (%)	99	17.1
Malaria positive (%)	268	32.6
Fever in last 24 h (%)	230	27.3
Stunted (HAZ < −2) (%)	253	30.1
Wasted (WHZ < −2) (%)	31	3.7
Underweight (WAZ < −2) (%)	105	12.5

CRP, C-reactive protein; HAZ, height-for-age *z*-score; Hb, haemoglobin; NICHE, Nyando Integrated Child Health and Education Project; RBP, retinol-binding protein; SD, standard deviation; WAZ, weight-for-age *z*-score; WHZ, weight-for-height *z*-score. *Only includes *n* = 579 children with CRP ≤ 10 mg L^{-1}.

male and nearly three out of four were anaemic. Nearly 50% of children resided in households that had previously participated in household monitoring as part of the NICHE study.

Comparison to prior evaluations

Table 2 compares Sprinkles use and marketing efforts in the study area from 2007 to 2010. Results shown are from cross-sectional surveys in all 60 study villages, except for the March 2008 follow-up survey, which only included children from the 30 intervention villages to facilitate comparisons of those who had the potential to receive the intervention in each of the years. Sprinkles awareness among households was consistently high throughout the study period at 95% or higher. However, Sprinkles use declined between the March 2008, March 2009 and August 2010 follow-up evaluations, whether measured as ever used (*P* < 0.001), used in the last 24 h (*P* < 0.001) or used in the last 7 days (*P* < 0.001). The mean number of sachets consumed per week decreased from 3.2 sachets week^{-1} at the initial March 2008 follow-up to 1.6 sachets week^{-1} in March 2009 to 1.1 sachets week^{-1} in August 2010 (ANOVA *P* < 0.001). Similarly, average Sprinkles use among those reporting ever use decreased from 3.2 sachets week^{-1} in 2008 to 2.2 sachets week^{-1} in 2009 to 1.8 sachets week^{-1} in 2010 (ANOVA *P* < 0.001).

Between 41% and 44% of households reported visits by SWAP vendors in the period prior to the survey, with no significant difference between study years (*P* = 0.57). There was variability in receipt of Sprinkles marketing and promotional items during the study period. While there was a significant decrease in ever receiving a Sprinkles calendar (*P* < 0.001), there were no decreases in receiving a brochure or cup. Reports of attending a Sprinkles promotional launch did not change over the time period (from 34% to 42%). Reported affordability of Sprinkles remained high (71–82%). The most commonly reported barriers to giving Sprinkles to children in the study areas were cost, loose stools or diarrhoea, parents forgetting and increase in appetite. There was an increase in the barrier related to parents forgetting to give Sprinkles (*P* < 0.001).

Table 2. Sprinkles use and marketing in Nyando Division, 2007–2010

	March 2007 baseline	March 2008 follow-up[†]	March 2009 follow-up	August 2010 follow-up
Children				
Sample size	1063	530	680	849
Male gender	51.7	50.4	50.7	50.4
Age (mean)[‡]	19.9 ± 8.5	29.1 ± 11.7	21.0 ± 9.2	21.4 ± 8.3
Ever used Sprinkles**	–	87.5	72.4	59.3
Used Sprinkles in the last 24 h**	0.3	37.0	21.0	11.2
Used Sprinkles in the last 7 days**	–	64.9	34.9	21.9
Mean # sachets consumed week^{-1}[‡]	–	3.2 ± 2.9	1.6 ± 2.5	1.1 ± 2.4
Households				
Heard about Sprinkles	9.7	98.3	94.8	95.0
Visited by SWAP	2.2	42.2	44.0	41.1
Ever purchased Sprinkles from SWAP*	–	38.4	36.0	31.7
Ever received calendar**	–	69.0	60.3	54.5
Ever received brochure	–	28.7	25.2	30.4
Ever received cup*	–	50.6	72.9	60.8
Attended promotional launch	–	41.7	34.4	41.9
Perceived Sprinkles affordable	–	82.0	71.0	76.5
Perceived barrier – cost*	–	28.2	31.1	22.9
Perceived barrier – diarrhoea**	–	13.8	6.0	3.8
Perceived barrier – parents forget**	–	11.5	20.4	22.3
Perceived barrier – increase appetite	–	4.9	4.1	3.7

ANOVA, analysis of variance, SWAP, Safe Water and AIDS Project. *Chi-square trend for 2008–2010, $P < 0.05$; **$P < 0.001$. [†]FU1 only includes children from 30 intervention villages, both those followed up from the initial baseline cohort ($n = 422$) and new births from those same households ($n = 108$). [‡]ANOVA for 2008–2010, $P < 0.001$.

Using SWAP office records, the number of promotional items and wholesale Sprinkles sales to vendors in intervention villages were categorised by study period (year 1: 30 July, 2007–30 March, 2008; year 2: 1 April, 2008–30 March, 2009; year 3: 1 April, 2009–3 September, 2010). There were decreases in both the number of calendars and t-shirts that were distributed in year 1 (10 879 calendars and 248 t-shirts), year 2 (4278 calendars and 78 t-shirts) and year 3 (95 and 55 t-shirts). A majority (69.3%) of cups were distributed in year 2. The total number of Sprinkles sachets sold to SWAP vendors decreased from 127 910 in year 1 to 84 582 in year 2 and 32 639 in year 3.

Association of promotional items and Sprinkles use

Given the decreased Sprinkles use at the August 2010 follow-up, we aimed to evaluate factors associated with Sprinkles use. Table 3 shows the unadjusted and adjusted odds of Sprinkles use in the last 7 days among the 819 children without any missing covariate values. Factors associated with recent Sprinkles use included age 6–23 months compared with 24–35 months [adjusted odds ratio (aOR) = 1.5, 95% confidence interval (CI) = 1.1–2.2]; lowest 2 quintiles of socio-economic status (aOR = 1.7, 95% CI = 1.2–2.4), attendance at trainings or launches (aOR = 2.8, 95% CI = 1.9–4.2) and receipt of promotional items including brochures, calendars, cups, stickers and t-shirts (aOR = 1.7, 95% CI = 1.02–2.9). Child's gender, maternal education and whether or not the household was part of prior study monitoring were not associated with recent Sprinkles use. Multivariate analysis looking at factors associated with ever Sprinkles use resulted in similar findings, with attendance at trainings or launches (aOR = 2.7, 95% CI = 1.9–3.8) and receipt of promotional items (aOR = 2.7, 95% CI = 1.9–3.9) associated with Sprinkles use. However, older age (24–35 months compared with 6–23 months, aOR 2.8, 95% CI = 2.0–4.0) was also associated with ever Sprinkles use.

Table 3. Factors associated with recent Sprinkles use at August 2010 follow-up

Variable	Sprinkles use in the past 7 days (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Gender			
Female	22.1	–	NA
Male	21.7	1.0 (0.7–1.4)	–
Age*			
6–23 months	25.4	1.6 (1.1–2.2)	1.5 (1.1–2.2)
24–35 months	17.8	–	–
SES*			
Quintiles 1–2	25.2	1.4 (0.98–1.5)	1.7 (1.2–2.4)
Quintiles 3–5	19.8	–	–
Maternal Education			
None to some primary school	21.3	–	NA
Completed primary school or greater	22.7	1.1 (0.8–1.5)	–
Attended launch*			
No	14.0	–	–
Yes	33.3	3.1 (2.2–4.3)	2.8 (1.9–4.2)
Received promotional item*			
No	12.0	–	–
Yes	25.6	2.5 (1.6–3.9)	1.7 (1.02–2.9)
Prior NICHE household			
No	18.7	–	–
Yes	25.6	1.5 (1.1–2.1)	1.1 (0.8–1.7)

CI, confidence interval; NA, not applicable; NICHE, Nyando Integrated Child Health and Education Project; OR, odds ratio; SES, socioeconomic status, where quintile 1 is lowest. *Logistic regression $P < 0.05$, adjusted for cluster sampling; $n = 819$ in the final model.
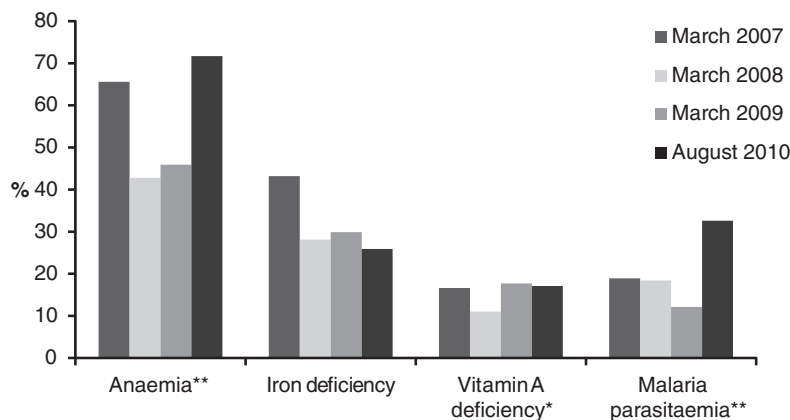

Fig. 2. Nutritional biomarkers among preschool children by year, Nyando Division, Kenya. Data represent $n = 1063$ (aged 6–35 months), 530 (aged 6–47 months), 680 (aged 6–35 months) and 849 (aged 6–35 months) in each survey; analysis of iron deficiency and vitamin A deficiency only includes $n = 755, 427, 575, 579$ children with C-reactive protein ≤ 10 mg L^{-1}. *Chi-square trend from 2008 to 2010 $P < 0.05$; **$P < 0.001$.

Associations with nutritional biomarkers

We compared the prevalence of anaemia, iron deficiency, vitamin A deficiency and malaria parasitaemia by study year (Fig. 2). Approximately 66% of children were anaemic at baseline, 42.8% were anaemic in 2008, 45.9% were anaemic in 2009 and 71.7% were anaemic in 2010, with a significant trend of anaemia increase from 2008 to 2010 ($P < 0.001$). Logistic regression adjusting for age showed increased odds of anaemia in 2010 compared with 2008 (aOR = 2.8, 95% CI = 2.2–3.5). Multivariate analysis adjusting for age, gender, height-for-age z-score, inflammation, iron deficiency, vitamin A deficiency and malaria showed a

significant association between study year and anaemia ($P < 0.001$). Adding village type (e.g. original intervention vs. control village) to this model did not significantly change the relationship (data not shown). Although there were improvements in iron deficiency and vitamin A deficiency from baseline to the 2008 follow-up, there was no significant difference in iron deficiency ($P = 0.36$), and an increase in vitamin A deficiency ($P = 0.02$) from March 2008 to August 2010. There was a significant increase in the prevalence of malaria by study year with 18.4% in 2008, 12.1% in 2009 and 32.6% in 2010 ($P < 0.001$). Changes in iron deficiency, vitamin A deficiency and malaria by study year were independent of age.

Despite decreases in Sprinkles use and increases in anaemia at the August 2010 follow-up, Sprinkles use was associated with lower prevalence of iron deficiency, with 33.2% iron deficiency among those never using Sprinkles, compared with 24.4% iron deficiency among those ever using Sprinkles ($P = 0.03$). While there was less vitamin A deficiency among those who ever used Sprinkles (15.7%), compared with those who never used Sprinkles (20.2%), this difference was not significant ($P = 0.17$). The association between Sprinkles use and anaemia or mean Hb concentration did not achieve statistical significance. The association between Sprinkles use and anaemia across the study period, adjusting for covariates, approached significance (aOR = 0.78, $P = 0.055$).

Discussion

Despite initial success of community-based distribution of Sprinkles in western Kenya, we found that there was a decrease in the use of Sprinkles and an increase in the prevalence of anaemia, vitamin A deficiency and malaria, 18 months after study-related marketing and household monitoring efforts ended. Attendance at trainings or launches and receipt of promotional items including free Sprinkles, calendars, cups and t-shirts were associated with Sprinkles use at follow-up. These findings suggest that ample promotion and marketing efforts may be important factors for programme sustainability.

To our knowledge, this is the first study of sustainability of MNP distribution. Most of the evidence of MNPs come from short-term efficacy studies, lasting 2–12 months in duration and in controlled settings (De-Regil *et al*. 2011). As countries begin scaling-up MNP programmes, whether through facility-based, community-based or market-based distribution, it is important to evaluate what factors are associated with sustainability.

Key components of programme sustainability include addressing the health concerns of a population, programme elements and drivers of the programme, each influenced by the sociopolitical context and availability of resources (Gruen *et al*. 2008; Scheirer 2005). In our study, perceived benefits of Sprinkles or changes in the health status of the population were unlikely contributing factors of sustainability; in fact, awareness and demand of Sprinkles remained high in the community. At the 2010 follow-up, 95% of households with young children had heard of Sprinkles and nearly one-third had ever purchased Sprinkles from SWAP. However, programme components, such as the lack of a steady Sprinkles supply, were likely important factors. The Sprinkles supply was interrupted twice in 2008 due to the time-consuming process of ordering and shipping from a foreign producer, coupled with expiration of the sachets 2 years from production. Complicated importation procedures and import taxes were also barriers. The lack of drivers, or a government champion of the programme to create an enabling policy and regulatory environment, may have also limited sustainability. SWAP was discouraged from pursuing Sprinkles distribution outside of a research context due to changes in international iron supplementation policy, which in 2007 recommended stopping iron supplementation of children under 2 years of age in malarial areas without first screening individuals for iron deficiency (WHO Secretariat on behalf of the participants to the Consultation 2007). These international recommendations made it difficult for SWAP and other implementing organisations in Kenya to advocate for scaling-up the programme. Although SWAP initially planned to utilise funds raised from sales of Sprinkles to supplement purchases after the study ended, the policy environment prevented them from doing so. In addition, once the formal study ended, there was no plan

or resources for local production or continued importation of Sprinkles.

The increase in anaemia prevalence at follow-up may have been largely due to the increased prevalence of malaria, rather than nutritional effects from decreased Sprinkles use. To our knowledge, there were no changes in malaria control efforts in the study area, including ITN use, which remained high during the study period (89–93%). CDC recently reported on similar increases in malaria and anaemia rates in 2008 compared with 2005–2007 in western Kenya, despite high ITN use, which may be explained by antimalarial drug stock-outs or seasonality (Hamel *et al.* 2011). Even with decreased use of Sprinkles and increased anaemia, there remained an association between Sprinkles use and iron deficiency, suggesting that there was still an impact among those who used Sprinkles.

Affordability did not appear to be a major factor in the use of Sprinkles. In fact households from the lower 2 quintiles of socio-economic status were more likely to have recently used Sprinkles, compared with those in the top 3 quintiles, suggesting that the intervention reached even the poorest of the poor. This was likely due to the low cost of Sprinkles, both the wholesale price to vendors and the retail price to users. In China, a soy-based MNP, Ying Yang Bao, was sold at a much higher retail price ($0.15) and accordingly purchases were lower at 13.5% (Sun *et al.* 2011).

The minimal level of promotion and marketing needed to maintain adequate levels of Sprinkles purchases and use is unknown. The costs associated with the purchase and promotion of Sprinkles by SWAP in this study was quite high, compared with the income received from sales. For example, during the first year of the study, even though the Sprinkles sachets were donated, it still cost approximately $2000 for Sprinkles import and shipping, $10 000 for promotional materials and $6000 for launches (net $18 000). SWAP only earned approximately $1300 from Sprinkles sales, resulting in a net loss of $16 700. Furthermore, these costs do not include start-up costs, such as the qualitative research that determined appropriate messaging, packaging, willingness to pay, and consumer and vendor incentives (Suchdev *et al.* 2010;

Jefferds *et al.* 2010). If market-based distribution of Sprinkles is continued and/or taken to scale, it will be important to annually budget for recurrent costs of social marketing and promotions to ensure that Sprinkles remain affordable.

This study had limitations. First, we evaluated a pilot Sprinkles distribution programme that was limited to a single division in western Kenya. Evaluating the sustainability of a similar market-based Sprinkles distribution model on a larger scale is important to determine whether the findings of this study are applicable to a broader population. Second, this analysis only included cross-sectional surveys of households in study villages, and the primary outcomes of Sprinkles use and marketing activities may have been better measured using longitudinal data. Third, the three follow-up studies used to describe sustainability may not be comparable. For example, data from the 30 intervention villages in the 2008 survey, which included follow-up of children aged 18–47 months and new births aged 6–18 months from study households, may not be representative of the underlying population. To account for the different ages of these children compared with those in the 2009 and 2010 surveys, analyses were adjusted for age. Also, most of the children who were lost to follow-up migrated outside the study area to escape the political violence following Kenyan elections, and baseline characteristics of the 2008 sample were similar to those lost to follow-up. Finally, it was difficult to separate the effects of ceasing study-related household monitoring (e.g. Hawthorne effect) vs. reduced marketing efforts on Sprinkles use at the 2010 follow-up. Adjusted analysis showed that whether or not households were part of the prior study monitoring was not associated with Sprinkles use.

In conclusion, market-based community distribution of Sprinkles could be an effective way to control childhood anaemia and improve iron and vitamin A deficiency, provided that factors such as an enabling policy environment, stakeholder support and investment in promotion and marketing activities are incorporated into the programme. Furthermore, attention to issues related to the safety of Sprinkles in malarial areas and regulations for local Sprinkles production or importation may help facilitate the

implementation and sustainability of future Sprinkles programmes in Kenya.

Conflicts of interest

The authors have no financial relationships or conflicts of interest to disclose.

Contributions

PSS and LJR designed the study; PSS, AS, MDJ, AE, MP and LJR and supervised the fieldwork; PSS analyzed the data, wrote the manuscript and had primary responsibility for the final content. All authors read and approved the final manuscript. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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