Ecological Assessment Of Vitamin A Status Of Primary School Children In Ulu Trengganu

by
N. Chandrasekharan, B.Sc., M.B.,B.S., Ph.D.,
Associate Professor
Department of Biochemistry
Faculty of Medicine, University of Malaya,
Kuala Lumpur, Malaysia.

Hypovitaminosis A is a well known problem in South and East Asia (Oomen, McLaren and Escapini, 1964) and it has been suggested as an important cause of blindness (Patwardhan, 1969). Prolonged deficiency of the vitamin may have serious effects on growth and development, besides affecting resistance to infection (Hayes, 1971). In Malaysia vitamin A deficiency is often encountered in certain parts of Trengganu, especially amongst pre-school and school going children (Soni, 1971, Chong, Mckay and Lim, 1972 and Chen, 1972).

An understanding of the factors contributing to vitamin A deficiency is very essential for any effective therapeutic or public health programmes aimed at combatting this nutritional problem. The present work gives an account of some nutritional and biochemical investigations for elucidating the multifactorial etiology of vitamin A deficiency amongst children in the district of Ulu Trengganu. It also discusses the interrelationships of various factors affecting the availability and utilisation of vitamin A and its precursors in foods. Such information has considerable bearing on the prophylactic measures for the prevention of this condition. A preliminary account of this work was reported earlier (Chandrasekharan, 1973).

Materials and Methods

Ten primary schools located in different parts of the district of Ulu Trengganu were selected randomly. The children attending these schools were drawn from surrounding villages in some cases up to a radius of 3-5 miles. The enrollment in the schools ranged between 30 and 200 and consisted of both boys and girls. For the purpose of this study, all children in the schools were examined clinically for evidence of vitamin A deficiency and the following categories of children were picked out for detailed nutritional and biochemical investigations. All those (a) who complained of night blindness or had an history of diminished vision at night (b) who appeared to be malnourished clinically (c) with xerotic changes in the eye and pigments in the conjunctive (d) with hyperkeratosis of the skin. This condition can also be due to causes other than vitamin A deficiency (Kamel, 1973). By this procedure about 10% of the children examined were selected. The sample studied could be considered as representative of the primary school population of Ulu Trengganu. For comparitive studies the children attending the primary school in Pulau Perhentian Kechil were investigated.

Blood samples were collected in the morning using vacutainer tubes and the serum was separated from the cells by centrifugation. Serum retinol and β carotene levels were determined by the trifluoroacetic acid method (Gyorgi and Pearson, 1967). Total serum protein concentration was determined with a refractometer (American Optical Co., Buffalo, U.S.A.) and the serum albumin estimated by electrophoresis on cellulose acetate (Chandrasekharan, 1969).

The homes of all students were visited for a detailed enquiry into the family's food habits and food consumption - by the 24 hour recall of the food consumed as well as data on foods purchased in a week. This process was greatly facilitated by trained medical students and school teachers drawn from the locality, who were very familiar with local conditions and had the confidence of the community investigated. The daily food consumption per individual was calculated and the nutrient intake was computed from food composition tables available for this country (Olivero, 1955, DHEW and FAO, 1974).

Results

The places visited for this study in Ulu Trengganu are shown in Fig. 1. The schools were accessible in most cases by road. Many of the homes had to be approached by foot paths and in some cases by boats. Most of the houses visited had home gardens. Poultry in small numbers were seen in some houses. Some possessed cattle, but fresh milk consumption was practically nil, as the cows were not milked at all. Thus a good source of protein and preformed vitamin A is made unavailable. The majority of the families visited made a living from agriculture. Except for the town of Kuala Brang, there was no electricity or piped water supply in the other places surveyed. Mobile health clinics served these areas periodically. There was no regular school feeding programmes in the schools investigated.

Table I shows the average intake of calories, carbohydrate, protein, fat and vitamin A by the subjects investigated. Fig. 2 shows the percentage contribution of calories from carbohydrates, proteins and fats in the diets of the children studied. More than 75% of the calorie intake was in the form of carbohydrates.

Only about 10% of the calories were accounted for by fats. The protein intake averaged about 39g per day of which only 35% was animal origin, against the national intake of 49g. The daily consumption of fat was particularly low, fats and oils accounting for only 21g compared with the national figure of 40.6g. (FAO-1971). The fats were mostly of vegetable origin, mainly coconut oil with practically no animal fat.

Consumption of foods rich in preformed vitamin A was very low and infrequent. In fact the only source was fish eaten in small amounts once or twice a week. As fish liver was not generally eaten, a concentrated form of vitamin A is lost. Over 95% of the vitamin A consumed was in the form of the provitamin from vegetables and fruits. The average daily intake of vitamin A in terms of retinol equivalence was 205μg which is inadequate when compared to the recommended allowance of 488μg for the age group under investigation (Van Veen and Van Veen, 1973).

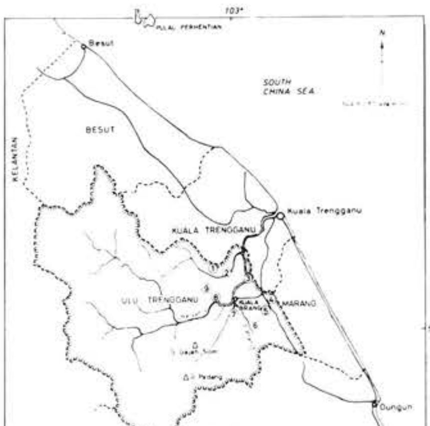

Fig. 1. Map of Ulu Trengganu showing the locations of schools which were surveyed. (1) Tengkawang (2) Matang (3) Tanggol (4) Bukit Apit (5) Bukit Diman (6) Kua (7) Bukit Gemuroh (8) Kuala Dura (9) Tapah and (10) Kuala Brang.
Scale: 1" = 16 miles

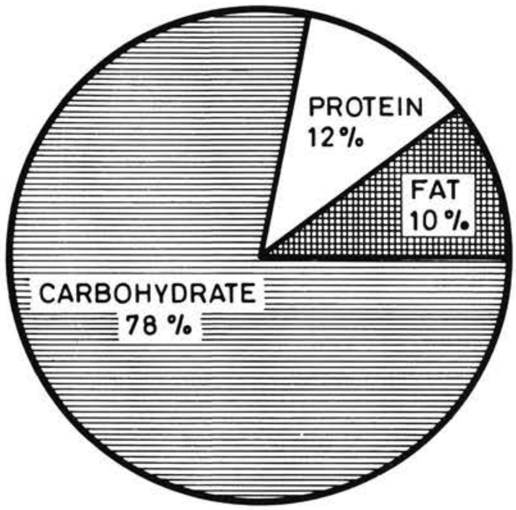

FIG. 2. % CALORIES FROM CARBOHYDRATES, PROTEINS AND FATS IN THE DIETS OF PRIMARY SCHOOL CHILDREN IN ULU TRENGGANU.

Table I

Average daily nutrient intakes of primary school children Ulu Trengganu

Locality	No. of homes visited	Total No. of individuals	Calories		Protein Total(g)		Protein Animal(%)		Fat(g)		Vitamin A 'Retinol Equivalence'		Vitamin A Retinol(%)
			Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean
1. Tengkawang	7	40	1580	98	39	5	35	6	19	5	209	13	4.0
2. Matang	16	93	1647	326	43	7	34	13	18	9	203	4	1.3
3. Tanggol	20	132	1571	429	41	15	33	13	20	10	202	2	0.7
4. Bukit Apit	14	96	1605	247	44	9	42	16	21	9	202	2	1.0
5. Bukit Diman	19	117	1550	289	40	9	36	9	22	8	205	9	1.8
6. Kua	10	65	1571	164	36	6	26	8	23	6	202	2	0.7
7. Bukit Gemọroh	21	131	1566	238	40	8	33	8	20	7	210	11	3.4
8. Kuala Dura	8	85	1441	305	37	9	35	18	21	5	207	8	3.0
9. Tapah	3	15	1140	244	27	3	33	16	18	7	205	5	2.3
10. Kuala Brang	25	161	1560	218	42	10	39	12	23	11	205	6	2.8
Average for Ulu Trengganu			1528	147	39	5	35	4	21	2	205	5	2.1
Recommended National Allowance(a)			2095		40						488		20

(a) IMR Report No. 64 (1964) Kuala Lumpur

For the purpose of expressing the provitamin A (β carotene) intake in terms of "retinol equivalence" the following factors have been taken into consideration:- The availability of carotenes in diets is 33% and the efficiency of conversion of β carotene into retinol is only 50%. So in man lug of β carotene in the diet is taken to have the same biological activity as 0.167μg of retinol (W.H.O.,1967)

Table 2 shows the serum levels of protein, retinol and β carotene in primary school children. The total serum protein and albumin levels could be considered to be within accepted limits. However the retinol and β carotene levels were lower than those reported for supposedly healthy children from other parts of the country (ICNND, 1964). The serum level of retinol was higher in children from Pulau Perhentian, and the β carotene levels lower than those from Ulu Trengganu. This could be attributed to the greater availability and higher consumption of fish and other sea foods in the island, which is mainly habited by a fishing community.

Fig. 3 shows the percentage distribution of children examined who could be considered to have a vitamin A nutrition problem based on the criteria of the Pan American Health Organisation (1970). The population is considered to have a vitamin A nutrition problem when 15% or more of the persons surveyed have serum retinol values less than 20μg/100ml and/or 5% or more present serum values less than 10μg/100ml.

Discussion

The present study provides us with information on dietary intake of some nutrients and the vitamin A status of selected primary school children in the district of Ulu Trengganu.

Table II

Serum protein, retinol andB-carotene levels amongst primary school children in Ulu Trengganu

Locality	No. Examined	Total Protein (g/100ml)		Serum Albumin (g/100ml)		Serum Vitamin A (μg/100ml) Retinol		B-carotene	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
1. Tengkawang	17	6.40	0.39	3.7	0.45	16	7	41	14
2. Matang	20	6.20	0.65	3.7	0.39	21	13	42	13
3. Tanggol	22	6.20	0.60	3.5	0.40	25	17	50	26
4. Bukit Apit	20	6.40	0.55	3.7	0.40	26	13	45	14
5. Bukit Diman	23	6.30	0.49	3.6	0.36	25	7	35	17
6. Kua	20	6.10	0.57	3.6	0.47	25	8	37	11
7. Bukit Gemeroh	22	6.50	0.59	3.8	0.41	25	11	49	23
8. Kuala Dura	20	6.30	0.50	3.5	0.35	19	11	39	13
9. Tapah	8	6.90	0.71	3.6	0.48	18	7	42	12
10. Kuala Brang	50	6.30	0.65	3.7	0.48	26	10	48	14
Pulau Perhentian	27	6.80	0.50	3.5	0.37	32	17	29	18
Average for Ulu Trengganu		6.36		3.6		22	4	44	5
Normal School Children(b)						29		76	

(b) From ICNND Survey: Federation of Malaya (1962) Interdepartmental Committee on Nutrition for National Defence, Washington, D.C.

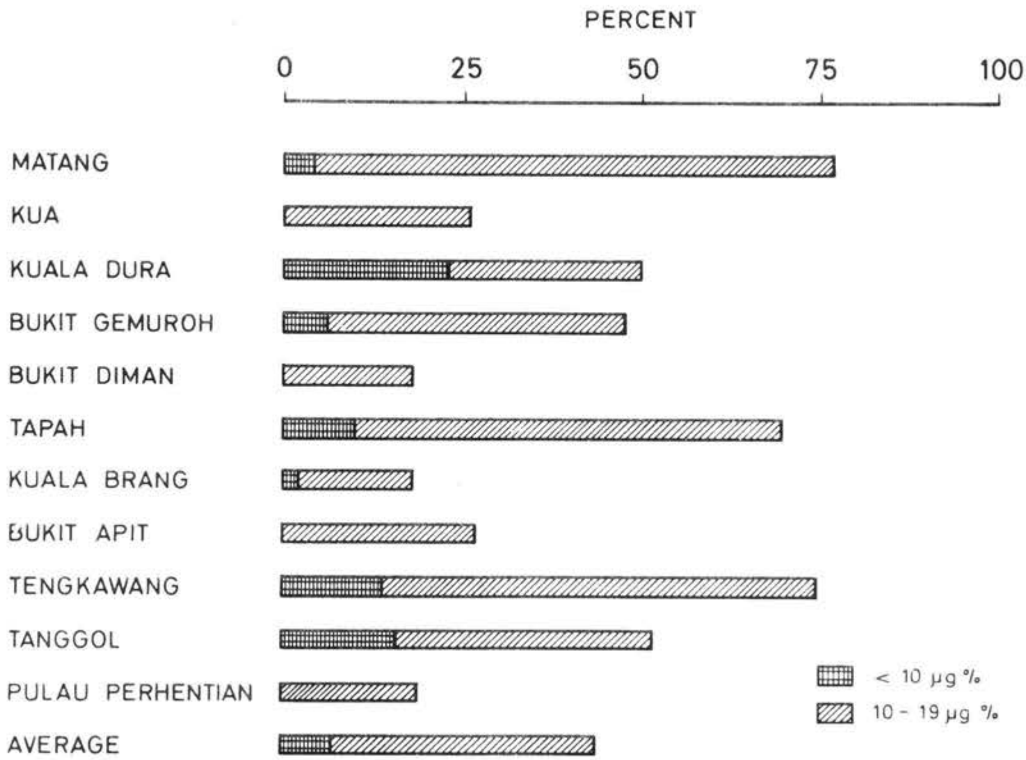

Fig. 3. Percentage distribution of children with vitamin A deficiency in Ulu Trengganu based on serum retinol concentration determinations

The principal source of vitamin A was green vegetables and fruits, the β carotene in them contributing to over 95% of the total daily vitamin A intake. This is much higher than that reported for a rural area in the West Coast of Peninsular Malaysia (Teoh, 1973). In most developing countries carotenoids in the diet provide over 60% of the total vitamin A activity ingested (Oomen et al.,1964). A number of dietary factors such as food source, fat and protein intake are known to affect the utilisation of carotenes (Rodriguez and Irwin, 1972). Similarly the utilisation and metabolism of vitamin A are interrelated with several other nutrients in the diet. So in assessing the intake and requirements of vitamin A, one has also to consider the intakes of calories, total protein, animal protein and fat in the diet.

Protein deficiency impairs intestinal absorption, transport and metabolism of retinol and depressess conversion of carotene to retinol. It has been reported that there may be an optimal protein intake for maximum carotene utilisation in the gut (Deshmukh and Ganguly, 1964, Mahadevan, Malathi and Ganguly 1965, and Roels and Mack, 1971). Experiments in rats have shown that a high protein intake leads to storage of vitamin A in the liver (Rodriguez and Irwin, 1972). The level of dietary protein in addition to affecting utilisation of vitamin A may also be directly related to the requirement for vitamin A. Vitamin A appears to be required for normal growth, definitely in association with protein utilisation and weight gain (Hayes, 1971). A high protein diet promotes growth and this in turn requires a high rate of expenditure of vitamin A (Moore, 1969).

Adequate serum and dietary proteins are necessary for the mobilisation of retinol from the liver and its transport in the blood. Retinol circulates in plasma mainly associated with a transport protein called retinol binding protein (RBP). The synthesis of RBP may be affected by dietary deficiencies of protein (Moore, 1969). The quantity and quality of protein consumed cannot be considered to be entirely satisfactory. However the serum levels of protein and albumin do not suggest any protein malnutrition in the children investigated. Increments of dietary proteins may result in increased mobilisation of retinol from the liver and deplete the liver stores faster, if there is no simultaneous increase in the intake of vitamin A. It has been demonstrated that nutritional status with regard to dietary protein and calories amy strongly influence vitamin A metabolism by affecting the metabolism of the retinol transport proteins (Smith, Goodman, Zaklama et al., 1973).

The absorption and utilisation of β carotene is also dependent upon the amount of dietary fat and its normal absorption. However, dietary lipids do not appear to be as important for utilising the preformed vitamin A as they are for the pro-vitamins. β carotene is converted to vitamin A by the intestinal epithelial cells and some is also absorbed unchanged (Goodman, Blomstrand, Werner et al., 1966). Animal experiments suggest that both the quantity and quality of fat have a definite effect on carotene utilisation (Rodriguez and Irwin, 1972). Very low intakes of dietary fat may diminish the availability of β carotene. The amount of carotene absorbed from the diet does not depend directly on the amount of carotene it contains, but on the amount of fat with which it is associated. Unsaturated fatty acids are essential for assimilation of vitamin A in animals. In the present study the amount of fat in the diet was relatively low and judging from the nature of oils and fats in the diet could also be considered as poor in unsaturated fatty acids.

The level of carotenoids in plasma are believed to vary and are affected by the preceding intake of carotenoid rich foods. Dietary intake is the only source of carotene in man and in contrast to retinol, it is not stored in the body and dietary deficiency can deplete serum levels in three to four weeks (Goodman, Blomstrand, Werner et al., 1966).

One of the satisfactory ways of determing the extent of vitamin A deficiency problem in population groups resulting from inadequate intake of vitamin A is by the estimation of plasma retinol concentration. The level of retinol has generally been considered as an indicator of vitamin A nutrition. Retinol content of liver influences its serum concentration.

It is known that 90% of the body stores of vitamin A is in the liver. Only when the liver stores of retinol are exhausted, does the level of plasma retinol begin to fall. The low levels of serum retinol are indicative of low liver reserves. This could in turn be attributed to poor utilisation of the pro-vitamin as a result of inadequate intakes of protein and fat, both in terms of quantity and quality. The low intake of both preformed and provitamins could be an additional factor.

Children with low levels of serum retinol represent a very vulnerable group in terms of health and can develop serious clinical lesions of the eye. The ideal long term measure for preventing the occurrence of vitamin A nutrition problem would be the improvement of the diets of all affected and vulnerable groups. An adequate diet in all respects promotes adequate storage of retinol in the liver. As preformed vitamin A is relatively expensive, because it is derived from animal sources, dependance on plant sources is likely to prevail for a long time to come. Increase in the consumption of high quality proteins as well as increase in the intake of fats and oils may facilitate the increased utilisation of the pro-vitamin from plant sources.

In this country the red palm oil is a potent source of β carotene and in view of its associated fat content - the efficiency of utilisation of β carotene is likely to be higher. Palm oil has a β carotene concentration of 410μg/g (Hartley, 1967). In fact red palm oil has been successfully used in the prevention of vitamin A deficiency in West Africa and Indonesia and a considerable degree of protection can be accorded by its use (Roels, Trout and Dujaequier, 1958; Roels, Djaeni Trout et al., 1963; Lian, Tie, Rose et al., 1967). Trials with palm oil after suitable modification are likely to be rewarding. Its use in the prevention of vitamin A deficiency deserves much consideration.

Apart from the long term measures of improving the diet of the vulnerable groups, immediate measures should be taken to supplement their diets with vitamin A preparations. Fortunately for us today, high potency preparations of retinol derivations are available at relatively low prices (Bauernfeind, 1973). In terms of cost for one child's annual requirement of vitamin A as the ester, it would be around 25 cents (twenty five cents). These are very useful in the prevention and treatment of vitamin A deficiency and its clinical manifestations. One massive dose of vitamin A consisting of 100mg or 300,000 I.U. as retinyl palmitate given orally can maintain satisfactory blood levels for between 4-12 months. The side effects, if any, from the administration of such massive doses are usually minimal and are not manifested after 24 hours (Oomen, 1972 and Oomen, 1973). The massive doses would build up liver reserves of the vitamin. Alternatively it is also feasible to give periodic doses of the vitamin in smaller amounts if facilities are available.

Conclusion

The consequences of prolonged deficiency of vitamin A are very serious and incapacitating. "To be able to see is the most precious gift that nature has given us." As such the problem of vitamin A deficiency should be recognised and treated early and appropriate prophylactic measures taken to reduce their occurrence and progress in this country. It would be very unfortunate if we fail to tackle this problem despite the low cost of the vitamin.

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Summary

The magnitude of the problem of vitamin A deficiency and the role of various dietary factors in the etiology of hypovitaminosis A was investigated amongst children attending 10 primary schools in Ulu Trengganu district in Trengganu State.

The dietary intake of various nutrients was obtained by the recall of foods consumed over 24 hours and longer periods. Serum levels of retinol, β carotene and proteins were determined in all children. The protein and fat contributed to 12% and 10% of the total calorie intake respectively. The proteins were mostly of vegetable origin and the fats were of the saturated type. β carotene accounted for over 95% of the vitamin A activity of the diets. Total vitamin A intake was inadequate by recommended standards and serum levels of retinol and β carotene were low, partially due to poor utilisation of the dietary provitamins. The utilisation of the provitamins depends upon many factors amongst which are an adequate supply of dietary protein and fat, both in terms of quantity and quality.

The primary school population is considered to have a vitamin A nutrition problem. Suggestions are made for both short and long term preventive and therapeutic measures to overcome the problem, which if untackled may lead to serious consequences.

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