

# PLASMA VITAMIN 'A' AND CAROTENE LEVELS IN KARACHI POPULATION

Pages with reference to book, From 117 To 126

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## Abstract

Plasma Vitamin 'A' and carotene levels were estimated in 1036 apparently healthy subjects of various ages and socio-economic groups by dietary, clinical and biochemical methods.

In adult population (15-50 ± yrs) Vitamin 'A' for men averaged (mean ± SE)  $42.6 \pm 1.5$  mcg% and carotene  $56.9 \pm 2.8$  mcg%; for women the corresponding values were  $38.27 \pm 2.0$  mcg% and  $52.65 \pm 2.5$  mcg%.

Diet was generally low in vitamin 'A' animal protein and calories especially in children under 15 years of age. Conjunctival xerosis and Bitot's spots were observed in 27% and 1.85%, respectively, in the same age group, plasma Vitamin 'A' and carotene levels (mean ± SE) were  $27.8 \pm 1.3$  mcg% and  $32.3 \pm 2.7$  mcg% in males, and  $26.2 \pm 1.0$  mcg% and  $33.3 \pm 2.8$  mcg% in females, respectively.

Significantly low levels of Vitamin 'A' were noted in 20.4% males and 16.4% females and deficient and low levels of carotene in 51% males and 42% females under 15 years of age.

According to WHO and Pan American Health criteria (dietary and biochemical) only children under 15 years are at "risk" in Karachi (JPMA 37: 117, 1987).

## INTRODUCTION

Vitamin 'A' deficiency is an important public health problem because of its world-wide prevalence, severity, duration of morbidity and mortality pattern.<sup>1-5</sup> Results of previous nutritional surveys and studies in Pakistan indicate suboptimal intake and sub-clinical levels of Vitamin 'A' in certain segments of population. The incidence is particularly high in vulnerable groups like pre-school, school-going children, pregnant and lactating mothers.<sup>6-10</sup>

Information regarding Vitamin 'A' status in various populations is available from many countries,<sup>11-13</sup> such data being non-existent in Pakistan.

Liver reserves of Vitamin 'A' are the best indicators of Vitamin 'A' status<sup>14,15</sup>. Since it is not practical to obtain liver biopsies on survey basis, the assessment of Vitamin 'A' status by dietary, clinical and biochemical methods in field studies of population groups is the most convenient way of determining the prevalence of hypovitaminosis 'A' resulting from insufficient intake of Vitamin 'A'<sup>16-18</sup>. The present study was undertaken to estimate the Vitamin 'A' and carotene levels in a sample of Karachi population in relation to age and sex. It also provides base line data for comparative studies to determine the magnitude of the problem and dietary correlation with Vitamin 'A'.

## MATERIAL AND METHODS

Plasma Vitamin 'A' and carotene levels were determined in 1036 apparently healthy subjects of various ages, sex and socio-economic groups residing in Karachi from July 1976 - June 1979. They were randomly selected from different organisations, educational institutions, MCH centres, attendants of patients, hospital staff and industrial workers.

The age and sex distribution percentage of persons included in this study is consistent with that of the

general population of Pakistan according to census 1972.

### **COLLECTION OF DATA**

The data were assembled on pre-coded proforma. The name, age, sex, occupation, address, general physical health, dietary history, presence or absence of Vitamin 'A' deficiency, heights, weights and results of biochemical investigation were recorded.

### **METHODS OF ASSESSMENT OF VITAMIN 'A' STATUS**

Assessment of Vitamin 'A' was carried out by dietary, clinical and biochemical methods.

### **DIETARY METHODS**

Dietary intake for 1 week was recorded by recall method according to Interdepartmental Committee on Nutrition for National Defence (ICNND)<sup>19</sup>. The nutritional intake was calculated as food consumption per capita per day from food composition table by Pallet.<sup>20</sup> Relative levels of Vitamin 'A', nutrition and criteria for assessment of population of various age groups were taken from WHO<sup>21,22</sup> and International Vitamin 'A' consultative group.<sup>23</sup> Recommended dietary intake for Pakistan were taken from the values assigned by National Health Laboratories<sup>24</sup>.

### **CLINICAL ASSESSMENT**

The clinical manifestations of Vitamin 'A' deficiency (eye and skin lesions) were documented according to WHO/USAID.<sup>25</sup>

### **BIOCHEMICAL METHODS**

The grouping of Vitamin 'A' and carotene was done as described in ICNND<sup>26</sup> The criteria for significance is used as described by Pan American Health Organisation.<sup>27</sup>

### **LABORATORY INVESTIGATIONS**

Vitamin 'A' and carotene levels were estimated by the technique of Neeld and Pearson.<sup>28</sup> Hemoglobin was done by cyanmethemoglobin method<sup>29</sup>. Total lipids, cholesterol and triglycerides were determined in 358 subjects by the methods of Kunkel Ferro and Sigma kit<sup>30-32</sup>. SGOT, SGPT and alkaline/phosphatase were done by Frankel and Wilkinson methods.<sup>33,34</sup> Total protein and albumin were estimated by Gornol and Doumas method<sup>35,36</sup>.

A minimal of 2ml blood was taken from all subjects. 5ml blood was drawn from individuals all subjects. 5ml blood was drawn from individuals in whom detailed biochemical investigations were carried out using disposable syringes.

## **RESULTS**

### **AGE AND SEX**

The study included 1036 (526 males, 510 females) apparently healthy individuals. Forty seven percent were under 15 and 53% over 15 years. The age and sex pattern of the population selected for Vitamin 'A' status proximated to the population structure ascertained by the census 1972.

### **OCCUPATIONAL STATUS**

All subjects were classified into eleven groups. Fortynine percent of the subjects were students (22% males, 27% females). The next were professionals (14.8% males and 7.7% females), then house wives (7.7%) and minors, 10.6% (5.1% males, 53% females)

### **DIETARY DATA**

**TABLE - I**  
**Nurtient intake of Apparently Healthy Males and Females of Various Age Groups.**  
**(Per Person/day)**

Age in Years	Total amount of foods (Grams)		Total Calories		Total Protein (Grams)		Animal Protein (Grams)		Fat (Grams)		Retinol Equivalent mcg	
	M	F	M	F	M	F	M	F	M	F	M	F
0 – 1	–	–	–	–	–	–	–	–	–	–	–	–
1 – 3	538	452	1050	1068	29.8	29.0	11.3	11.7	34.0	29.5	146	140
4 – 6	547	563	1590	1528	45.6	40.0	10.7	9.4	46.6	42.2	195	264
7 – 9	587	553	1660	1552	47.8	43.1	11.1	7.8	44.1	45.8	191	221
10 – 12	588	612	1828	1740	47.0	48.3	9.2	9.8	44.3	49.5	193	222
13 – 15	629	658	1851	1902	49.5	51.7	10.5	9.8	47.5	49.0	264	242
16 – 19	871	811	2283	2058	64.0	59.2	15.2	11.6	72.2	52.2	404	343
20 – 29	840	859	2316	2288	64.3	59.8	16.0	14.5	65.4	51.4	371	438
30 – 39	961	859	2472	2248	68.1	59.4	17.4	15.0	68.4	70.8	492	389
40 – 49	832	696	2204	2026	54.6	55.5	14.4	11.3	65.7	65.1	417	277
50 <sup>+</sup>	704	725	2120	2018	57.8	52.8	14.8	12.0	70.5	68.3	318	264

Table 1 shows the nutrient intake per person per day. Low caloric intake was observed in all age groups except women aged 20-40 years. Proteins intake was generally low in all groups, especially children under 15 years. Fat intake was satisfactory. Vitamin 'A' intake was less than 50% adequacy of RDA for Pakistan (NHL)<sup>24</sup> except in 30-39 years age group. Maximum nutrient intake was also noted in the same age group. The intake of teenagers was found to be less than half, with adequate intake and even below the critical intake (< 250-300 mcg) as assigned by IVACC at which the group was at risk<sup>23</sup> in some age groups under 15 years of age (Figures 1 and 2).

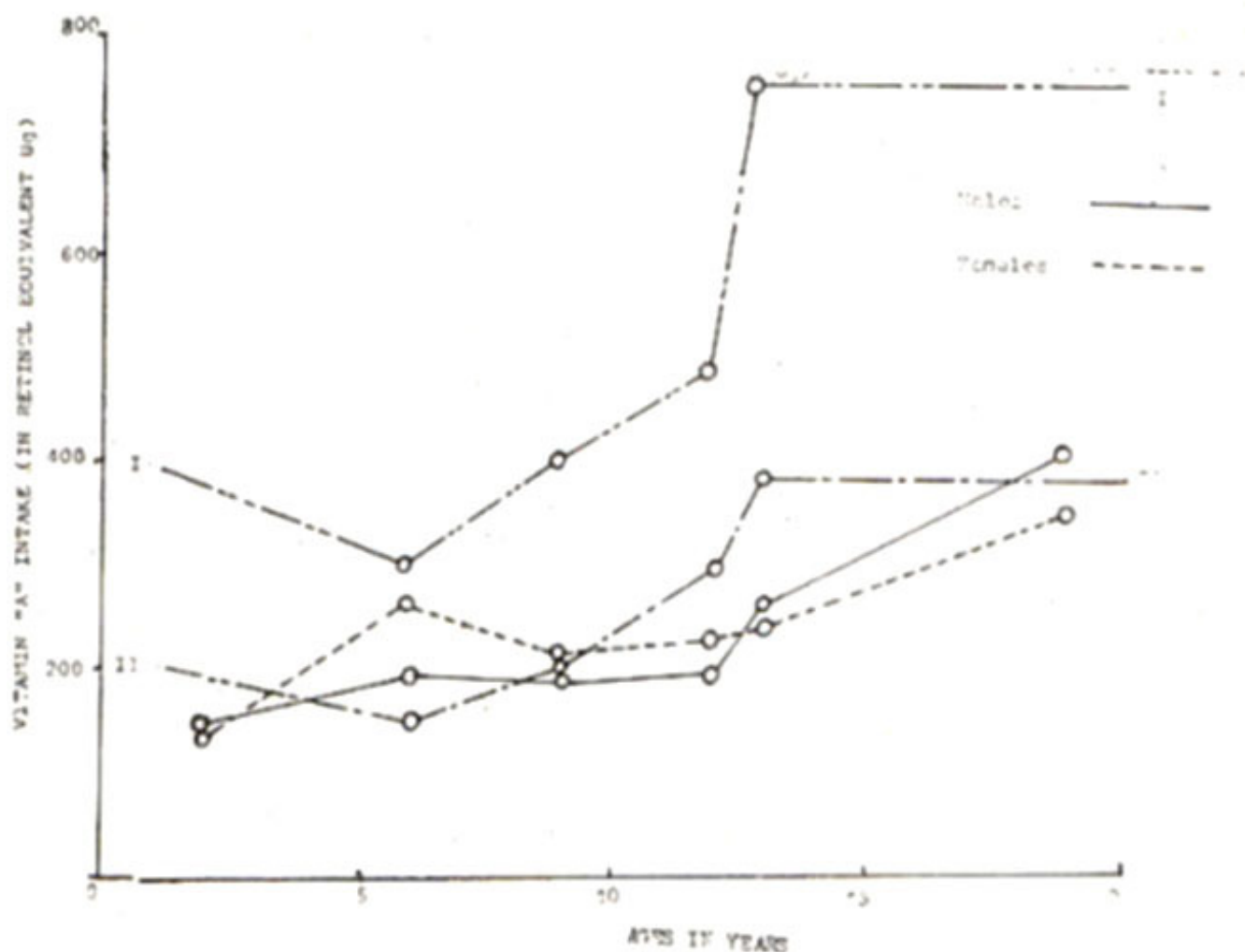
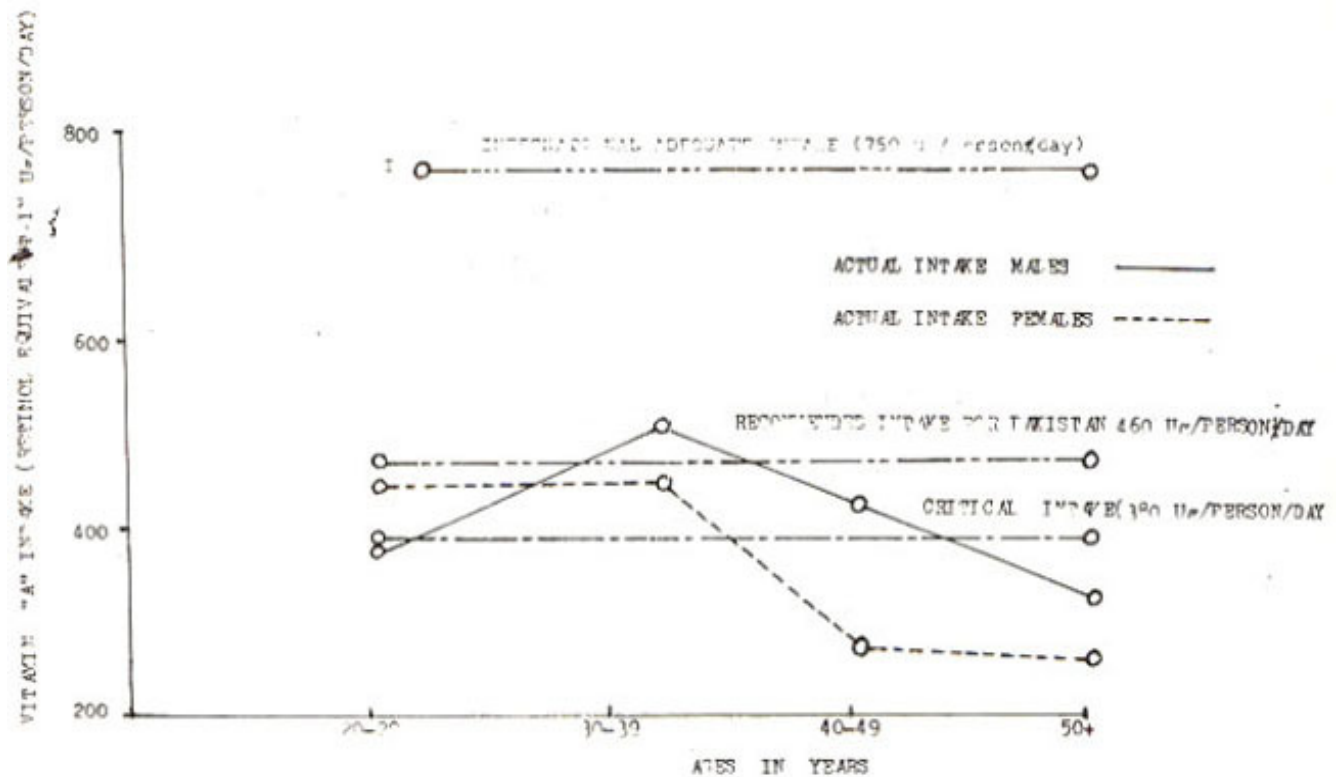


Figure 1. Comparison of Vitamin A intake (0-19 yrs) of Males and Females with (I) International adequate intake of vitamin A (II) with critical intake of vitamin A (in Retinol Equivalents ug/ International adequate intake person/day).



**Figure 2.** Comparison of Vitamin A intake (In Retinol Equivalents ug/person/day) of adult males and Females with I International intake of Vitamin A, II with recommended intake for developing countries and III with critical intake.

Males had higher intake of Vitamin-'A' after the age of 13 years (Figures 1 and 2). After the age of 19 years, Vitamin 'A' intake was much above the critical intake (250-300 mg) assigned by IVAC23 in both sexes (Figure 2). The maximum intake of Vitamin 'A' was seen in males 30-39 years, and in females 20-29 years. The intake of Vitamin 'A' declined at the age of 50 years in males and 40 in females.

#### CLINICAL DATA

All the subjects were thoroughly examined especially for clinical manifestations of Vitamin 'A' deficiency in the eye and skin. According to the classification, Vitamin 'A' deficiency is diagnosed by the sign XIA and XIB (Conjunctival xerosis, Bitot's spot) and follicular hyperkeratosis was maximally seen in school going children ( $P < 0.01$ ). Males frequently exhibited higher percentage of clinical signs than females of the same age ( $P < 0.05$ , Table II).

**TABLE – II**  
**Clinical Manifestation of Vitamin A Deficiency in Pre-School, (0.3 years). School going Children**  
**(4–15 years) and in Males and Females (above 15 years).**

Signs of Vitamin A deficiency	Pre-School 0-3 years			School Going 4-15 years			Adult above 15 years		
	M	F	T	M	F	T	M	F	T
Total No. of cases examined	53	57	110	173	212	385	300	241	541
XIA Xerophthalmia and Thicken bulber Conjunctive	2 (3.7%)	1 (1.75%)	3 (2.7%)	64 (37%)	37 (17.4%)	101 (26.2%)	22 (7.3%)	10 (4%)	25 (5.6%)
XIB Bitot's spots	–	–	–	4 (2.3%)	3 (1.4%)	6 (1.85%)	–	–	–
Follicular Hyperkeratosis				8 (4.9%)	1 (0.5%)	9 (2.3%)	1 (0.3%)	2 (0.8%)	2 (0.55%)

\* P value < 0.05

\*\* P value < 0.01

## BIOCHEMICAL DATA

### PLASMA VITAMIN 'A' LEVELS

The mean plasma Vitamin 'A' levels were found to be normal in all subjects except in children under 15 years where they were in lower limits of normal i.e. < 30 mcg%, (Table III).

**TABLE – III**  
**Mean Plasma Vitamin 'A' Levels in Apparently Healthy Males (526) and Females (510)**  
**in Various Age Groups.**

Age in Years	Nos		Plasma Vit . A ± S.E. (mcg%)		Normal Range (20–50 mcg%) Range Observed	
	M	F	M	F	M	F
0 – < 1	17	20	20.2±1.3	20.4±0.8	11.5–34	11.5–27.5
1 – 3	36	37	24.4±1.1	23.2±0.7	13.5–40	15–33
4 – 6	28	27	25.2±0.8	26.2±1.0	18–32	18–32
7 – 9	57	55	27.3±1.0	28.2±0.9	15–46	20–46.5
10 – 12	50	48	27.6±1.6	27.8±1.3	4.5–63.5	15–54
13 – 15	28	82	35.4±2.1	31.5±1.2	18.5–51.5	15.5–67
16 – 19	70	39	40.9±1.2	37.1±1.6	21–57	16.5–53.5
20 – 29	93	96	41.7±1.2	37.3±1.1	15–77.5	17.0–66.5
30 – 39	55	50	43.9±1.3	44.2±1.9	18–63	22–98
40 – 49	51	31	46.5±2.3	38.8±2.7	28–113.5	21.5–97
50 <sup>+</sup>	41	25	40.3±1.6	36.3±2.7	21–64	20–76

Note: Mean Plasma vitamin A was found to be 27.8±1.3 in males and 26.2±1.0 in females under 15 years, 42.6±1.5 in males and 38.27±2.0 in females over 15 years of age.

Plasma Vitamin 'A' increased with age, the mean values ran parallel in both sexes upto 12 years of age; difference thereafter widened and males had higher values of Vitamin 'A' than females. The highest levels were reached in the age 40-49 years in males and 30-39 years in females. Decline was observed from the age of 50 years in males and 40 years in females (Figures 3 and 4).

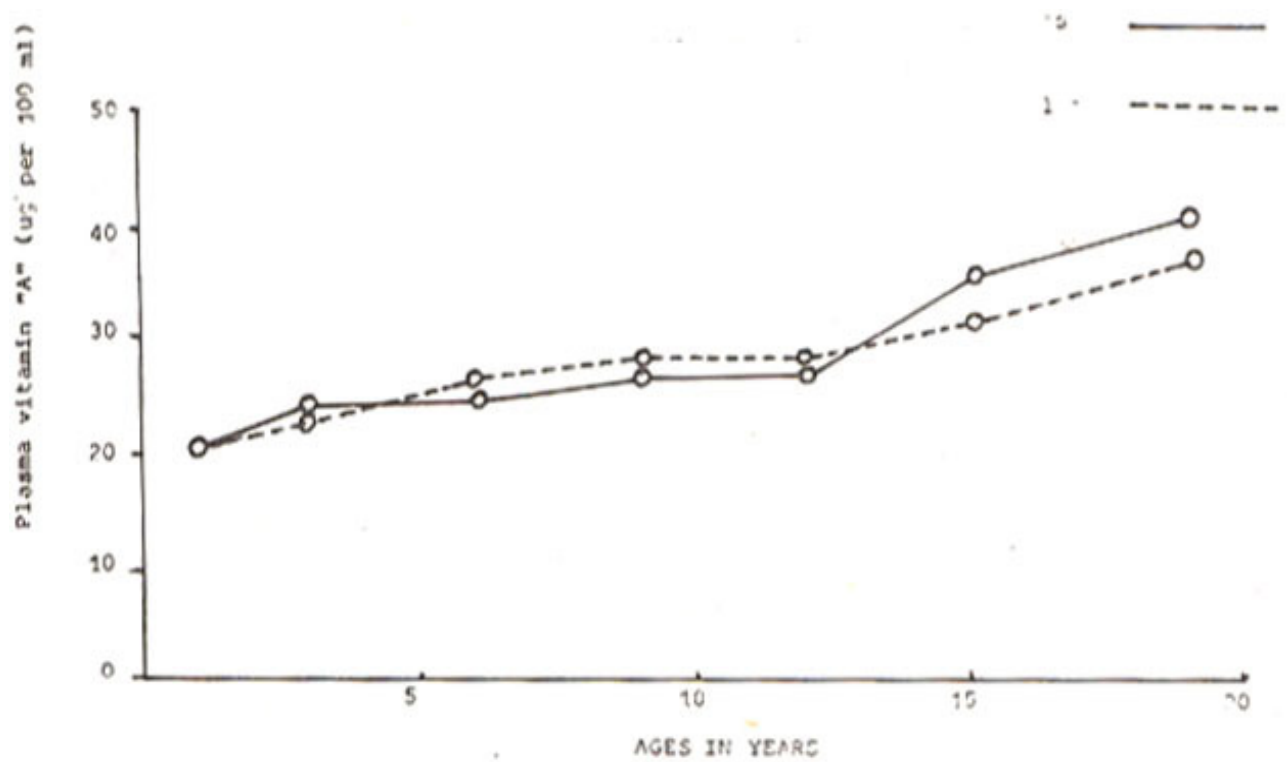


Figure 3. Mean Plasma Vitamin A levels in (0-19 yrs) Males and Females.

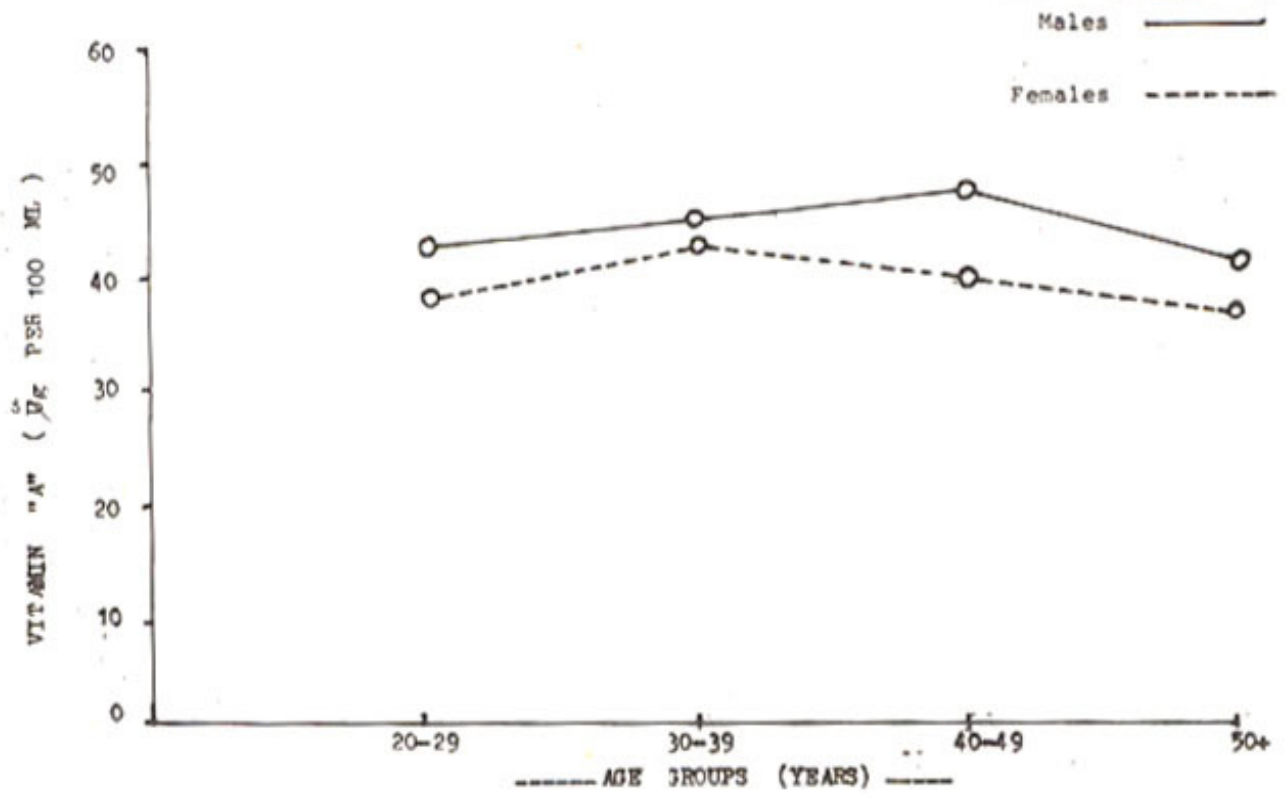


Figure 4. Mean Plasma Vitamin A Levels in apparently Healthy Males and Females of various age groups.

**PLASMA CAROTENE LEVELS**

The mean carotene levels were found to be deficient and low in children upto 12 years of age in both sexes. All other groups had normal values, with maximum values of carotene in males at 40-49 years, in females 30-39 years of age (Table IV).



**TABLE – IV**  
**Mean Plasma Carotene Levels in Apparently Healthy Males (526) and Females (510) of Various Age Groups.**

Age in Years	Nos		Plasma Carotene (mcg% ± S.E.)		Normal Range (40–100 mcg%) Range Observed	
	M	F	M	F	M	F
0 – <	17	20	12.0±2.3	10.1±3.0	0–26	0–26
1 – 3	36	37	28.2±2.2	26.9±1.6	0–45	8.5–50.5
4 – 6	28	27	35.5±2.1	30.7±1.5	25–48	20–60
7 – 9	57	55	36.4±2.4	43.8±1.8	0–55	0–80
10 – 12	50	48	38.1±1.5	43.0±2.3	19–60	0–80
13 – 15	28	82	43.7±2.5	46.2±1.4	15–90	15–80
16 – 19	70	39	54.3±2.1	44.2±1.8	30–120	20–65
20 – 29	93	96	56.1±2.1	54.2±2.2	0–125	0–125
30 – 39	55	50	52.7±2.6	58.7±3.8	15–125	30–180
40 – 49	51	31	65.8±3.3	50.6±2.8	32–150	20–100
50 <sup>+</sup>	41	25	55.7±3.9	55.5±4.1	15–150	0–90

Note: Mean carotene levels in males was 32.3±2.7 mcg% 30.7± 1.96 and in females under 15 years age, 56.9±2.8 in males and 52.65±2.4 in females over 15 years age.

Carotene levels also increased with advancement of age but no sex difference was recorded in this series (Figures 5 and 6).

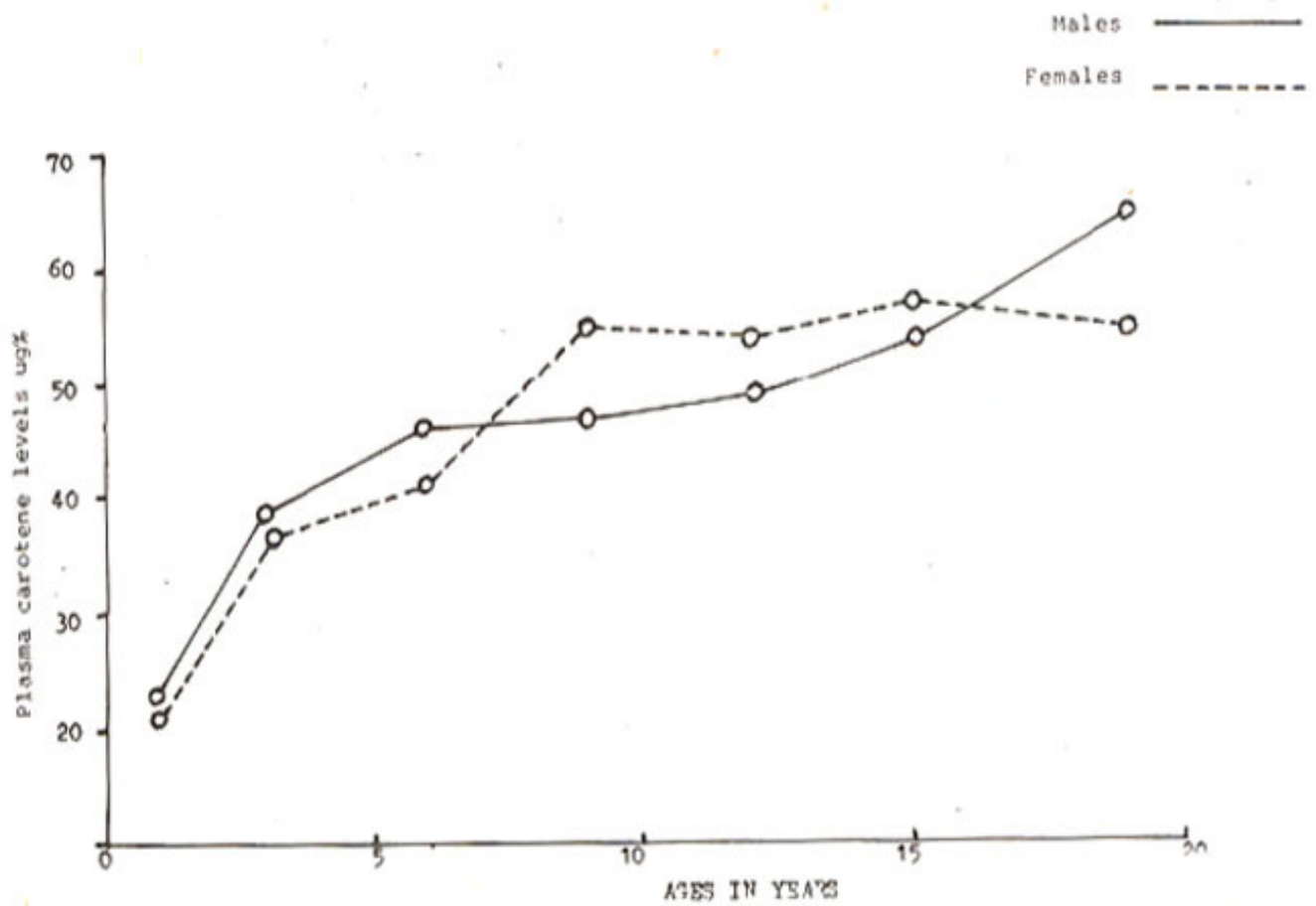


Figure 5. Mean Plasma Carotene levels in (0-19 yrs) Males and Females.

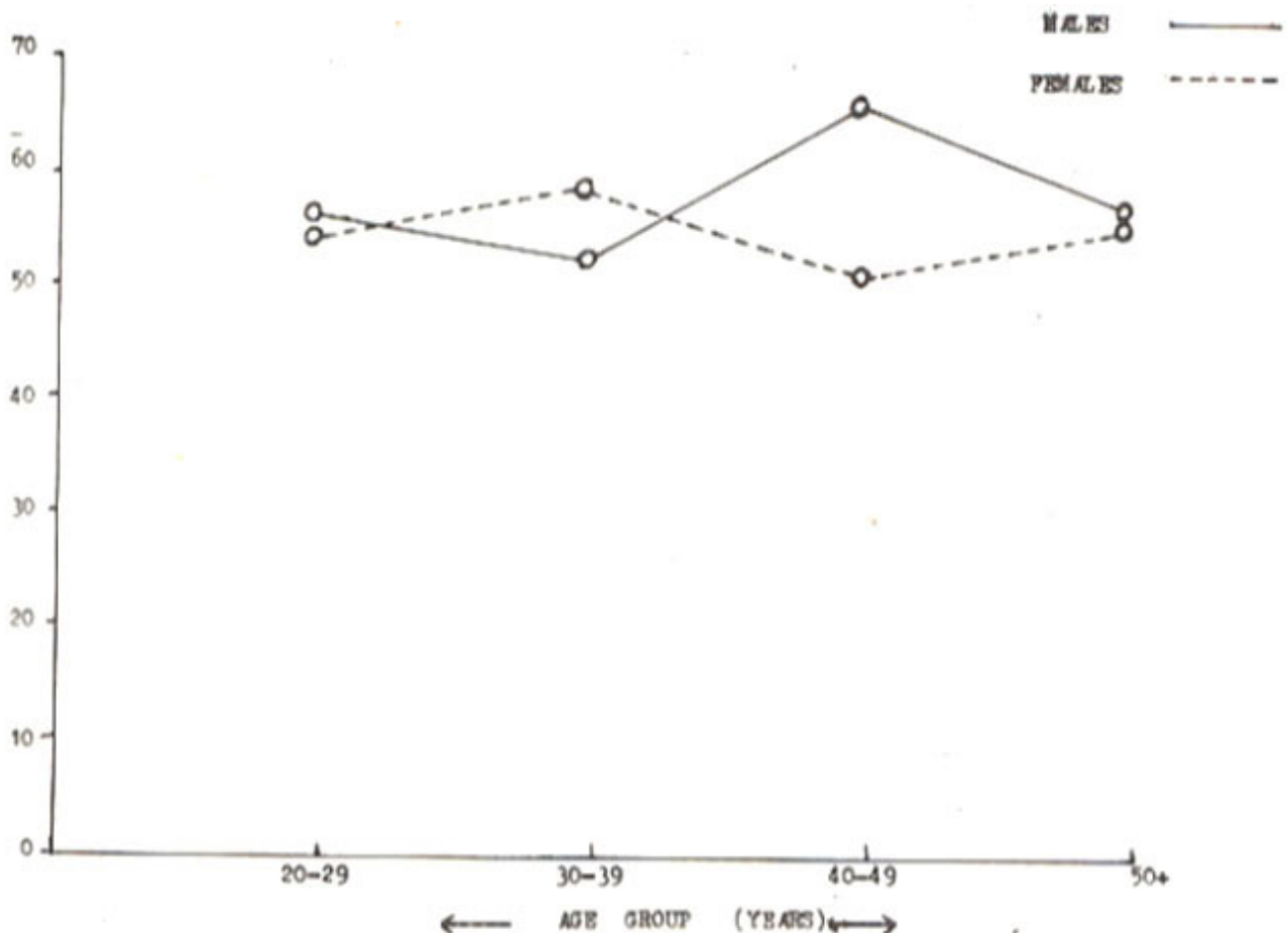


Figure 6. Mean Plasma Carotene Levels in Apparently Healthy Males and Females of various Age Groups.

**GROUPING OF INDIVIDUALS ACCORDING TO ICNND) CLASSIFICATION (1963)9 OF PLASMA VITAMIN A AND CAROTENE**

When subjected to ICNND classification (1963), the maximum deficiency of Vitamin 'A' was observed in children under 15 years of age, the number of males significantly higher than females (Table V)

TABLE -V

Comparison of Percent Distribution of Vitamin 'A' Levels in Males and Females under 15 Years & Over 15 Years. (Total Nos. given in Parenthesis).

S. No.	Grouping of Plasma Vitamin 'A' (ICNND) Classification	Under 15 Years		Over 15 Years		P. Value
		M (216)	F (269)	M (310)	F (241)	
1.	Deficient (0-9 mcg%)	-	-	-	-	
2.	Low (10-19 mcg%)	44 (20.4%)	44 (16.36%)	4 (1.29%)	5 (2.09%)	*
3.	Acceptable (20-40 mcg%)	167 (77.3%)	219 (81.41%)	264 (85.15%)	210 (87.13%)	**
4.	High (50 mcg%)	5 (2.3%)	6 (2.23%)	42 (13.55%)	26 (10.78%)	

\* P Value < 0.05

\*\* P Value < 0.01

Deficiency of carotene was generally seen in children under 15 years of age as compared to adults, and the number of males was significantly ( $P < 0.01$ ) higher as compared to females in the same age group (Table VI).

TABLE - VI

Comparison of Percent Distribution of Plasma Carotene in Males and Females Under 15 Years and Over 15 Years (Total Nos. given in Parenthesis).

S. No.	Grouping of Plasma Carotene (ICNND) Classification	Under 15 Years		Over 15 Years		P. Value
		M (216)	F (269)	M (310)	F (241)	
1.	Deficient (0-19 mcg%)	35 (16.2%)	33 (12.0%)	3 (1.00%)	5 (2.2%)	*
2.	Low (20-39 mcg%)	76 (35.2%)	82 (30%)	42 (13.6%)	20 (8.39%)	**
3.	Acceptable (40 - 100mcg%)	105 (48.6%)	154 (58.0%)	256 (82.5%)	212 (87.9%)	***
4.	High (100 mcg%)	-	-	9 (2.9%)	4 (1.6%)	

\* P Value < 0.05

\*\* P Value < 0.01

### INFLUENCE OF PROTEIN INTAKE, FAT INTAKE AND VITAMIN 'A' INTAKE ON PLASMA VITAMIN 'A'

A positive correlation co-efficient was found between plasma Vitamin 'A' and Protein Healthy Males and Females of various Age intake ( $r=0.91$  in males and  $0.78$  in females), with fat intake ( $r=0.90$  in males and  $0.6$  in females) and with Vitamin 'A' intake ( $r=0.92$  in males and  $0.84$  in females).

### CORRELATION COEFFICIENT PLASMA CAROTENE, TOTAL SERUM PROTEIN, ALBUMIN AND TOTAL LIPIDS

A positive correlation coefficient was observed between plasma Vitamin 'A' with plasma carotene (r=0.80 for males and 0.88 for females), with serum total protein (r=0.89 in males and 0.83 in females) with albumin (r=0.76 in males and 0.78 in females) and with serum total lipid (r=0.78 in males and 0.81 in females).

## **DISCUSSION**

The present study included 1036 randomly selected apparently healthy individuals of a fairly representative population of Karachi as regards age, sex and socio-economic status. Since it is a cosmopolitan city, this represents a cross sectional sample of all the people belonging to different categories and professions and thus reflects the general population.

### **DIETARY ASSESSMENT**

Like most other highly populous and under developed countries, the diet is generally low in calories, proteins, (especially animal origin) and Vitamin 'A', especially in children under 15 years of age (Table I).

The present dietary findings are similar to previous nutritional surveys conducted with in the country<sup>7,8,9</sup> and else where<sup>17,37-40</sup>.

### **CLINICAL ASSESSMENT**

Borderline deficiency state has been observed at varying frequency as shown by the occurrence of Bitot's spots, conjunctival xerosis and follicular hyperkeratosis (Table II)<sup>6-10</sup>

Vitamin 'A' deficiency generally seems to occur at any age but the clinical xerophthalmia is predominantly a disease of the infants and preschool children<sup>35,41,44</sup>. In this study the clinical signs of Vitamin 'A' deficiency were maximally observed in school going children (Table II). The higher occurrence of Vitamin 'A' deficiency in this age group may be due to diet deficient in Vitamin 'A' (below critical intake) and lacking in some essential nutrients such as animal protein and calories (Table 1, Figure 1). These observations to those of other investigators<sup>2,44,47</sup> but differed from the Jordan and West Pakistan survey report<sup>44,7</sup>. The relative resistance of infants and preschool children is probably attributable to most of the infants included in this study having been breast fed upto 2 years. The mother's milk, not itself a good source of Vitamin 'A' is apparently adequate to prevent manifestations of clinical signs<sup>21</sup>.

The study also shows a good correlation of clinical manifestation of vitamin deficiency with inadequate intake of Vitamin 'A' in children under 15 years of age. As this intake increased above the critical intake, the signs of Vitamin 'A' deficiency disappeared P<0.05) (Table 11, Figures 1 and 2).

### **BIOCHEMICAL ASSESSMENT**

According to ICNND<sup>19</sup> the mean values of plasma Vitamin 'A' and carotene were considered normal for this population (Table III and IV) as the specimens were taken from apparently healthy subjects, free at that time from systemic diseases which could interfere with liver function<sup>14,48</sup> and with the absorption of lipids,<sup>15</sup> as accordingly by the estimation of lipids and normal values of liver function tests in these subjects.

Although the mean values of Vitamin 'A' were found to be within normal range in all age groups, children upto 12 years (groups 1-5) had mean values of Vitamin 'A' in the lower limits of normal range (Table III) below 30mcg% with an average intake of Vitamin 'A' below the critical intake (Table I and Figure 1) as assigned by IVACG (1976)<sup>23</sup>. Low plasma carotene levels reflect low carotene intake in these subjects. The mean values of Vitamin 'A' are similar to the mean values reported from Guatemala,<sup>49-51</sup> and United States<sup>52</sup>.

In adults, the mean values of Vitamin 'A' and carotene were found in the upper limit of norms (Table III and N). However, they were also lower than those found in developed countries, like U.K., U.S.A. and

Canada<sup>11,13</sup> but higher than Thailand.<sup>53</sup> This may be due to the intake of Vitamin 'A' in these subjects (Table 1, Figure 3) being inadequate compared to the intake recommended by WHO<sup>22</sup> whereas the intake of Vitamin 'A' was adequate in developed countries.<sup>11,54,55</sup>

### **SEX AND AGE**

Variations in Plasma Vitamin 'A' values were observed with age and sex.<sup>56</sup> Many investigators reported that males had higher levels of Vitamin 'A' and lower levels of carotene than females.<sup>57,11,13</sup> The present study shows no variations in plasma Vitamin 'A' upto 12 years of age and the results match those of Kothari<sup>58</sup>, but in later age groups, the difference between males and females widen (Figure 3 and 4), as males had Vitamin 'A' levels higher than those of females, possibly attributable to comparatively higher intake of Vitamin 'A' in males.

This study shows that the mean plasma Vitamin 'A' levels increased with age, maximising at 40-49 years in males and 30—39 years in females, declining thereafter in both sexes. These findings are similar to those of Leitner<sup>11</sup>. except that maximum levels were attained here at earlier age. This may be due to an inadequate intake of Vitamin 'A' in these younger individuals whereas in developed countries the Vitamin 'A' intake is adequate at all ages.<sup>55,11,54</sup>

Higher carotene levels were reported in females from various countries<sup>57,11,13</sup> while, in this study, no such differences were observed. The levels, however, progressively increased with the advancement of age upto 40-49 years in males and 30-39 years in females (Figures 5 and 6).

Vitamin 'A' and carotene levels are known to decline in elderly subjects<sup>55,11</sup>. As observed in the present series (Figures 4 and 6).

### **DIETARY CORRELATIONS**

The primary dietary factors, influencing the serum Vitamin 'A' and carotene concentrations, are the amount and sources of Vitamin 'A', protein and fat.<sup>57,59</sup> The positive correlation co-efficient between plasma Vitamin 'A' and these nutrients was reaffirmed in present study.

Similarly positive correlation co-efficient between plasma Vitamin 'A' with plasma carotene, total protein, Albumin and lipids have also been found in this study.<sup>60,61,58,15</sup>

### **INCIDENCE OF LOW PLASMA VITAMIN 'A' AND CAROTENE LEVELS**

The present study like others shows that 20.4% males and 16.6% females had low levels of Vitamin 'A' in children Under 15 years of age (Table 5 and 6) due to low intake of Vitamin 'A'<sup>17,16,62,18,63,64</sup>. As hypovitaminosis 'A' presents a public health problem in children under 15 years, a curative and preventive programme should be launched to protect children from Vitamin 'A' deficiency diseases caused by low intake of Vitamin 'A' precursor, carotenoids. This can be achieved by either oral or parenteral administration of Vitamin 'A' rich foods.

It is recommended that preferably pharmaceutical preparations, containing high doses of Vitamin 'A' should be given to infants and growing children through MCH centre, school health services and the public health department.

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