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The Effect of Vitamin A Supplementation on the Growth of Preschool Children in the Sudan

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ABSTRACT

Objectives. This study assessed the effect of vitamin A supplementation at 6-month intervals on child growth.

Methods. Sudanese children (n = 28 740) 6 to 72 months of age were weighed and measured at baseline and at each of three follow-up visits.

Results. Periodic vitamin A supplementation had no effect on the rate of weight or height gain in the total population or on the incidence of wasting, stunting, or wasting and stunting among children who were normally nourished at baseline.

Conclusions. Reducing poverty and improving access to adequate diets should remain the goals of programs designed to improve the nutritional status of malnourished populations. (*Am J Public Health.* 1997;87:1359–1362)

Introduction

Malnutrition is a major public health problem in many developing countries. About 43% of children (or 230 million) under the age of 5 years in developing countries are reported to be stunted, while about 9% (or 50 million) are wasted.[1]

Xerophthalmia, as a proxy for vitamin A deficiency, has been associated with wasting and/or stunting in several cross-sectional studies.[2–5] Six intervention studies carried out in different countries in Asia[6–11] and two trials carried out in Ghana[12] have examined the effect of vitamin A supplementation on child growth with varying results. Published studies have addressed the relationship between vitamin A supplements and attained weight or height but not the association between vitamin A intake and the risk of stunting or wasting among previously normally nourished children. In this report, we examine the effect of supplementation with 60 mg of vitamin A (200 000 IU) at 6-month intervals on the growth of children who participated in the Sudan Vitamin A Study.[13]

Methods

The Sudan Vitamin A Study was initiated in June 1988 to examine the

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TABLE 1—Change in Height and Weight between Baseline and 18 Months Later in Vitamin A and Placebo Groups: 21 251 Sudanese Children

Characteristic	No. Children	Baseline Measurement, Mean (SD)	Univariate Analysis: Vitamin A Mean (SD)	Univariate Analysis: Placebo Mean (SD)	P^a
		Height gain, mm			
Overall	21 251	888 (128)	109 (32)	108 (32)	.40
Male age group, y					
≤1	627	715 (44)	131 (31)	129 (29)	.50
2	2 166	758 (44)	122 (34)	122 (33)	.93
3	2 033	833 (62)	112 (32)	114 (31)	.19
4	1 975	913 (63)	106 (29)	106 (28)	.88
5	1 756	979 (63)	99 (22)	97 (29)	.22
>5	2 079	1 051 (63)	93 (24)	93 (26)	.80
Female age group, y					
≤1	583	698 (49)	137 (39)	135 (30)	.56
2	1 991	744 (56)	126 (33)	124 (34)	.42
3	2 023	820 (63)	115 (29)	112 (31)	.02
4	1 985	902 (65)	106 (30)	105 (29)	.63
5	1 875	971 (64)	99 (24)	97 (28)	.05
>5	2 120	1 041 (63)	93 (29)	93 (25)	.79
Children breast-fed	3 255	720 (46)	129 (35)	129 (33)	.82
Children not breast-fed	2 112	773 (56)	122 (32)	119 (32)	.03
		Weight gain, g			
Overall	21 231	11 790 (3 091)	2 627 (1 022)	2 621 (1 047)	.66
Male age group, y					
≤1	625	8 136 (1 135)	2 789 (978)	2 844 (995)	.49
2	2 165	8 956 (1 441)	2 828 (1 007)	2 907 (1 012)	.07
3	2 030	10 657 (1 724)	2 671 (1 018)	2 724 (970)	.23
4	1 973	12 471 (1 824)	2 440 (938)	2 446 (982)	.88
5	1 763	13 934 (1 885)	2 430 (910)	2 433 (1 040)	.94
>5	2 081	15 650 (2 051)	2 625 (1 039)	2 657 (1 208)	.52
Female age group, y					
≤1	582	7 635 (1 240)	2 952 (998)	2 709 (982)	.003
2	1 987	8 423 (1 387)	2 938 (1 018)	2 935 (1 065)	.95
3	2 020	10 077 (1 674)	2 761 (1 019)	2 653 (967)	.01
4	1 980	11 975 (1 796)	2 440 (954)	2 428 (935)	.77
5	1 870	13 572 (1 881)	2 387 (961)	2 345 (971)	.35
>5	2 117	15 156 (2 064)	2 561 (1 160)	2 518 (1 134)	.39
Children breast-fed	3 247	8 103 (1 230)	2 889 (982)	2 878 (1 027)	.77
Children not breast-fed	2 112	9 113 (1 518)	2 861 (1 045)	2 905 (1 032)	.34

Note. Age refers to age at baseline. Median age of children in the highest group was 66.6 months. *P* values were obtained from *t* tests. Breast-feeding status refers to status at baseline. Analyses were limited to children in the first 2 years of life.

relationships between vitamin A intake and the health and survival of preschool children. Additional details on the study design and the study population have been published elsewhere.[13–15] The study population consisted of children 6 to 72 months of age in five rural councils in northern Sudan where vitamin A deficiency was prevalent. Equal numbers of boys and girls were enrolled, and all study children were free of eye signs of vitamin A deficiency. About 28% of the mothers were literate, and 50% of the households had running water. Interviewers enrolled all eligible children at baseline (round 1) and subsequently visited each household three times at 6-month intervals. All eligible children in alternate households were assigned to receive, every 6 months, either a capsule of 60 mg (200 000 IU) of vitamin A and 40 mg (40 IU) of vitamin E or a capsule of 40 mg of vitamin E without vitamin A. Children who had evidence of xerophthalmia at any round were given vitamin A capsules and dropped from the study. Field personnel were divided into six teams, each consisting of two interviewers, two anthropometricians, and a supervisor. At each round, all households were visited; anthropometric measurements were made by each team at a central location after household visits had been completed.

At baseline, information was collected on potential determinants of nutritional status, including household wealth (subjectively assessed on a four-point scale), availability of water in the house, maternal literacy, and region of residence. Morbidity at baseline was assessed by asking the mother whether, in the preceding 7 days, the child had had diarrhea, cough, fever, or measles. Interviewers also asked whether each child was exclusively breast-fed, exclusively bottle-fed, both breast- and bottle-fed, breast-fed and receiving a solid diet, or fully weaned. Given that few children were young enough to be exclusively breast-fed, partial and exclusive breast-feeding were grouped together. At each round, interviewers also assessed child dietary vitamin A intake by administering to mothers a simple questionnaire that entailed recalling whether or not the child had consumed, in the previous day, any of a list of 30 foods containing vitamin A. Approximate dietary intake of total vitamin A was computed by multiplying the nutrient content of each food item[16,17] by an assumed average portion.

At each round, the interviewers measured each child's weight and height. Weight was measured, with a Salter scale, to the nearest 100 g. Height (or recumbent length for children under 85 cm) was measured to the nearest 1 mm with a locally made anthropometer. The Centers for Disease Control and Prevention Anthropometric Software Package, which is based on National Center for Health Statistics growth curves,[18] was used to calculate anthropometric indicators. All children with *Z* scores below −2 were considered malnourished. Such children were considered wasted if they were deficient only in terms of weight for height, stunted if they were deficient only in terms of height for age, and both stunted and wasted if they were deficient in terms of both parameters. Children with

Z scores of −2 or above on both weight for height and height for age were classified as not malnourished (i.e., classified as normally nourished).

Follow-up rates at rounds 2, 3, and 4 were 92.1%, 87.5%, and 84.2%, respectively. Children who were not available at round 4 included those who had died, those who were diagnosed to be xerophthalmic at round 2 or 3 and were excluded from further follow-up, and those who were lost to follow-up, mostly as a result of the mother being absent from the home at the time of the follow-up surveys.[13] Data on height and weight were not collected at round 4 from an additional 6.3% of the total baseline population because the mother did not go with the child to the central location where measurements were taken. Therefore, 77.9% of the total baseline population was measured at round 4. There was no association between availability of a measurement at round 4 and experimental capsule assignment.

We examined the relationships between vitamin A supplements and gain in height or weight over the 18 months of follow-up. These relationships were examined, in the total study population, within categories of baseline anthropometric status, quintiles of dietary vitamin A intake, 1-year age subgroups and sex subgroups, and children 2 years of age and younger categorized by breast-feeding status. We also examined the relationships between vitamin A supplements and the risk of becoming stunted, wasted, or stunted and wasted at round 4 among children who had normal anthropometric status at baseline. An intention-to-treat analysis was used to examine the effect of the supplements on these end points. A *t* test was used to compare univariate differences in weight or height between children in the two experimental groups. Multiple linear regression and logistic regression models were used to adjust for a number of potentially confounding variables at baseline, namely age, sex, morbidity, and the four socioeconomic variables. Variances generated by these models were used to estimate 95% confidence intervals (CIs). We used a probability level of less than .05 to define statistical significance. Statistical Analysis System software (SAS Institute, Cary, NC) was used in analyzing data.

The study was approved by the Committee on the Use of Human Subjects in Research at the Harvard School of Public Health, the director general of primary health care at the Ministry of Health in the Sudan, and the directors of health for the Khartoum and Central regions.

TABLE 2—Risks of Stunting, Wasting, or Stunting and Wasting at 18-Month Follow-Up in Vitamin A and Placebo Groups of Children of Normal Anthropometric Status at Baseline

Nutritional Status	Univariate Analysis: Vitamin A, No. Cases (%)	Univariate Analysis: Placebo, No. Cases (%)	Univariate Analysis: Relative Risk (95% CI)	Multivariate Analysis[a]: Relative Risk (95% CI)
Stunting	331 (5.8)	371 (6.4)	0.9 (0.8, 1.0)	0.9 (0.8, 1.1)
Wasting	238 (4.2)	265 (4.6)	0.9 (0.8, 1.1)	0.9 (0.8, 1.1)
Stunting and wasting	18 (0.3)	21 (0.4)	0.9 (0.5, 1.6)	1.0 (0.5, 1.8)

Note. CI = confidence interval.
[a]From individual logistic regression models that included age (continuous variable of six 1-year groups), gender, wealth (continuous variable with four levels), availability of water in the house (yes/no), maternal literacy (yes/no), region of residence (four dummy variables), capsule (vitamin A/placebo), and quintiles of dietary vitamin A intake (continuous).

Results

Among the study participants, 47% were malnourished at baseline; 36% were stunted only, 5.6% were wasted only, and 5.6% were stunted and wasted. No consistent or significant differences were noted between the two treatment groups in the rate of height or weight gain (Table 1). The results were virtually the same after adjustment for age, gender, socioeconomic status, and dietary vitamin A intake when multivariate analyses were used. This was also the case within groups of children defined by baseline anthropometric status (data not shown). Vitamin A supplements were associated with larger weight gain among girls 1 and 3 years of age, but no clear effects were seen among the other age/sex subsets (Table 1). Neither dietary vitamin A intake nor breast-feeding status modified the effect of supplements on change in weight or height.

Among children who were normally nourished at baseline, 5.8% of those in the vitamin A group became stunted over the following 18 months, as compared with 6.4% of children who received placebo (relative risk [RR] = 0.8, 95% CI = 0.8, 1.1). Vitamin A supplements did not reduce the incidence of wasting or the incidence of stunting and wasting (Table 2).

Discussion

Doses of vitamin A given at 6-month intervals did not have consistent appreciable effects on ponderal or linear growth over an 18-month period among a population of Sudanese children with a high prevalence of chronic malnourishment. The statistical power of the study and the duration of follow-up were adequate to detect differences between the treatment groups had they occurred. Significant differences associated with the supplements with respect to weight gain among girls 1 and 3 years of age may be attributed to statistical chance.

The findings of this study are in agreement with the results of two vitamin A trials carried out in Tamil Nadu, India[8,11]; two others from Ghana[12]; and two trials from Thailand that examined the effect of vitamin A and other nutrients vs placebo.[9,10] The supplements had no effect on growth in Tamil Nadu[8] and Ghana[12] even though there were significant reductions in mortality in both studies.[19,20] In two intervention studies carried out in Indonesia, vitamin A supplements had apparently contradicting results. The first study, carried out in Java, showed that children who consumed small, frequent amounts of vitamin A in fortified monosodium glutamate experienced greater height gain but similar weight gain relative to control children.[6] In the second study, carried out in Aceh, large doses of vitamin A given every 6 months had little effect on height but were associated with increases in weight, although this finding was limited to boys who were 4 to 5 years old.[7] Both studies were small (approximately 1700 and 2000 subjects, respectively), and neither was placebo controlled.

The lack of effect of vitamin A supplements on growth in the Sudan study is inconsistent with positive associations of dietary vitamin A intake with attained weight and height and with reduced risks of stunting and wasting in the same study population.[21] These results are in agreement with previous findings in this population: supplements had little effect on the risk of xerophthalmia and no effect on morbidity or mortality, while dietary vitamin A intake was associated with large reductions in the risk of xerophthalmia, morbidity, and mortality.[13–15,22] Unlike the effects of vitamin A supplements, which were examined in a placebo-controlled design, the associations with dietary vitamin A intake were investigated in a prospective observational design that may have been limited by residual confounding. The limited effect of supplements on growth in the face of a positive association between dietary vitamin A intake and growth was also noted in one of the two studies from Tamil Nadu.[11]

Periodic distribution of vitamin A may not lead to an improvement in child growth even in areas where such a regimen may be associated with reduced mortality. Reducing poverty and improving access to adequate diets should remain the goals of programs designed to improve the nutritional status of malnourished populations. □

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