Home gardens focusing on the production of yellow and dark-green leafy vegetables increase the serum retinol concentrations of 2–5-y-old children in South Africa[1–3]

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ABSTRACT

Background: Production of yellow and dark-green leafy vegetables at the household level may provide economically deprived households with direct access to provitamin A–rich foods.

Objective: The aim of the study was to determine whether the dietary intake of yellow and dark-green leafy vegetables and the serum retinol concentrations of children improve with a home-gardening program.

Design: A home-gardening program was integrated with a community-based growth-monitoring system in a rural village. Cross-sectional data were collected at baseline and 20 mo after implementation of the program. The dietary intake, serum retinol concentrations, and growth of 2–5-y-old children and maternal knowledge regarding vitamin A were determined. A neighboring village served as a control village.

Results: In the experimental village, 126 home gardens were established, representing approximately one-third of the households. Serum retinol concentrations in the experimental village increased significantly ($P = 0.0078$), whereas those in the control village decreased significantly ($P = 0.0148$). At follow-up, children from the experimental village consumed yellow and dark-green leafy vegetables more often and had significantly higher ($P = 0.005$) serum retinol concentrations (0.81 ± 0.22 μmol/L; $n = 110$) than did children from the control village (0.73 ± 0.19 μmol/L; $n = 111$). Maternal knowledge regarding vitamin A improved significantly in the experimental village ($P = 0.001$).

Conclusion: A home-gardening program that was integrated with a primary health care activity, linked to nutrition education, and focused on the production of yellow and dark-green leafy vegetables significantly improved the vitamin A status of 2–5-y-old children in a rural village in South Africa. *Am J Clin Nutr* 2002;76:1048–54.

KEY WORDS Home gardens, yellow and dark-green vegetables, vitamin A, rural South Africa, preschool children, serum retinol, dietary intake

INTRODUCTION

Vitamin A deficiency continues to be a major health problem in developing countries and has far-reaching consequences on growth, development, and health, especially in children. The dietary intakes of economically and socially deprived communities in developing countries usually consist of plant-based staple foods, and fruit, vegetables, and animal products are seldom consumed, predisposing these communities to low vitamin A intakes. Although clinical vitamin A deficiency in South Africa is not a problem, as it is in some of the other sub-Saharan countries, 1 in 3 preschool children has a serum retinol concentration <0.7 μmol/L, and children from rural areas are affected the most (1).

Supplementation with high-dose capsules, food fortification, and food diversification strategies are used to combat vitamin A deficiency. Foods of animal origin are good sources of vitamin A, but they are often too expensive for poor households to afford. Local production of fruit and vegetables may potentially provide households with direct access to foods that are rich in provitamin A carotenoids. For example, in Bangladesh, locally produced fruit and vegetables that are rich in provitamin A provide a valuable contribution to vitamin A intake in communities where alternative dietary sources of vitamin A are scarce (2).

Strategies focusing on food diversification aim to increase the production and availability of, access to, and subsequent consumption of foods that are rich in vitamin A and provitamin A carotenoids. Home-garden interventions are most effective when combined with promotional and educational interventions (3). The problem in many rural areas in South Africa, and probably in many other African countries, is a lack of infrastructure for the implementation and promotion of sustainable gardening programs that are aimed at addressing specific nutritional needs. To overcome this problem, we integrated a home-gardening program with a primary health care activity, namely, a community-based growth-monitoring system in a rural area in KwaZulu-Natal, South Africa. The aim of the gardening program was to address the vitamin A deficiency prevalent in the area (4) by promoting the production and consumption at the household level of foods that are rich in provitamin A carotenoids. The community-based growth-monitoring system provided the infrastructure that was needed for relevant nutritional education, home-gardening promotion, and training in agricultural activities.

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In this study we determined whether the home-gardening program improved the dietary intakes of yellow and dark-green leafy vegetables and the serum retinol concentrations of 2–5-y-old children from this area. Growth and maternal knowledge regarding vitamin A were assessed as secondary outcomes.

SUBJECTS AND METHODS

Study area

The study was carried out in Ndunakazi, a mountainous rural village that is ≈60 km northwest of the coastal city of Durban in KwaZulu-Natal, South Africa. Most of the population has a low socioeconomic status. A situation analysis conducted in 1995 showed that extensive micronutrient deficiencies were prevalent in this community (4). Before the implementation of the home-gardening program, some vitamin A–rich crops (pumpkin and *imifino*) were produced locally, but the quantity that was grown and eaten was low. *Imifino* is a collection of various dark-green leaves that is eaten as a vegetable; the leaves either grow wild or come from vegetables such as pumpkin and beetroot. A survey of primary school children in this area showed that their diet was comprised of a few food items and was deficient in most of the micronutrients and that fruit and vegetable consumption was low (5).

There are no health care facilities in the area, except for a mobile clinic that is scheduled to visit the area once or twice a month. The poor transport system makes it difficult for mothers to attend the nearest clinic, which is ≈18 km away. Until 1994, the growth of most preschool children was monitored only on immunization dates. In 1995, the lack of health facilities within the area prompted the establishment of a community-based growth-monitoring program (6). The program is run by nutrition monitors (local persons specifically trained for the project) through home-based centers (named *Isizinda*). As part of their contribution to the program, families make their homes available on a voluntary basis once a month to serve as growth-monitoring points. Since 1999, the community-based growth-monitoring program has been used as a focal point for promoting the local production and consumption of provitamin A–rich foods. The *Isizinda* also served as demonstration and training centers for the agricultural activities.

Study design

The home-gardening program was preceded by a period of sensitization and skill development. The serum retinol concentrations and food consumption of 2–5-y-old children were determined at baseline during a cross-sectional survey. Twenty months after implementation of the program, another cross-sectional survey including all 2–5-y-old children was done. A neighboring village that is under the same tribal authority served as a control village. The control village had the same community-based growth-monitoring system as that of the experimental village but no household food production or promotion program.

The study was approved by the Ethics Committee of the South African Medical Research Council, and permission was obtained from local community leaders. Written informed consent was obtained from the mother or guardian of each participant after a detailed explanation of the purpose of the study.

Sensitization and skill development

Information obtained during a situation analysis (4) was used during a workshop that was attended by community representatives. An objective-oriented project-planning process (7) was used to facilitate the formulation of the intervention. A garden committee was established, and together with nutrition monitors, they formed a food garden production forum.

The chairperson of the food garden production forum and 4 nutrition monitors attended a 5-d training course presented by the Agricultural Research Council. Additional on-the-job training was done as a continuous process. An advisor from the Agricultural Research Council visited the area during critical production phases in the vegetable production season.

Intervention

A demonstration garden was established at each of the 9 *Isizinda* in the experimental village. Butternut squash, carrots, orange-fleshed sweet potatoes, and spinach were planted, and each garden had a pawpaw tree. The production and consumption of pumpkin and *imifino* were promoted, but these 2 crops were not planted in the demonstration gardens because they were already produced locally.

The demonstration gardens served as training centers. The children's caregivers were trained by the nutrition monitors. They were encouraged to plant the yellow and dark-green leafy vegetables in addition to the crops that they were already planting. Staggered planting, cyclic production, and crop rotation were promoted to ensure an adequate supply of provitamin A–rich foods throughout the year. The progress of the home gardens was monitored continuously by the nutrition monitors.

The nutritional education component of the food production program at the *Isizinda* in the experimental village focused on the relation between vitamin A and health, the identification of vitamin A–rich foods, cooking methods, and the importance of a home garden as source of vitamin A–rich foods. Vegetables that were produced locally in the demonstration gardens were cooked at the *Isizinda* on the days during which growth was monitored. The grating of carrots, the addition of a little fat, and, for small children, the mashing of vegetables were recommended.

Evaluation

A cross-sectional survey that included all 2–5-y-old children was carried out at baseline. Twenty months after implementation of the program, another cross-sectional survey including all 2–5-y-old children was done. It was calculated that 70 children per village were needed to show a significant difference of 0.105 μmol/L at a 5% significance level and with 80% power. The expected differences were based on the outcomes of a previous randomized placebo-controlled trial in which fortified biscuits were used as part of a school feeding program to address iron and vitamin A deficiencies in the area (8).

Sampling

Baseline. Before the implementation of the food production program, all 2–5-y-old children who attended growth-monitoring sessions at the *Isizinda* were recruited. At the time of the survey, there were 8 *Isizinda* in the experimental village and 3 *Isizinda* in the control village. Sociodemographic information was collected by questionnaire, blood samples were collected, anthropometric measurements were taken, and dietary intake was recorded. In the experimental village, of the 129 children who were recruited, 110 attended the blood-drawing sessions. Blood could not be obtained from 3 children, and serum retinol concentrations were therefore measured in 107 children. The sociodemographic questionnaire was completed for 97 households. In the control village, of the 85 children who were recruited, 60 attended the blood-drawing sessions. Blood could not be obtained from 2 children, and serum retinol concentrations were therefore measured in 58 children. The sociodemographic questionnaire was completed for 48 households.

Follow-up survey: November 2000. At the time of the follow-up survey, there were 9 *Isizinda* in the experimental village and 4 *Isizinda* in the control village. For the follow-up cross-sectional survey, all 2–5-y-old children who attended growth-monitoring sessions were recruited. In the experimental village, of the 127 children who were recruited, 114 attended the blood-drawing sessions. Blood could not be obtained from 4 children, and serum retinol concentrations were therefore measured in 110 children. Of these children, 84% were from households with a project garden. The questionnaire was not completed for 13 children because their caregivers could not provide the necessary information. In the control village, of the 113 children who were recruited, 111 attended the blood-drawing sessions. The questionnaire was not completed for 18 children because their caregivers could not provide the necessary information.

Questionnaire

The mother or principal caregiver (a member of the household, usually the grandmother, who cared for the child during the day) was interviewed in her native language by a nutrition monitor using a structured questionnaire that was compiled according to the guidelines of Gross et al (9). The questionnaire was designed to collect information on socioeconomic and demographic characteristics (only at baseline), the health status of the child, and the mother's knowledge and practices related to vitamin A nutrition. For the purpose of this study, the following variables were used to calculate a knowledge score, which could range from 0 to 5: *1*) identification of 3 foods that are rich in vitamin A (1 point for each correct food item), *2*) the color of foods that are rich in vitamin A [green or orange or yellow (0.5 points) or green and orange or yellow (1 point)], and *3*) one symptom that may be related to vitamin A deficiency (1 point for a correct answer). During the follow-up survey, questions related to the project gardens were included for the experimental village only.

Blood sampling and serum retinol analysis

Blood (5 mL) was obtained by antecubital venipuncture performed by a pediatrician. The blood was centrifuged immediately after collection, and the serum was stored at $-80\,^{\circ}C$ until analyzed. Serum retinol was determined by using a modified version of the reversed-phase HPLC method described by Catignani and Bieri (10).

Anthropometry

While the children wore light clothing and no shoes, their weight was measured with the use of a load cell–operated digital scale (UC-300 Precision Health Scale; A&D Co Ltd, Tokyo) and was recorded to the nearest 0.05 kg. The children's height was measured while they were not wearing shoes with the use of a wooden height board fitted with a measuring tape and a movable headpiece and was recorded to the nearest 0.1 cm. The date of birth was obtained from either the *Isizinda* records or the child's clinic card. Each child's anthropometric data and age were used to obtain 3 measures of nutritional status: height-for-age, weight-for-age, and weight-for-height. The anthropometric data were analyzed with EPI-INFO 2000 (Centers for Disease Control and Prevention, Atlanta) with the use of National Center for Health Statistics (NCHS) reference data (11) and were expressed as z scores for each of the anthropometric indexes of malnutrition. Children were defined as *1*) stunted or chronically undernourished if their height-for-age z score was > 2 SD below the median of the NCHS reference data, *2*) underweight if their weight-for-age z score was > 2 SD below the median of the NCHS reference data, *3*) wasted or acutely malnourished if their weight-for-height z score was > 2 SD below the median of the NCHS reference data, and *4*) overweight if their weight-for-height z score was > 2 SD above the median of the NCHS reference data.

Dietary intakes

The children's habitual intake of specific food items, especially animal products and fruit and vegetables that are rich in provitamin A, was determined by a questionnaire administered to their caregivers. The frequency of the children's consumption of prespecified food items during the past month was recorded; the participants had a choice of 5 options: *1*) every day, *2*) most days (not every day but ≥ 4 d/wk), *3*) once a week (< 4 d/wk but ≥ 1 d/wk), *4*) seldom (< 1 d/wk), and *5*) never.

The caregivers were asked how much they and the children liked the foods promoted by the home-gardening program. They had a choice of 3 options: *1*) like it, *2*) indifferent, and *3*) do not like it.

Statistical analysis

The data were analyzed with the use of univariate and frequency analysis performed with the SAS statistical package (version 6.12; SAS Institute Inc, Cary, NC). The data for the 2 villages were analyzed with a two-factor analysis of variance with interaction, including area (experimental and control villages) and time (baseline and follow-up) as the main effects. If the interaction was significant, means were compared individually between the 2 areas at a specific time (baseline and follow-up) and over time within an area by using a t test.

In addition, the data for the serum retinol concentrations of the children in the experimental area 20 mo after the implementation of the program were divided into 2 groups: those from children with project gardens and those from children without project gardens. The difference in serum retinol concentrations between the control area, the experimental area with project gardens, and the experimental area without project gardens was analyzed with analysis of variance. The main variable showed a significant effect, and the data were further tested by using Tukey's post hoc analysis.

For categorical data, differences in proportions were tested by using two-factor analysis of variance with interaction, including area and time as the main effects. If the interaction was significant, proportions were compared individually between the 2 areas at a specific time (baseline and follow-up) and over time within an area by using a chi-square test or, if a cell had < 5 observations, Fisher's exact two-tailed test. $P < 0.05$ was considered significant.

RESULTS

Sociodemographic information

At baseline, sociodemographic information was collected from 97 households in the experimental village and 48 households in

TABLE 1
Sociodemographic information on the households represented in the baseline survey

	Experimental village (n = 97)	Control village (n = 48)
Household size (n)		
Total	8 ± 3[1]	8 ± 3
Females	4 ± 2	4 ± 2
Males	3 ± 2	4 ± 2
Adults	4 ± 2	4 ± 2
Schoolchildren	3 ± 2	2 ± 2
Preschool children	2 ± 1	2 ± 1
Unemployed adults	2 ± 1	3 ± 2
Toilet facilities (%)[2]		
Pit toilet	89	65
None	11	35
Source of drinking water (%)[3]		
River	2	19
Tap[4]	91	73
Piped	7	8
Electricity (%)[2]	84	52

[1] $\bar{x}$ ± SD.
[2,3] There was a significant difference between the villages: [2] P = 0.001, [3] P = 0.002.
[4] Their own, a neighbor's, or a public tap.

TABLE 2
Percentage of children who consumed provitamin A–rich vegetables at least once a week during the month before the surveys at baseline and at 20 mo after implementation of a home-gardening program

	Experimental village	Control village	P
	%	%	
Carrots			
Baseline	22	26	NS
Follow-up	90[1]	20	0.001
Pumpkin or butternut squash			
Baseline	77	65	0.034
Follow-up	79	26[1]	0.001
Spinach			
Baseline	56	23	0.001
Follow-up	94[1]	67[1]	0.001
Imifino			
Baseline	68	77	NS
Follow-up	92[1]	59[2]	0.001

[1,2] Significantly different from baseline: [1] P = 0.001, [2] P = 0.021.

the control village. This sociodemographic information is summarized in **Table 1**. Although the 2 neighboring villages were under the same tribal authority, fewer households in the control village had access to pit toilet facilities and tap water. Although 84% and 52% of households in the experimental and control villages, respectively, had electricity available, most households (>75%) in both villages used wood as the energy source to cook food on an open fire inside the dwelling.

Project gardens

After the onset of the study, the number of project gardens gradually increased, and at the time of the follow-up survey, there were 126 project gardens (demonstration gardens included), of which 54% belonged to households with preschool children. It is estimated that at the time of the follow-up survey, approximately one-third of all households had a project garden.

Most (86%) of the households with project gardens used water from a tap to water the garden, 12% used water from the river, and 2% used water from a borehole. The major problems experienced by the garden caretakers were the destruction of vegetables by goats (60%) and the presence of insects (54%). Fifteen percent of the households reportedly experienced no major problems with the gardens.

When asked what difference the project gardens made to the household, 33% of the respondents appreciated the fact that they did not have to buy vegetables, 21% related the gardens to poverty alleviation, and the remaining 46% gave a variety of answers. Although home gardening has the potential to be a source of additional income, food security was the first priority of the households, and only 8% of the households with project gardens sold some of the produce for cash.

Knowledge regarding vitamin A

Food sources

The caregivers were asked to name 3 foods that are good sources of vitamin A. At baseline, 21% and 59% of the caregivers in the experimental and control villages, respectively, said they did not know any such foods. At follow-up, these figures dropped to 5% and 22%, respectively. In the experimental village, the proportion of caregivers that could name 3 food sources that are rich in vitamin A increased significantly from baseline to follow-up (from 26% to 71%; P = 0.0001). At follow-up, the proportion of caregivers that could name 3 food sources of vitamin A was significantly higher in the experimental village than in the control village (71% compared with 18%; P = 0.001).

Color of vitamin A–rich fruit and vegetables

At follow-up, significantly more caregivers in the experimental village than in the control village related yellow and green (the Zulu language does not distinguish between light and dark green) with foods rich in vitamin A (82% compared with 15%; P = 0.001).

Symptoms related to vitamin A

The caregivers were asked to name one symptom that may be related to a lack of vitamin A in the diet. At baseline, 46% of caregivers in the experimental village and 19% in the control village could name one correct symptom. At follow-up, significantly more caregivers in the experimental village than in the control village could name one correct symptom (74% compared with 27%; P = 0.001).

Maternal knowledge score

At baseline, the mean (± SD) maternal knowledge score in the experimental village was 2.3 ± 1.6, whereas that in the control village was 1.2 ± 1.5 (P = 0.0001). Between baseline and follow-up, there was a significant increase in maternal knowledge scores in the experimental village (P = 0.0001), whereas scores did not change significantly in the control village. At follow-up, the score in the experimental village was 4.2 ± 1.4, whereas that in the control village was 2.0 ± 1.5 (P = 0.0001).

Habitual dietary intake

The percentage of children who consumed provitamin A–rich vegetables at least once a week during the month before the baseline and follow-up surveys is shown in **Table 2**. At follow-up,

TABLE 3
Percentage of caregivers at the time of the follow-up survey who listed a particular fruit or vegetable as being among the 3 fruits or 3 vegetables that their children ate the most

	Experimental village (n = 108)	Control village (n = 100)
	%	
Fruit		
Banana	97	95
Orange	94	94
Apple	92	92
Pear	13	11
Peach	2	3
Pawpaw	1	0
Vegetables		
Spinach	85	34
Carrots	80	21
Butternut squash	43	4
Imifino	30	24
Cabbage	29	89
Potato	23	72
Pumpkin	3	3
Green beans	3	0
Orange-fleshed sweet potato	2	0
Green pepper	1	0
Beetroot	1	1
Brinjal	1	0
Beans	0	25
Tomato	0	19
Onions	0	1
White sweet potato	0	1

significantly more children in the experimental village than in the control village consumed carrots (P = 0.001), pumpkin or butternut squash (P = 0.001), spinach (P = 0.001), and *imifino* (P = 0.001). The orange-fleshed sweet potato was not available in the area before the intervention; at follow-up, 19% of the children in the experimental village consumed it at least once a week, whereas none of the children in the control village did.

During the follow-up survey, each child's caregiver was asked to name the 3 fruits and 3 vegetables that the child ate the most. These fruits and vegetables are listed in **Table 3**. The yellow fruit and vegetables and dark-green leafy vegetables that were promoted were well accepted, with the exception of pawpaw, which was disliked by 25% of the respondents.

Nutritional status of the children

Serum retinol concentrations

The serum retinol concentrations of the children at baseline and at follow-up are shown in **Table 4**. From baseline to follow-up, serum retinol concentrations increased significantly in the experimental village (P = 0.0078) but decreased significantly in the control village (P = 0.0148). At follow-up, the children from the experimental village had significantly (P = 0.0050) higher serum retinol concentrations than did the children from the control village. Among the children from the experimental village, those from households without a project garden (n = 27) had significantly lower serum retinol concentrations than did those from households with a project garden (n = 83) (0.72 ± 0.02 compared with 0.84 ± 0.21 μmol/L; P = 0.0197) and had concentrations similar to those of the children from the control village. In the experimental village, the proportion of children with a serum retinol concentration < 0.7 μmol/L decreased from 58% to 34% (P = 0.001), and at follow-up, the proportion of children with a serum retinol concentration < 0.7 μmol/L was significantly lower in the experimental village than in the control village (34% compared with 67%; P = 0.001).

TABLE 4
Serum retinol concentrations of 2–5-y-old children at baseline and at 20 mo after implementation of a home-gardening program[1]

	Experimental village	Control village	P
	μmol/L		
Baseline	0.73 ± 0.22 [107]	0.80 ± 0.20 [58]	0.0436
Follow-up	0.81 ± 0.22[2] [110]	0.73 ± 0.19[2] [111]	0.0050

[1] $\bar{x}$ ± SD; n in brackets.
[2] Significantly different from baseline, P < 0.05 (ANOVA).

Anthropometry

There was no significant difference between the 2 villages in any of the anthropometric indexes of malnutrition either at baseline or at follow-up.

DISCUSSION

Twenty months after implementation of the home-gardening program, approximately one-third of all households in the experimental village had a project garden. Maternal knowledge regarding vitamin A nutrition, the frequency of consumption of yellow and dark-green leafy vegetables, and the serum retinol concentrations of 2–5-y-old children were more favorable in the experimental village than in the control village.

The evaluation of food-based strategies for influencing nutritional status is often complicated by various factors, one of which is finding a suitable control community. The present study included a neighboring village as a control village. That the baseline serum retinol concentrations of the children from the control village were higher than those of the children from the experimental village was unexpected. On the basis of the finding that primary school children in the 2 villages had comparable mean serum retinol concentrations (±0.72 μmol/L) (ME Van Stuijvenberg, personal communication, 2000), one would assume that the 2–5-y-old children in the 2 villages would have comparable mean serum retinol concentrations. In the control village, poor *Isizinda* coverage at the time of the baseline survey (the *Isizinda* register was used for recruitment) and poor compliance (31% of children who were recruited did not attend the blood-drawing session for unknown reasons) probably caused the sample to be biased toward children who received better care. At baseline, there was little incentive for mothers in the control village to participate in the survey, whereas at follow-up, awareness was created and they knew that the home-gardening program would soon be extended to their village. In Bangladesh, the effect of a homestead-gardening program was assessed by collecting data through a cross-sectional survey and then comparing households with and without gardens (12). When this approach was used for the present study, the positive effect of the home-gardening program within the experimental village was reflected in the higher mean serum retinol concentrations of the children from households with a project garden than of those from households without a project garden.

In the experimental village, the caregivers of all the children were exposed to the nutritional education and agricultural demonstration sessions at the *Isizinda*, regardless of whether they had a project garden. The finding in the experimental village that the serum retinol concentrations of the children from households with a project garden were higher than those of the children from households without a project garden suggests that access to a supply was critically more important than was education without ready access.

Before implementation of the home-gardening program, the vitamin A intake of children in the area was low (35% of the recommended dietary allowance) (13), and this background diet remained the same throughout the year (M Faber, unpublished observation, 1999–2000). The availability of the individual vegetables that were promoted depended on the season, but because of staggered planting, cyclic production, and the different varieties of vegetables that were planted, provitamin A–rich vegetables were available throughout the year. At the time of the follow-up survey, spinach and carrots were mostly available. The follow-up survey was done at the beginning of the new growing season for orange-fleshed sweet potato and butternut squash. If the follow-up survey had been done exactly 24 mo after the baseline survey, orange-fleshed sweet potato and butternut squash would have been in abundance, and a bigger response would have been anticipated. Practical considerations forced us to complete the follow-up survey before the end of the calender year.

The project showed that home gardens can play an important role in improving the dietary intake of vitamin A–rich foods. The habitual intake of yellow and dark-green leafy vegetables increased, and a dietary survey 1 y after implementation showed a significant increase in the dietary intake not only of vitamin A but also of various other essential micronutrients (14). There are several examples in the literature of a positive effect of yellow fruit and vegetables on vitamin A status (15–18). de Pee et al (19) showed that dark-green leafy vegetables have no effect on vitamin A status because of their low bioavailability. As a result, the role of dark-green leafy vegetables in improving vitamin A status has been questioned. Among 2–15-y-old subjects in Bangladesh, however, serum vitamin A concentrations were strongly associated with food intake; the most significant association was with the intake of dark-green leafy vegetables (20). In children aged 2–6 y, consumption of green leafy vegetables with added fat also improved vitamin A status (21, 22).

The concept of gardening was not new to the community. It has been reported previously that most households obtained some food from their own garden (4) and that the crops produced were mostly pumpkin, *imifino*, maize, and cabbage. Pumpkin was planted mainly for the leaves (5). The home-gardening program strengthened existing gardening activities, and it was recommended that the yellow and dark-green leafy vegetables be planted in addition to existing crops, thereby increasing the variety of vegetables available.

The favorable effect of the home gardens on serum retinol concentrations makes the inclusion of yellow and dark-green leafy vegetables into gardening programs a viable strategy to address vitamin A deficiency in rural areas. People in rural areas often do not benefit from clinic-based nutritional programs because of a lack of health facilities within these areas, and these people have limited access to commercially available fortified foods. The integration of home gardens with community-based growth monitoring resulted in a multisectored community program containing primary health care, agricultural, nutritional, and educational activities. Awareness of vitamin A malnutrition was created within the community, thereby empowering its members to make informed decisions regarding the health of their children. The better maternal knowledge at baseline in the experimental village may be explained, at least partly, by the awareness that was created during the sensitization period that preceded the baseline survey.

The members of the community had a positive attitude toward the program. They appreciated the fact that they no longer had to buy vegetables, and they realized that there were health benefits for their children. Approximately 20% of the caregivers who were interviewed related the food production program to poverty alleviation. In the long term, this could have a powerful effect because the food production program, with its strong element of skill development, may empower the community to achieve social advancement.

This small-scale pilot study developed an integrated health and gardening system that was adapted to local conditions and gardening practices, thus making the model viable in the rural African context. In Bangladesh, a pilot study was successfully scaled up to a national homestead-gardening program (23). Using the Bangladeshi program as a guideline, we are looking into possibilities of expanding our program to other rural areas. In conclusion, a home-gardening program that was integrated with a primary health care activity, linked to nutritional education, and focused on the production of yellow and dark-green leafy vegetables had a favorable effect on serum retinol concentrations, habitual intake of yellow and dark-green leafy vegetables, and maternal knowledge regarding vitamin A nutrition.

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