THE HELEN KELLER INTERNATIONAL FOOD FREQUENCY METHOD MAY UNDERESTIMATE VITAMIN A INTAKE WHERE MILK IS A NORMAL PART OF THE YOUNG CHILD DIET

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A recent innovation in assessing community vitamin A status is the Helen Keller International Food Frequency Method (HKI FFM), based on weekly intakes of key foods. Since it excludes animal milk, we investigated whether the amount of animal milk 345 pre-school children received in a rural area of India contributed significantly to their total vitamin A intake. Degree of dilution and quantity of milk usually given were estimated and 9 milk samples were analysed for fat content.

Mean frequency of milk intake was 5.3 days/week. The range of milk consumed at one time was 50-200 ml. Median fat concentration was 3.7%. Intake of vitamin A from this milk corresponded to a daily average of 5-18% of the "safe" RDI for vitamin A, a high proportion of the apparently deficient intake. HKI FFM should be revalidated for settings where milk is commonly given to pre-school children.

KEY WORDS: Vitamin A, animal milk, dietary assessment, young child nutrition, India

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INTRODUCTION

Surprisingly few large-scale experiences exist in utilising diet-based approaches to overcome vitamin A deficiency (VAD) problems in society, although they are gaining increased attention (FAO/ILSI, 1997). Certain constraints are becoming increasingly evident. First, for the poor who are almost exclusively the ones who suffer from VAD, few if any dietary sources of pre-formed retinol are available. Yet, the nutritional value of dietary carotenoids in relation to retinol appears to be influenced by many factors, such as fat intake (El-Gorab *et al.*, 1975; Jayaran *et al.*, 1980), parasitic infection (Sivakumar and Reddy, 1975; Mahalanabis *et al.*, 1976; Mahalanabis *et al.*, 1979; Marinho *et al.*, 1991), cooking methods (Erdman, 1988; Rahman *et al.*, 1990; Simpson and Chichester, 1981) and the vegetable matrix in which the carotenoids are located (dePee *et al.*, 1995). The nutritional value as defined by WHO/FAO of the United Nations in 1967 is the beta-carotene/retinol ratio of 6:1, but this is now being questioned. Recent studies in Indonesia and Vietnam suggested revising this conversion factor to 12 for yellow/orange fruits and 27 for vegetables (West and Hautvast, 1997).

Second, the planning and implementation of programmes to reduce VAD require simple and reliable methods of assessing risk of VAD at community level. Conventional, quantitative methods including xerophthalmia prevalence surveys and biochemical analyses pose important financial, logistical and technical constraints. Simple methods of estimating intakes of vitamin A rich foods are also needed to plan and monitor diet-based interventions, particularly when this more sustainable approach is intended gradually to replace "short-term" measures such as universal distribution of vitamin A supplements (Greiner, 1993; ACC/SCN, 1997).

Perhaps the simplest and most innovative method to assess community risk of VAD now coming into frequent use is the Helen Keller International Food Frequency Method (HKI FFM) (Rosen *et al.*, 1993). The HKI method measures risk of VAD at community level by studying the diet of children 1–6 years of

age. A score is assigned to each child based on the number of rich sources of vitamin A, both animal and plant, consumed during the past week, with amounts ignored. HKI only include major sources of vitamin A; i.e. containing at least 100 retinol equivalents (RE) per 100 grams of food. The vitamin A content of animal milk has been found to vary between 10 and 90 RE (Renner, 1983) and thus it is not considered a major source of vitamin A. Furthermore, HKI assumes that in low-income countries animal milk is too diluted as given to young children to be important in vitamin A nutriture. However, given the recent evidence that bioavailability of beta-carotene in most vegetable foods may be lower than was previously thought, the relative importance of animal milk deserves to be re-evaluated. This is especially true in countries where many children consume milk, even if it is served somewhat diluted to them.

The present study was thus conducted in 1996 in a rural area of India with the aim of estimating whether animal milk given to children aged one to six years contributed significantly to total vitamin A intake.

MATERIALS AND METHODS

Study Area

The study was performed in seven villages of Purandar Block in Pune district, Maharashtra state, India from May to July 1996 during the dry period of the year. The study area is a semi-arid zone of the western Ghats. In this area many people have goats, buffaloes or cows, the latter being crossbreeds, either Jersey or Holstein Friesian (HF). According to reports from the cattle breeding centre laboratory in the study area, milk from the Jersey and the HF breed have a fat content of 5–7% and 3–4% of milk respectively (personal communication).

Study Population

Approximately 50 households were selected from each of the seven villages. The sampling method used and also the number

TABLE I
Characteristics of the study population

Village	Number of children	Boys		Girls		Mean age $\pm$ S.D. (months)
		N	(%)	N	(%)	
Rajewadi	48	26	(54.2)	22	(45.8)	30 $\pm$ 12
Shingapur	61	30	(49.2)	31	(50.8)	40 $\pm$ 18
Wagapur	43	20	(46.5)	23	(53.5)	42 $\pm$ 19
Malshiras	60	40	(66.7)	20	(33.3)	35 $\pm$ 13
Guroli	49	16	(32.7)	33	(67.3)	38 $\pm$ 15
Tekawadi	34	22	(64.7)	12	(35.3)	40 $\pm$ 19
Amble	50	27	(54.0)	23	(46.0)	40 $\pm$ 16
Total	345	181	(52.5)	164	(47.5)	Mean: 38 $\pm$ 16

of households selected per village was recommended by and described in the HKI FFM (Rosen *et al.*, 1993). First, a central area (village square) within the village was located. A pen was spun and household interviews begun in the direction it pointed toward in the first household encountered which had a child from 1 to 6 years old. Households continued to be visited by moving in a systematic fashion down streets through the community until 50 households with children aged 12–72 had been surveyed. Within each of these households, one mother/caretaker was randomly selected through the toss of a coin, where necessary. After the mother was selected, one of her children from one to six years of age was chosen by the same method. The total sample size was 345 children. Some characteristics of the subjects in the study are shown in Table I. Mean age was 38 months; 164 (47.5%) were girls and 181 (52.5%) were boys. The predominant caste in this region was Maratha, most of whom own land and cattle, and 272 subjects (78.8%) belonged to that group. Among the remaining respondents, 19 (5.5%) belonged to the lower castes and 54 (15.7%) to other castes.

The HKI FFM

The HKI FFM asks respondents how many days in the last week the child consumed the foods listed on a predesigned food

frequency questionnaire (FFQ). Only major sources of vitamin A are taken into consideration, though some attention are given to other foods. Since amounts consumed are ignored, the data collected cannot be used to estimate the vitamin A intake of individuals. The HKI FFM is rather intended to assess whether or not VAD is likely to be a public health problem in a population. It may also prove useful in monitoring large-scale shifts in consumption of these foods, for example in response to campaigns promoting dietary improvements.

The HKI FFM approach has certain advantages. General eating habits are easier to remember and, therefore, more reliably reported than specific quantities of foods. A seven-day FFM captures eating patterns over a whole week, increasing the likelihood that holidays and market days are included, when dietary habits may be different. It has been shown that estimating the exact nutrient intake in individuals is not always necessary to predict the prevalence of nutritional deficiency in a community (Block, 1982; Hernandez-Avila and Hunter, 1988). FFMs have also been shown to have predictive power in relating the intake of food to risk of disease (Willett *et al.*, 1985).

The HKI FFM has been validated against serum retinol in three countries—the Philippines, Guatemala and Tanzania (Sloan *et al.*, 1997). However, the majority of VAD cases are located in South Asia (WHO, 1995), where such studies have not yet been conducted. A community was defined to have a VAD problem when 15% or more of the children had a serum retinol value of less than $0.70 \mu\text{mol/litre}$, a cut-off value set by WHO/UNICEF (1994). The HKI FFM correctly classified 11 of 15 communities as either having or not having VAD. However, 43% of those communities without VAD were incorrectly classified as having it. One possibility for this lack of specificity could be that certain key sources of vitamin A, such as milk were left out. Programmatically that could be costly, though it is probably less harmful than low sensitivity (falsely labelling communities as not having it which occurred in 12.5% of the cases).

Data Collection

Dietary information for each child was obtained through interviews with the mother. The interviews included administration of the HKI FFM plus questions regarding ownership of dairy cattle and frequency of milk consumption. Interviewers who had at least primary school education were trained on the project, the sampling methods to be used, interview technique and the HKI FFM. All lived in the same villages they were working in.

Milk Consumption Practices

Three group discussions and ten key informant interviews were held to obtain information on children's milk drinking. People from all castes were included, but in different groups. Questions included how milk is fed to young children, if the cream is separated or mixed with the rest, how the milk is diluted when given to young children, and approximately how much milk is usually given.

Fat Analysis of Milk

To confirm the qualitative data, aliquots of cow milk as consumed by young children were analysed for fat concentration within three hours of collection. Nine milk samples were taken "as consumed" from homes, all from the village of Guroli; six were from Maratha families and three from families of other castes, and kept in a refrigerator prior to analyses. An anti-foaming compound, EDTA, and an emulsifier were added to 0.5 ml samples of milk which were then taken to the nearby cattle breeding centre laboratory in Uruli Kanchan. They were analysed using a spectrophotometric method used in most dairy societies of India that can analyse fat levels from 0–13% (Milko Tester Minor 184, Foss Electric, Denmark).

Statistics

All data analyses were carried out using SPSS/PC 6.1 statistical software (1995). Means, medians and standard deviations (S.D.)

were calculated. Normality tests for distribution of data were performed by Kolmogorov-Smirnov goodness of fit test. Kruskal-Wallis one-way analyses of variance (ANOVA) and Mann-Whitney *U* test were used to compare differences in frequency of milk consumption, and the Chi-square test was used to compare caste differences in milk cattle ownership.

RESULTS

Milking Cattle Ownership

Fifty-six percent of the households had dairy cattle. At 64%, ownership was significantly higher among the Marathas than the combined ownership among the lower caste group (32%) and other castes (22%) ($p < 0.001$, see Table II).

Milk Consumption

The mean frequency of milk consumption was 5.3 days per week (S.D. 2.7) for the participating children (Table II). During the week prior to the interview, 67% of the children had consumed milk every day. The highest consumption rate was found in the youngest age group, 12–23 months, with a mean consumption of 6.3 days per week and the lowest in the age group 48–59 months, with a mean of 4.5 (Table III). The difference in milk

TABLE II
Cattle ownership and milk consumption by caste

Caste group	Cattle ownership (%)	Milk consumption (days/week)
Maratha	64***	5.2
Lower castes	31	5.0
Other castes	22	5.9
Total	56	5.3

*** $p < 0.001$ (Chi square test).

Table III
Milk consumption by age group

Age group (months)	Number of children (%)	Mean intake $\pm$ S.D. (days/week)
12-23	70 (20.3)	6.3 $\pm$ 1.9***
24-35	72 (20.9)	5.2 $\pm$ 2.9
36-47	83 (24.1)	5.4 $\pm$ 2.7
48-59	62 (18.0)	4.5 $\pm$ 2.9
60-72	58 (16.8)	4.8 $\pm$ 2.7
Total	345	5.2 $\pm$ 2.7

*** $p = 0.001$ (Mann-Whitney U test).

consumption between the youngest and all the other four groups combined was statistically significant ($p < 0.001$). Despite the differences between the caste groups in cattle ownership, there were no significant differences in frequency of milk consumption. The Marathas consumed milk at a mean of 5.2 days per week, compared to 5.0 in the lower castes and 5.9 in the other castes ($p = 0.27$, see Table II).

The key informant interviews and group discussions suggested that mostly cow milk, but also buffalo and goat milk were consumed. The majority of the people sold most of their milk, making it an important source of income. All respondents said they diluted milk given to children. There were two reasons for this: to obtain "an increased volume of milk", and because young children are considered to be unable to digest undiluted milk. The most common way to dilute the milk was to add one glass of water (approximately 200 ml), to one small bowl of milk (approximately 500 ml). Thus, 2/7 or nearly 30% is water. After dilution, the milk is boiled before being given to children. The amount of milk said to be given to these pre-school children varied from 50 to 200 ml per day, depending on how much milk was kept within the household and the child's thirst. Only on rare occasions cream was skimmed off to make clarified butter (ghee) or yoghurt.

Milk Fat Analyses

The mean fat concentration was 4.4% (range 2.4–6.6%) which is approximately the same concentration as the 4.1% in the whole milk reported for India (Gopalan *et al.*, 1989). One possible explanation for the fat concentration being this high despite the milk samples being diluted could be that the milk used for home consumption had been boiled before being consumed, leading to water loss.

Estimated Vitamin A Content in Milk

According to Indian food composition tables (Gopalan *et al.*, 1989), whole unboiled cow milk contains 53 RE per 100 grams when fat concentration is 4.1% (48 for buffalo milk and 55 for goat milk) giving a vitamin A concentration of 48 RE per 100 g diluted milk “as consumed” by the children, when the median fat concentration 3.7% is used. Since milk is consumed 5.3 days per week, the daily intake of vitamin A from diluted milk would then range from 18 to 72 RE, corresponding to the range of intakes mentioned, 50–200 ml. This in turn corresponds to a daily mean of 5–18% of the “safe” recommended daily intake (400 RE) of vitamin A for children 1–5 years old (FAO, 1988).

DISCUSSION

Data on caste membership in this area are limited. However, the majority of the people in Maharashtra belong to the Maratha caste. It could be that our study population is slightly skewed, and that the actual proportion of lower caste people is larger than the 8% of this sample. This could have been caused by the way interviewers chose houses to visit. For example, some might have avoided visiting some of the poorer low-caste households. A group discussion with people of lower castes showed that cattle ownership is uncommon and that only families with cattle consume milk. Therefore, it could also be that the interviewers selected the “better-off” lower castes households, leading to the

high percentages of households having cattle (31%) and children consuming milk (5.0 days per week). In this part of India, caste belonging does not always correlate with socio-economic status. However, most people from lower castes are poor. In future studies in the area, it would probably be of greater interest and importance to stratify for caste than for village. It may be that the HKI FFM sampling method is too simple to be useful in a setting where people of very different socio-economic status live in the same villages but segregated.

The effect of boiling on vitamin A has been reported to be very small; studies have shown that the vitamin A content of pasteurised, ultra high temperature treated, and sterilised full cream milk is in all cases 55 RE (Renner, 1989). However, some vitamin A may be lost due to light exposure, though in this area cooking is performed inside the houses. According to the Indian food composition table, concentration of vitamin A in cow milk is 53 RE/100 g when fat concentration is 4.1% (Gopalan *et al.*, 1989). Information on which variety of cow the data comes from is not given. However, since the vitamin A concentration in cow milk is highly correlated with fat concentration (Renner, 1983) this probably does not matter.

The question of dilution was more complicated than we expected. While it may be that people with very few cows dilute the milk more, all group discussions and key informant interviews led us to believe that the usual level of dilution is one glass of water to one bowl of milk, leading to a product consisting of about 30% of water before boiling. Mothers say they do boil the milk before giving it to their children and perhaps this restores it to the approximately the original fat concentration. In any case, we calculated that the vitamin A concentration of the children's milk, as consumed, was in the order of 50 RE per 100 grams.

This study showed that vitamin A from cow milk may provide 5–18% of the "safe" RDI. The vitamin A contributed by milk would of course represent a much larger proportion than this of the vitamin A in diets that failed to meet the RDI. The HKI FFM should only be used to classify communities as VAD or non-VAD, and cannot be used to estimate nutrient intake. However, in a sub sample of children ($n=49$) we found

that 27.3% had serum retinol values of $<0.70 \mu\text{mol/l}$ (unpublished findings). Therefore, it is likely that many of the sampled children had difficulties also to reach "basal" recommended intake of vitamin A, 200 RE (FAO, 1988). Milk may have contributed much more than 5–18% of RDI of their total intake of vitamin A, certainly between 10–40%. The study was conducted between May and June, the dry season during which vegetable availability is low. Animal milk may play a less important role in vitamin A nutriture during the rainy season, particularly the mango season.

In conclusion, this study suggests that animal milk is likely to be an important source of vitamin A among pre-school children in certain areas of India where ownership of crossbred cattle is common and/or where many children consume milk. Based on that, we recommend that the HKI FFM be revalidated or at least that recommendations are given on how to adjust for milk consumption, to make it a useful tool even in areas where animal milk is common in the diets of pre-school children, even if served somewhat diluted.

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