Vitamin D status in different subgroups of British Asians

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Summary

To assess the effect of religious dietary practices and social customs on the vitamin D status of Asian immigrants, we kept records of the dietary intake and time spent out of doors of 81 Ugandan Asian men, women, and girls (9-19 years old). Sera were analysed for 25-hydroxycholecalciferol (25-OHD$_3$), and 28% of the subjects were found to have levels below the lower limit of normal. The (vegetarian) Hindus had the lowest dietary intakes, least time out of doors, and lowest serum 25-OHD$_3$. The Goan (Roman Catholic) Asians, despite more pigmentation, had 25-OHD$_3$ levels similar to those found among indigenous British people and had the most satisfactory vitamin D intakes. Among Asians, whose exposure to sunlight may be limited, dietary vitamin D becomes the major determinant of serum 25-OHD$_3$.

Introduction

Rickets and osteomalacia were first reported among Asian immigrants to Britain in 1962,[1] but only since the development of a protein binding assay for 25-hydroxycholecalciferol (25-OHD$_3$)[2] has it become possible to assess directly their vitamin D status. Reports indicate that Asian adolescents and pregnant women living in Britain have low serum 25-OHD$_3$ concentrations.[3 4]

The poor dietary intake of vitamin D by Asians,[3 5] particularly vegetarian women,[4] has been implicated as a causative factor. The diets eaten by Asians in Britain are, however, thought to differ little from those eaten in India, where the incidence of vitamin D deficiency is lower.[6] It has been suggested that this is due to more adequate exposure to sunlight in India. The custom of Asian girls and women to remain indoors and wear traditional dress[7 8] is thought to limit their exposure to sunlight in Britain. Asian men are thought to be protected from vitamin D deficiency by a liberal diet eaten at work and more exposure to sunlight.[9] The serum 25-OHD$_3$ concentrations of Asians in Britain rise during the summer months but less steeply than among Whites.[10]

Reports of dietary studies show that the Indian diet is high in phytic acid[3]; there have been suggestions that this may hinder calcium absorption.[11] Nevertheless, withdrawing chapatties for four days did not affect the calcium balance of an adolescent Kenyan Asian boy.[7] Indeed, it has been suggested that to improve the vitamin D status of Asians chapatti flour could be fortified with vitamin D.

Our study was undertaken to assess the vitamin D status of Ugandan Asians and to investigate the relation of religious dietary practices[12 13] and social customs to the incidence of vitamin D deficiency. The subjects were taking part in a larger continuing study of the adaptation of food habits of Ugandan Asians settling in this country. Because they had been expelled from Uganda two years earlier all the subjects had lived in Britain for the same period. On average, Ugandan Asians are better educated and might therefore be expected to have less vitamin D deficiency than most Asian immigrants.

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Methods

The subjects were apparently healthy Asians who had arrived from Uganda in September 1972. All 34 families who were taking part in a larger study and who lived in Greater London or Reading and had a girl aged 9-19 years were asked for their co-operation, and 32 (94%) agreed to participate. The families belonged to five religious communities: Roman Catholics, who originate from Goa; Ismailis, who are a subgroup of Moslems who follow the Aga Khan and lead a more Western way of life; Moslems; Sikhs; and Hindus. Blood was taken from women and men aged over 35 years and from girls (aged 9-19) in each family (total 81 people) during one week in October 1974. The mean ages of the women, men, and girls were 43·2 years, 48·6 years and, 13·5 years, respectively. No boys were sampled. The autumn was chosen because serum 25-OHD$_3$ concentrations should be at their maximum after the summer.[10] All blood samples were taken in the subjects' homes and the sera were separated within two hours, deep frozen, and kept at -20°C. Serum 25-OHD$_3$ was measured by the competitive protein binding assay of Preece *et al*.[2]

At some time in the next 15 weeks each individual measured his or her dietary intake over five days (Tuesday to Saturday). The method combined the weighed inventory and household measures methods.[14] When possible the subjects weighed food on a flat-top balance and entered the weight in their record books. Otherwise special ladles were provided for serving with, and the number of ladles of food taken (including halves) was recorded. This system had to be used for Asian dishes, as people help themselves to food continually during the meal (unlike the British habit of taking one or two helpings) and to weigh food each time they took it would have been impractical. All the ingredients used in the Asian dishes were weighed and recorded by the same investigator (SPH) while the food was being prepared. This was necessary because few nutrient analyses of prepared Asian dishes are available. Food eaten outside the home was recorded by size of helpings. The schools where the children ate lunch were contacted and recipes obtained for all dishes eaten. During the five-day study all the families were visited at least twice a day, once while they were cooking for the investigator to weigh ingredients and again later in the evening to discuss and update the record books kept by the individual family members.

The energy and nutrient content of the dishes were calculated from tables for the composition of foods based on those of McCance and Widdowson[15] with additions from other tables.[16 17] To convert the five-day measured intake to the corresponding seven-day value the Saturday intake was doubled to represent Sunday and a mean for the four measured weekdays was added (to represent Monday). The seven-day total was then divided by seven to give the daily nutrient intake.

Each individual also kept a diary of the time spent out of doors throughout the six days from Tuesday to Sunday. These entries were checked and clarified every evening. An average of the weekdays' values was added to represent Monday, giving a value for the whole week. The values given for time out of doors did not differentiate between clear or cloudy daylight or night (though few people went out at night), and no account was taken of clothing, which varied with sex, religious group, and age.

Statistical methods—Non-parametric significance tests were used. Kendall's τ was used to obtain correlation coefficients and the Mann-Whitney test was used to test for significant differences between groups.

Results

Table I gives the mean vitamin D intakes, serum 25-OHD$_3$ levels and time spent out of doors according to religion, sex, and age. The mean daily vitamin D intake of all the subjects was 1·30 μg (52 IU): the women received least (0·80 μg), the men 1·50 μg, and the adolescent girls most (1·63 μg). The difference between the vitamin D intake of the women and that of the other groups was significant ($P = 0{\cdot}0001$). The women spent significantly less time outside than the other subjects ($P = 0{\cdot}001$). The mean time in the open air for all subjects was 332 minutes per week, but there was much individual variation (0-1140 minutes).

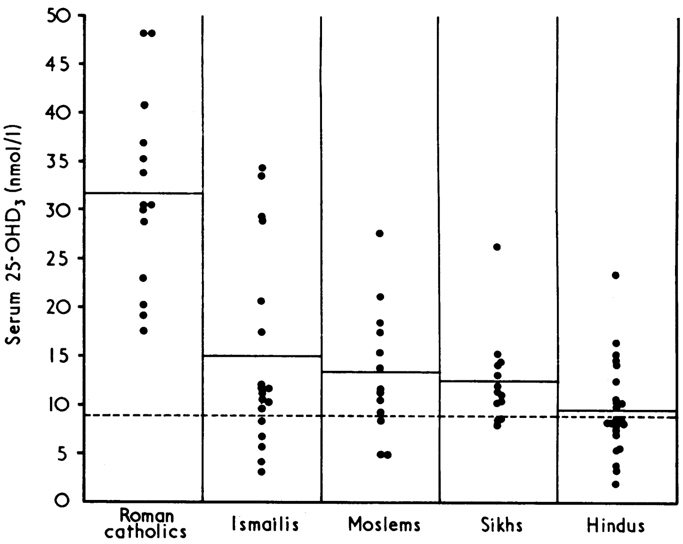
The serum $25\text{-}OHD_3$ levels in women, girls, and men did not differ significantly. The mean level was 15·7 nmol/l (6·3 ng/ml). Twenty-eight per cent of the subjects were found to have levels below 8·n nmol/l (3·5 ng/ml). There was a significant correlation between vitamin D intake and serum $25\text{-}OHD_3$ levels in all subjects ($\tau = +0{\cdot}25$; $P = 0{\cdot}001$.) A correlation was also found between time outdoors and serum $25\text{-}OHD_3$ levels ($\tau = +0{\cdot}15$; $P = 0{\cdot}026$).

The figure shows the serum $25\text{-}OHD_3$ concentrations in the five religious communities. The Roman Catholics had significantly higher serum $25\text{-}OHD_3$ levels ($P = 0{\cdot}0001$) and vitamin D intakes ($P = 0{\cdot}0237$). The Hindus had a low mean serum $25\text{-}OHD_3$ concentration of 9·7 nmol/l (3·9 ng/ml), and over half (13 out of 23) had levels below the lower limit of normal (8·7 nmol/l (3·5 ng/ml)). Both their serum $25\text{-}OHD_3$ levels and vitamin D intakes were significantly lower than those of the other religious groups ($P < 0{\cdot}0002$).

The Hindus also spent less time outside, but not significantly less than the other religious groups. Women of all groups received significantly less sunlight than men and girls ($P = 0{\cdot}001$).

In this study Goans had the smallest families (mean 4·0 persons) and Sikhs the largest (mean 8·0). Excluding the Goans, who also had the highest vitamin D intakes, there was no relation between family size and family mean serum $25\text{-}OHD_3$ levels.

Table II gives the amounts of vitamin D supplied daily by different foods in the diet for men, women, and girls. Considerably less vitamin D was contributed to the diet by margarine and oily fish than in the general British population.[18] Women received significantly less from margarine than men and girls ($P = 0{\cdot}0006$).



Concentrations of serum $25\text{-}OHD_3$ in each regligious group. Horizontal bars represent means, and horizontal dotted line indicates lower limit of normal in Europeans (8·7 nmol/l (3·5 ng/ml)).

Conversion: SI to traditional units—$25\text{-}OHD_3$: 1 nmol/ ≈ 0·4 ng/ml.

TABLE I—*Mean serum $25\text{-}OHD_3$ values, vitamin D intake, and time spent outside ($\pm SD$) according to religion, age, and sex*

	No of subjects	Serum 25–OHD$_3$ (nmol/l)	Vitamin D intake (μg/day)	Time outdoors (min/week)
		Men		
Roman Catholics	5	32·7	2·08	441
Ismailis	6	12·0	1·13	413
Moslems	3	12·0	2·30	847
Sikhs	2	12·2	1·38	375
Hindus	7	10·2	1·05	317
All religions	23	16·0 ± 10·7	1·50 ± 1·30	443 ± 285
		Women		
Roman Catholics	4	38·7	1·10	282
Ismailis	7	14·7	0·80	202
Moslems	4	11·7	1·15	250
Sikhs	4	11·5	1·25	174
Hindus	10	9·5	0·35	157
All religions	29	15·5 ± 12·7	0·80 ± 0·65	200 ± 147
		Girls		
Roman Catholics	5	25·0	2·35	348
Ismailis	5	19·0	1·05	391
Moslems	6	15·5	1·95	375
Sikhs	7	13·2	0·83	377
Hindus	6	9·5	0·85	378
All religions	29	16·0 ± 8·0	1·63 ± 1·00	374 ± 153
		All subjects		
Roman Catholics	14	31·7 ± 9·7	1·90 ± 1·28	362 ± 191
Ismailis	18	15·0 ± 10·0	0·98 ± 0·63	325 ± 242
Moslems	13	13·5 ± 6·5	1·80 ± 1·28	440 ± 299
Sikhs	13	12·5 ± 4·7	1·58 ± 0·93	314 ± 171
Hindus	23	9·7 ± 4·7	0·68 ± 0·80	263 ± 172
All religions	81	15·7 ± 10·5	1·30 ± 1·05	332 ± 220

Recommended intake of vitamin D for adults and adolescents[23]: 2·5 μg/day.
Mean vitamin D intake in UK[18]: 2·89 μg/day.
Mean daylight exposure of White children in winter[28]: 563 min/week.
Conversion: SI to traditional units—$25\text{-}OHD_3$: 1 nmol/l ≈ 0·4 ng/ml.

TABLE II—*Vitamin D from different dietary sources according to age and sex (μg/day*)*

	No of subjects	Fish	Margarine	Eggs	Butter	Milk
Men	23	0·11	0·40	0·51	0·22	0·10
Women	29	0·00	0·10	0·35	0·16	0·08
Girls	29	0·10	0·63	0·46	0·17	0·07
All subjects	81	0·07	0·38	0·43	0·18	0·08
National Food Survey[18]		0·49	0·97	0·45	0·27	0·10

*1 μg is equivalent to 40 IU.

TABLE III—*Vitamin D from different dietary sources (μg/day) by religious groups*

	No of subjects	Vitamin D intake (μg/day)	Margarine	Fish	Eggs	Butter	Milk
Roman Catholics	14	1·90	0·31	0·41	0·88	0·13	0·05
Ismailis	18	0·98	0·24	0·00	0·32	0·10	0·08
Moslems	13	1·80	0·78	0·00	0·41	0·21	0·07
Sikhs	13	1·58	0·49	0·00	0·60	0·30	0·10
Hindus	23	0·68	0·22	0·00	0·17	0·19	0·09
All religions	81	1·30	0·38	0·07	0·43	0·18	0·08
National Food Survey[18]			0·97	0·49	0·45	0·27	0·10

TABLE IV—*Daily mean intakes (±SD) of calcium, phosphorus, phytic acid, and chapatti flour by religious groups*

	No of subjects	Calcium (mg)	Phosphorus (mg)	Phytic acid* (mg)	Chapatti as flour (g)
Roman Catholics	14	575±222	959±364	90±56	6±10
Ismailis	18	681±267	816±251	105±42	42±37
Moslems	13	766±335	984±317	139±58	54±55
Sikhs	13	897±240	1106±279	187±57	81±51
Hindus	23	720±292	784±259	150±49	72±36
All religions	81	723±286	906±307	134±60	52±46

*As phosphorus.

In table III the dietary sources of vitamin D are given by religious groups. The Roman Catholics were the only community eating oily fish. Moslems received more vitamin D from margarine than the other religious groups ($P=0.05$). The Catholics got more vitamin D from eggs than from other items ($P=0.0006$), while the Hindus derived the least amount of vitamin D from eggs ($P=0.0001$). The contribution made by butter and milk varied little between the religious groups, with the exception of the Sikhs, who received more vitamin D from butter than the other groups ($P=0.002$).

Table IV gives the daily calcium, phosphorus, phytic acid, and chapatti flour intakes by religious groups. The Sikhs had the largest intakes of phosphorus and phytic acid ($P=0.008$; $P=0.001$), owing to their higher consumption of chapatti flour and also legumes. The daily intake of chapatti flour by Sikhs averaged 81 g (range 11-174 g). In the other groups the means ranged from 72 g (for Hindus) down to 42 g/day (for Ismailis), except for Roman Catholics, who ate very little—only an average of 6 g chapatti flour a day.

Despite the absence of any significant correlation between dietary phytic acid and serum 25-OHD_3 levels a sigfinicant negative correlation was found between chapatti flour intake and serum 25-OHD_3 ($\tau=-0.30$; $P=0.001$). Levels of serum 25-OHD_3 as low as 3·3 nmol/l (1·3 ng/ml) were found in people eating only 11 g of chapatti flour a day, however, which suggested that chapatti flour was not in itself causative. The correlation was probably due to the tendency of people on low chapatti flour diets to have high vitamin D intakes. When the Roman Catholic group were excluded there was no significant correlation between chapatti flour intake and serum 25-OHD_3 levels ($\tau=-0.10$; $P=0.122$).

Discussion

The mean serum 25-OHD_3 concentration of the Ugandan Asians taking part in the survey was 15·7 nmol/l (6·3 ng/ml). This is considerably lower than the normal level of 30 nmol/l (12 ng/ml) in the British population and is similar to levels of 8·7 nmol/l (3·5 ng/ml) and 11·7 nmol/l (4·7 ng/ml) reported previously among apparently healthy Asians.[2 19] The subjects had blood taken for this survey in October, and their serum 25-OHD_3 levels had probably risen during the summer.[10] Hence their mean of 15·7 nmol/l (6·3 ng/ml) probably represented their peak level of 25-OHD_3.

Twenty-eight per cent of the sample had serum 25-OHD_3 levels of under 8·7 nmol/l (3·5 ng/ml)—that is, levels that are found in patients with clinically overt disease. This finding is consistent with those of earlier reports which suggested that about a quarter of Asians have biochemical rickets or osteomalacia.[19]

There was a significant positive correlation between dietary vitamin D and serum 25-OHD_3 levels and a weaker but still significant correlation between the time spent outside and serum 25-OHD_3 levels, although the mean 25-OHD_3 level in women was the same as that in girls and men who received more dietary vitamin D and went outside more. Apart from the Catholics, the Ismailis had higher 25-OHD_3 levels than the other groups but spent no more time outside and had a lower vitamin D intake. The lengths of time spent outside were not adjusted for cloud cover, but these values give an index of potential exposure to sunlight. The values allow the groups to be compared but are greater than the time of exposure to direct sunlight. The stronger influence of dietary vitamin D on 25-OHD_3 levels in the sample might suggest that in Asian communities, where exposure to sunlight is limited, dietary vitamin D becomes the most important factor determining vitamin D status, although vitamin D intakes usually correlate poorly with serum 25-OHD_3 levels.[7]

The serum 25-OHD_3 levels of men, women, and girls did not differ significantly. They did, however, differ between religious communities. Lower 25-OHD_3 levels have been reported among vegetarian Asians than among non-vegetarian Asians.[4] In this sample Hindus had significantly lower serum 25-OHD_3 values than the other religious communities. Hindus are predominantly vegetarian, and they rely largely on milk and butter for their dietary vitamin D and use little margarine; they had significantly lower vitamin D intakes than the other groups.

The Roman Catholic Goans had the highest serum 25-OHD_3 levels. Levels were similar to those found among British Whites.[19] The Goans' Western-type diet supplied more vitamin D than the traditional Eastern diets eaten by the other groups, although they still received only 66% of the average British vitamin D intake. Fish was a particularly important contributor to the vitamin D intake of the Catholics, who originate from the coastal state of Goa. Few other Ugandan Asians took fish as part of their diet because this was not customary in the areas of India from which they originate.[20] The Catholics were more darkly pigmented than the other groups in the sample,[21] but they wore Western dress, and, as with West Indians,[19] their pigmentation was not associated with low 25-OHD_3 levels.

Moslems, Ismailis, and Sikhs have maintained their traditional Eastern diet in Britain, but, unlike the Hindus, are not vegetarian. Their vitamin D intakes and serum 25-OHD_3 values were intermediate between those of the vegetarian Hindus and the Roman Catholics. Most of the Ugandan Asians received considerably less vitamin D from margarine and fish than the British, but had similar intakes of eggs, butter, and milk. The men and girls ate more margarine than the women, largely because they took food provided at work or school.

It is necessary to point out that any discussion of vitamin D intakes is limited by the shortage of accurate and up-to-date analyses of the vitamin D content of foods. Calcium intakes were lower than the average British intake[18] but usually exceeded the recommended intake.[23] About half the calcium was supplied by milk and 14% by bread and flour. Similar calcium and phosphorus intakes were found by Watney *et al* in their study of pregnant Asian women.[22]

The mean phytic acid intake of the sample was 134 mg, which is similar to that reported from Birmingham[22] and Glasgow[24] but lower than that found by Wills *et al*, who postulated that phytic acid is a causal factor in nutritional rickets and osteomalacia among Asians.[25] The phytic acid intake was also lower than that found in India,[26] where the flour used for making chapatties is less refined than British chapatti flour. The Sikhs ate most phytic acid but they also had the highest calcium intake. The Ismailis and Catholics took the least phytic acid.

The subgroup most at risk of vitamin D deficiency were Hindu women, with a mean 25-OHD_3 value of 9·5 nmol/l (3·8 ng/ml). They adhered strictly to vegetarianism and went outside for an average of only two and a half hours a week. Men and children benefited to some extent from going to work or school, where they were exposed to sunlight and were often given food containing margarine. The Roman Catholic Asians, despite their darker pigmentation, were least at risk and had the most satisfactory intake of vitamin D.

If chapatti flour were to be enriched with vitamin D, as has been found to be feasible in Glasgow,[27] Goans (whose intake of flour is low) would receive least benefit, but they appear to have satisfactory intakes already. Most chapatti flour was consumed by Sikhs and Hindus, whose intakes of vitamin D and serum 25-OHD_3 levels were low.

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Changed levels of endogenous sex steroids in women on oral contraceptives

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Summary

Serum and urinary levels of unconjugated testosterone, dihydrotestosterone, and oestradiol were measured by specific radioimmunoassays in 10 healthy women in the early follicular phase of their menstrual cycle and in nine healthy women taking oral contraceptives. The contraceptive group had testosterone levels 1·3 times higher and dihydrotestosterone levels two times higher than those in the controls. Serum oestradiol levels in the contraceptive group were much lower than those in the controls and similar to levels in postmenopausal women.

The contraceptive group had about twice the urinary excretion of unconjugated (free) testosterone and dihydrotestosterone of the controls, but their excretion of unconjugated oestradiol was 2·7 times lower. The great increase in serum and urinary androgen concentrations, as well as the suppression of oestradiol, may be related to the antiovulatory effect of oral contraceptives.

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Introduction

The way that oral contraceptives act is still unknown, but they are thought to either inhibit gonadotrophin release or directly affect the ovaries and the genital tract. Oral contraceptives lower serum and urinary gonadotrophin levels,[1] but there is conflicting evidence on whether they reduce oestradiol levels.[2-5] Raised serum testosterone concentrations have been found in women taking oral contraceptives,[3 6 7] but there are no data on 5α-dihydrotestosterone, an androgen that is more than twice as potent as testosterone in some bioassays.[8]

Oral contraceptives are often given as long-term replacement therapy in young women with hypogonadism resulting from operations, such as ^{90}Y or ^{198}Au pituitary implantation for treatment of pituitary tumours.[9]

In a small group of healthy women we assessed the effects of oral contraceptives on serum levels of the main sex hormones and measured the simultaneous urinary excretion of the unconjugated hormone.

Subjects and methods

Nineteen healthy members of the hospital staff, aged 18-34, volunteered for this study. Ten women who were not taking any medication acted as controls; they were studied in the first 10 days of their menstrual cycle. The other nine had all been taking oral contraceptives for at least two months and were studied at various days from their last menstrual bleeding. Five women were taking Ovran (ethinyloestradiol 50 μg and D-norgestrel 250 μg), two were taking Eugynon 50 (ethinyloestradiol 50 μg and DL-norgestrel 500 μg), and two were taking Gynovlar 21 (ethinyloestradiol 50 μg and norethisterone acetate 3 mg).