Nutrient intake of pregnant Asian women at Sorrento Maternity Hospital, Birmingham

By P. M. EATON,* P. A. WHARTON and B. A. WHARTON†
Sorrento Maternity Hospital, Birmingham B13 9HE

(*Received 25 January 1984 – Accepted 1 June 1984*)

1. The dietary intake of pregnant Asian women (that is originating from the Indian subcontinent) attending Sorrento Maternity Hospital in Birmingham was determined, using the weighed and recall techniques, at five-weekly intervals from 18 to 38 weeks of pregnancy.

2. Mean energy intake of the group was 7·1 MJ (1700 kcal)/d. The intakes of most nutrients were substantially below those consumed by pregnant European women in Britain, a little below those of expectant Pakistani mothers in Islamabad, and about the same as those of expectant East London mothers. Intakes of vitamin D, total folate, vitamin B_6, zinc and magnesium were particularly low.

3. These observations suggest that a number of Asian women in Birmingham are likely to experience nutritional stress in pregnancy, and there is some anthropometric and biochemical evidence from Sorrento, published elsewhere (Bissenden *et al.* 1981), to support this.

4. A possibly beneficial feature of the diet was a low sodium intake (2 g/d). Previous work at this hospital has noted a lower prevalence of hypertension in pregnant Asian women (Wharton *et al.* 1980; Bissenden *et al.* 1981).

Asian women have a variable dietary experience when they arrive in this country but there are few studies of their diet during pregnancy. However, Asian mothers are known to develop nutritional problems, such as osteomalacia (Watney *et al.* 1971), and some put on very little extra fat during pregnancy (Bissenden *et al.* 1981). Therefore, an investigation was undertaken to determine the diet of pregnant Asian women in central Birmingham. It ran in parallel with a dietary intervention trial concerning the effect of protein and energy supplementation on fetal growth (Viegas *et al.* 1982*a*, *b*). The present paper describes the nutrient intake, determined by weighed and recall methods, of Asian women during the second and third trimesters of pregnancy. The observed nutrient intake is compared with the recommendations made by various bodies and with other studies in pregnant European women and pregnant Asian women in Asia. A later paper describes the nutrient intake and the variety of foods eaten by the individual groups within this Asian community, Pakistani, Bangladeshi, Hindu and Sikh expectant mothers, in more detail (Wharton *et al.* 1984).

METHODS

Women studied

The women studied were taking part in a trial of selective dietary protein–energy supplementation (Viegas *et al.* 1982*a*). In the trial, women received a vitamin and iron supplement from 18 to 28 weeks of pregnancy and then at 28 weeks they were randomly allocated to one of three regimens to continue until 38 weeks: (a) vitamins supplement only, (b) vitamins plus an energy supplement, (c) vitamins plus a protein–energy supplement. Although dietary intakes of women on all three regimens were measured, results in the present paper are presented from women when they were receiving the vitamins supplement only. There are, therefore, more values for the second trimester (18–28 weeks) than for the

* Present address: Dudley Road Hospital, Birmingham.
† For reprints.

Table 1. *Details of Asian women studied at 23 weeks of pregnancy and their babies at birth (weighed and recall methods)*

No. of women...	Weighed method 17		Recall method 72	
	Mean	SD	Mean	SD
Description:				
Age at booking (years)	23·5	5·5	22·3	4·5
No. of primiparae	8	—	32	—
Religion: Hindu	1	—	15	—
Sikh	1	—	11	—
Moslem	15	—	46	—
Anthropometry:				
Height (m)	1·554	0·074	1·559	0·065
Wt (kg)	56·5	12·3	54·1	8·0
Triceps skinfold thickness (mm)	17·7	4·2	16·1	5·1
Social circumstances:				
Social class IV or below	10	—	38	—
> 1·5 persons per room	7	—	14	—
No English or single words only	11	—	43	—
< 2 years in Britain	7	—	32	—
No education or primary school only	7	—	25	—
Baby:				
Wt (kg)	3·19	0·35	3·09	0·48
< 2·5 kg: no.	1	—	6	—
% total	6	—	8	—

third (28–38 weeks). The Fe and vitamins supplements have not been included in the calculation of dietary intake.

The dietary studies took place from January to November, therefore allowing for seasonal variations in the diet.

Selection was dictated by work-load but approximately every 5th woman taking part in the supplementation trial was asked to weigh her diet for 3 d at five-weekly intervals from the eighteenth week to the thirty-eighth week of pregnancy, and the next three women had a 24 h recall. In addition, the intakes of other women were recalled once in each trimester at 23 and 33 weeks.

Details of the women at 23 weeks are shown in Table 1. The 23-weeks stage was chosen as representative of all the women taking part since there were more women at this time. The weight and triceps skinfold thickness of the women increased during pregnancy (mean (SD)): at 18 weeks weighed 51·4 (9·6) kg, triceps skinfold 15·6 (3·4) mm, at 38 weeks weighed 58·1 (8·2) kg, triceps skinfold 17 (6·0) mm. Similarly, recall women (mean (SD)) at 18 weeks weighed 54·5 (9·4) kg, triceps skinfold 15·7 (4·9) mm, at 38 weeks weighed 63·5 (7·0) kg, triceps skinfold 18·6 (4·6) mm.

Many of the women had been in this country for only a short time, lived in overcrowded conditions and had received limited education. Although women selected for a weighed-diet investigation came only from the Indian subcontinent, some of the recall women came from East Africa. Many spoke little or no English and so initially husbands were used as interpreters but often they answered without reference to their wife and so two part-time interpreters were employed to work on the project both in the clinic and in the women's homes.

Dietetic method

Illiteracy and inability to speak English limited the number of weighed diets which could be recorded because in these circumstances a dietitian had to be present during the preparation of all meals. On the other hand, it was considered that the recall method used alone would not give sufficiently accurate information, e.g. concerning recipes, cooking practices and portion size. It was, therefore, decided to use both the weighed and recall methods.

Weighed. Women were asked in the antenatal clinic by one of the dietitians (P.M.E. or P.A.W.) if they were willing to participate. An evening visit was then made to the home to gain family co-operation, especially the permission of the husband, and to instruct in the use of scales and the weighing method. Seven women refused to take part in the study for various reasons: too much work involved with a large family (1), not prepared to do repeated weighing (1), away from home (2), husband refused permission (1), too complicated (1), dietitian unable to make contact at home after clinic visit (1). The precise weighing technique set out in *Human Biology, a Guide to Field Methods* (International Biological Programme, 1969) was modified to suit the conditions found, e.g. it was rarely possible for a woman to keep her own daily supply of butter or milk separate from the household stock so her intake of such items had to be measured at each meal. A number of different weighing scales were used according to the facilities available in the home. Compression balances were most frequently used, 1 kg × 5 g or 500 g × 2 g, but on a few occasions where no table space was available the dietitians used a hand-held extension spring balance. A beam balance was used for weighing saucepans. Light heat-resistant plastic plates on which the meal was weighed, foil containers for weighing liquid curries, and a plastic measuring jug were supplied.

Initially, 7 d weighings were performed in seven women at 18 weeks of pregnancy but, since there was no marked difference in nutrient intakes at weekends, subsequent weighings were for a minimum of three weekdays at 18, 23, 28, 33 and 38 weeks. One of these 'weighed' days was also recalled at the clinic visit (see below). The dietitian emphasized the need to maintain the normal eating pattern and visited the home at least once daily during the weighing periods to check and collect each completed record. Where the woman could not write either in English or her own language, and there was no family member to record the weighing, a dietitian was present at the weighing of each meal. Two women who could only write in Urdu were instructed by the interpreter. Some breakfasts and between-meal snacks were measured by duplicate weighing. Plate waste was weighed and recorded. Where vomiting occurred within 0·5 h of a meal, the record for the day was rejected. Some recipes were measured before and after cooking to determine percentage weight loss.

Recall. The recall interview took place in the hospital clinic unless the woman missed her obstetric appointment, when a dietitian went to her home. As an aid to describing quantities, various sizes of cup, glass and spoon were used. Recipes were noted and as one large cooking pot of curry may well serve ten to twelve persons, but not all with an equal portion, careful questioning was necessary to ascertain the amount each woman ate. Models for the size of meat pieces and chapattis (150, 200 and 250 mm (6, 8 and 10 inch) diameter) were used. Very detailed questioning was necessary, for example a cup of tea with milk varied from 25 ml milk per cup to 'all-milk tea' with tea leaves infused in boiling milk; 'one spoonful' could vary from a teaspoon to a serving spoon (twice the capacity of a tablespoon).

Marr (1971) has stated that 'several separate 24-h recalls are necessary to establish a picture of the usual or customary intake'. Therefore, it was planned to perform a recall at five-weekly intervals from 18 to 38 weeks in the majority of women. In addition, women in whom the aim was to record intake once in each trimester had a 24 h recall at 23 and 33 weeks.

It was not always possible to do a 24 h recall as planned, e.g. through lack of clinic time, because the interpreter was not available, the woman left the district, refusal because of the extra time involved (mother to meet children from school) or, occasionally, invasion of privacy. Results are presented from women from whom complete sets of recalls were obtained, that is on the five occasions from 18 to 38 weeks or on the two occasions at 23 and 33 weeks. Ninety-three individual records were rejected because they did not form part of a complete set. Five complete sets were rejected either because of inadequate information in one or more of the recalls in the set, or because the gestational age at the time of the recall was subsequently changed by obstetric assessment so that the recalls were not timed to be at 18, 23, 28, 33 or 38 weeks.

Dietary calculations

The daily intakes, determined by the weighed or recall methods, were coded by the dietitians before entry into the computer. The food tables of Paul & Southgate (1978) were used mainly but it was necessary to compile a further set of food tables for Asian foods using the women's recipes or making up the recipes in Asian cookery books to determine yields, portion size and cooking losses (Wharton *et al.* 1983).

Wherever possible, recipes were reduced to their basic ingredients for coding rather than using a composite recipe. For example, when the exact amounts of butter and chapatti dough used to make a paratha were known, they were coded individually (Paul & Southgate, 1978: codes 140 and 46) instead of the composite paratha (Wharton *et al.* 1983: code A3).

For some foods taken from the *Sorrento Asian Food Tables* (Wharton *et al.* 1983) there was no information available from either published sources or direct analysis on the concentrations of some vitamins and minerals. These foods were generally consumed infrequently or in small amounts and would contribute little to the total intake of minerals and vitamins. However, this may have led to a small underestimate of the intakes of copper and zinc.

RESULTS

Tables 2–4 show the intakes of energy and nutrients in the women throughout pregnancy and compare the results obtained by the weighed and recall methods with those of four other studies of diet during pregnancy and the dietary guidelines of three authorities. Comparisons have been made in two ways: (a) as a percentage to express relative differences in the quantity of intake, (b) as a standard deviation score to express how a mean intake compared with a distribution of intakes seen in another study.

Results obtained by the recall method were generally a little below those obtained by the weighed method (mean of 3 d); exact comparison will be presented in another paper.

Comparison with other studies

The intakes of most nutrients were substantially below those consumed by pregnant European women in Aberdeen (Thomson, 1958) and the UK national sample (Darke *et al.* 1980), a little below those consumed by expectant Pakistani mothers in Islamabad (Afzal & Hussein, 1972) and about the same as seen in expectant East London mothers (Doyle *et al.* 1982). The percentage of energy derived from fat (35%) was lower than in other studies, the percentage of carbohydrate energy being correspondingly higher (Fig. 1). The percentage of energy derived from protein in all studies (12–16%) was higher than the 10% used as a basis for calculating recommended daily amounts (RDA) of protein in Britain (Department of Health and Social Security, 1979).

Table 2. *Daily intake of proximates and dietary fibre by Asian women during 2nd and 3rd trimesters of pregnancy*

n	Stage of pregnancy (weeks)	Energy (MJ) Mean	Energy (MJ) Range	Energy (kcal) Mean	Energy (kcal) Range	Adjusted energy MJ/$W^{0.75}$	Adjusted energy kcal/$W^{0.75}$	Protein (g) Mean	Protein (g) Range	Fat (g) Mean	Fat (g) Range	Carbohydrate (g) Mean	Carbohydrate (g) Range	Dietary fibre (g) Mean	Dietary fibre (g) Range
							Weighed method								
17	18	7·5	3·2–12·8	1779	752–3046	0·39	93	56	15–103	69	24–155	249	111–427	19	4–52
17	23	6·9	2·5–12·3	1644	600–2921	0·34	80	51	18–95	64	15–126	232	79–426	18	7–47
26	28	7·3	3·4–16·1	1729	799–3846	0·36	85	53	22–141	67	17–181	243	109–486	19	4–42
9	33	7·2	3·4–14·7	1723	811–3508	0·35	83	56	22–133	64	19–174	247	122–461	19	6–35
8	38	7·8	1·4–13·7	1859	326–3294	0·37	88	60	19–115	74	19–167	254	22–395	20	9–36
							Recall method								
40	18	6·8	3·8–12·8	1627	897–3044	0·34	81	54	24–142	64	34–152	223	92–378	16	5–31
72	23	7·2	2·4–16·2	1704	558–3872	0·36	86	58	16–118	64	14–186	238	75–472	18	2–46
40	28	7·1	2·1–15·0	1686	488–3566	0·33	79	57	22–130	66	18–152	231	64–449	17	3–40
23	33	7·1	2·6–18·1	1694	608–4316	0·33	78	54	19–210	66	17–219	236	75–522	19	4–43
11	38	7·8	4·4–11·7	1860	1043–2785	0·35	83	57	36–84	69	36–138	267	154–411	17	5–32
							RDA*								
—	—	—	UK	UK	USA I	UK	UK	UK	USA I	—	—	—	—	—	—
—	—	—	10·0	2400	2300 2500	0·46‖	110‖	60	74 55	—	—	—	—	—	—
							Other studies†								
—	—	—	N	A N	EL Is	—	—	A N	EL Is	A N	EL	A N	—	—	—
—	—	—	9·1	2354 2152	1723 1961	—	—	72 71	68 53	100 98	73	312 260	—	—	—
						Intake at 18 weeks compared with RDA‡									
—	—	—	—	%	SD score	—	—	%	SD score	—	—	—	—	—	—
—	—	—	—	−25·9	−1·3	—	—	−6·7	−0·2	—	—	—	—	—	—
						Extra intake at 38 weeks compared with intake at 18 weeks§									
—	—	—	—	%	SD score	—	—	%	SD score	%	SD score	%	SD score	%	SD score
—	—	—	—	4·2	0·2	—	—	7·1	0·2	7·2	0·2	2·0	0·1	0·1	0·1

* RDA, recommended daily amounts: UK, RDA for food energy and nutrients for groups of people in the UK for women aged 18–54 years plus extra for pregnancy (Department of Health and Social Security, 1979); USA, RDA in the USA for women aged 23–50 years plus extra for pregnancy ((US) National Research Council, 1980); I, RDA in India for moderately active women plus extra for later half of pregnancy (Gopalan *et al.* 1974).

† Nutrient intakes by weighed method recorded in other studies of pregnant women: A, 279 women, social classes IV and V, in Aberdeen during 7th month (Thomson, 1958); N, 435 women, national UK sample, during 6th–7th month (Darke *et al.* 1980); EL, 67 women in East London during 2nd trimester (Doyle *et al.* 1982); Is, 17 women in Islamabad during 3rd–7th month (Afzal & Hussain, 1972).

‡ Intake of all women (weighed method) at 18 weeks compared with UK or USA RDA:

$$\% = \frac{(\text{Intake at 18 weeks} - \text{RDA for mid-pregnancy}) \times 100}{\text{RDA}}, \quad \text{SD score} = \frac{\text{Intake at 18 weeks} - \text{RDA for mid-pregnancy}}{\text{SD of intake at 18 weeks}}.$$

§ Extra intake of all women at 38 weeks (weighed method) compared with intake at 18 weeks:

$$\% = \frac{(\text{Intake at 38 weeks} - \text{intake at 18 weeks}) \times 100}{\text{Intake at 18 weeks}}, \quad \text{SD score} = \frac{\text{Intake at 38 weeks} - \text{Intake at 18 weeks}}{\text{SD of intake at 18 weeks}}.$$

‖ RDA for 55 kg woman plus 6 kg for mid-pregnancy.

Table 3. *Daily intake of minerals and water by Asian women during 2nd and 3rd trimesters of pregnancy*

n	Stage of pregnancy (weeks)	Sodium (g) Mean	Sodium (g) Range	Potassium (g) Mean	Potassium (g) Range	Calcium (mg) Mean	Calcium (mg) Range	Magnesium (mg) Mean	Magnesium (mg) Range	Phosphorus (mg) Mean	Phosphorus (mg) Range
						Weighed method					
17	18	1·9	0·6–5·7	2·0	0·6–4·1	817	228–1941	223	62–530	982	284–1846
17	23	1·7	0·5–5·5	1·8	0·6–4·2	762	175–1614	219	73–508	914	328–1734
26	28	1·9	0·6–4·5	2·2	0·8–5·9	899	245–2633	232	72–513	988	435–2600
9	33	2·0	0·6–4·2	2·0	0·7–5·2	860	216–2510	239	77–514	1013	476–2453
8	38	1·7	0·2–3·4	2·3	0·5–5·5	956	341–2309	255	41–401	1116	423–2161
						Recall method					
40	18	1·6	0·7–3·6	2·0	0·7–5·9	783	338–1688	214	95–423	942	417–2147
72	23	1·9	0·5–5·0	2·1	0·4–6·1	807	191–2203	238	41–571	1014	268–2198
40	28	1·9	0·5–4·3	1·9	0·4–6·1	837	228–2015	229	50–610	1009	280–2482
23	33	1·8	0·7–3·8	1·9	0·6–4·9	809	225–2244	237	62–556	958	361–2876
11	38	1·8	0·7–3·0	2·6	0·9–6·0	876	319–1533	247	98–366	1022	665–1468
						RDA*					
—	—	—	USA	—	USA	UK	USA I	—	USA	—	USA
—	—	—	1·1‖	—	1·87‖	500††	1200 1000	—	450	—	1200
						Other studies†					
—	—	—	—	—	—	A N	EL Is	—	—	—	—
—	—	—	—	—	—	880 959	820 500	—	—	—	—
						Intake at 18 weeks compared with RDA‡					
—	—	—	—	—	—	%	SD score	%	SD score	%	SD score
—	—	—	—	—	—	63·4	1·1	−50·4	−2·6	−18·2	−0·8
						Extra intake at 38 weeks compared with intake at 18 weeks§					
—	—	%	SD score	%	SD score	%	SD score	%	SD score	%	SD score
—	—	−10·5	−0·3	15·0	0·4	17·0	0·5	14·3	0·4	13·6	0·5

n	Stage of pregnancy (weeks)	Iron (mg) Mean	Iron (mg) Range	Copper (mg)¶ Mean	Copper (mg)¶ Range	Zinc (mg)¶ Mean	Zinc (mg)¶ Range	Sulphur (mg) Mean	Sulphur (mg) Range	Chloride (g) Mean	Chloride (g) Range	Water (litres) Mean	Water (litres) Range
						Weighed method							
17	18	12	3–28	1·2	0·3–2·6	7·0	1·4–16·7	410	42–789	3·1	0·9–9·0	1·5	0·6–2·6
17	23	12	4–29	1·1	0·4–2·6	6·4	2·5–15·1	338	42–931	2·8	0·9–8·8	1·4	0·7–2·5
26	28	11	3–23	1·1	0·4–2·6	6·7	2·1–21·0	378	52–1038	3·1	1·0–7·3	1·6	0·6–5·2
9	33	12	5–21	1·2	0·5–2·5	7·6	2·7–20·0	372	63–1073	3·2	1·0–6·8	1·6	0·7–4·7
8	38	12	2–19	1·3	0·1–2·2	7·4	2·1–16·6	403	67–862	2·8	0·3–5·4	1·5	0·7–4·0
						Recall method							
40	18	10	5–20	1·0	0·5–2·2	6·7	2·9–14·1	386	136–1042	2·6	1·1–5·8	1·4	0·7–2·9
72	23	11	4–28	1·2	0·3–2·9	7·1	2·2–15·4	410	17–1091	3·0	0·8–7·7	1·4	0·7–2·3
40	28	11	3–24	1·1	0·3–3·0	7·4	2·2–20·8	385	64–1036	3·1	0·9–6·9	1·4	0·5–2·5
23	33	12	4–32	1·1	0·4–2·8	6·9	2·2–28·7	360	72–1682	2·9	1·1–6·0	1·4	0·7–2·8
11	38	12	8–18	1·2	0·5–2·0	6·7	4·0–11·7	394	225–678	2·9	1·1–5·0	1·5	0·9–2·3
						RDA*							
—	—	UK	USA I	—	USA	—	USA	—	—	—	USA	—	—
—	—	13	18** 40	—	2‖	—	20	—	—	—	1·7‖	—	—
						Other studies†							
—	—	N	EL Is	—	—	—	—	—	—	—	—	—	—
—	—	12	82 13	—	—	—	—	—	—	—	—	—	—
						Intake at 18 weeks compared with RDA‡							
—	—	%	SD score	—	—	%	SD score	—	—	—	—	—	—
—	—	7·7	−0·2	—	—	−65·0	−4·6	—	—	—	—	—	—
						Extra intake at 38 weeks compared with intake at 18 weeks§							
—	—	%	SD score	%	SD score	%	SD score	%	SD score	%	SD score	—	—
—	—	0·0	0·0	8·3	0·2	5·7	0·1	−1·7	−0·1	−9·7	−0·3	—	—

* RDA, recommended daily amounts: UK, RDA for food energy and nutrients for groups of people in the UK for women aged 18–54 years plus extra for pregnancy (Department of Health and Social Security, 1979); USA, RDA in the USA for women aged 23–50 years plus extra for pregnancy ((US) National Research Council, 1980); I, RDA in India for moderately active women plus extra for later half of pregnancy (Gopalan *et al.* 1974).

† Nutrient intakes by weighed method recorded in other studies of pregnant women: A, 279 women, social classes IV and V, in Aberdeen during 7th month (Thomson, 1958); N, 435 women, national UK sample, during 6th–7th month (Darke *et al.* 1980); EL, 67 women in East London during 2nd trimester (Doyle *et al.* 1982); Is, 17 women in Islamabad during 3rd–7th month (Afzal & Hussain, 1972).

‡ Intake of all women (weighed method) at 18 weeks compared with UK or USA RDA:

$$\% = \frac{(\text{Intake at 18 weeks} - \text{RDA for mid-pregnancy}) \times 100}{\text{RDA}}, \quad \text{SD score} = \frac{\text{Intake at 18 weeks} - \text{RDA for mid-pregnancy}}{\text{SD of intake at 18 weeks}}.$$

§ Extra intake of all women at 38 weeks (weighed method) compared with intake at 18 weeks:

$$\% = \frac{(\text{Intake at 38 weeks} - \text{intake at 18 weeks}) \times 100}{\text{Intake at 18 weeks}}, \quad \text{SD score} = \frac{\text{Intake at 38 weeks} - \text{intake at 18 weeks}}{\text{SD of intake at 18 weeks}}.$$

‖ Minimum value quoted for 'estimated safe and adequate daily dietary intake' for non-pregnant adults.

¶ There may be a small underestimate of the intakes of Cu and Zn (see p. 460).

** If Fe status is not satisfactory at beginning of pregnancy the requirement is increased and probably may not be met without supplementation.

†† RDA for 2nd trimester, increases to 1200 in 3rd trimester.

Table 4. *Daily intake of vitamins by Asian women during 2nd and 3rd trimesters of pregnancy*

	Stage of pregnancy	Retinol (µg)		Carotene (µg)		Vitamin D (µg)		Thiamin (g)		Riboflavin (mg)		Niacin (mg)		Tryptophan (÷60; mg)	
n	(weeks)	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
							Weighed method								
17	18	465	13–10007	1413	93–10999	1·0	Tr–10·5	1·1	0·3–4·1	1·2	0·3–4·9	9	2·7–54·9	12	3–21
17	23	397	25–1091	1222	29–7200	1·0	Tr–3·6	1·0	0·2–2·5	1·1	0·2–2·4	8	3·2–20·6	11	4–20
26	28	399	55–1146	2261	22–10112	1·2	0·1–15·2	1·1	0·2–3·1	1·3	0·2–4·3	9	2·6–24·3	11	3–29
9	33	395	108–1176	2024	106–10030	0·9	0·1–2·9	1·2	0·2–2·5	1·3	0·4–3·8	9	2·8–26·7	12	5–30
8	38	421	61–994	1331	43–5100	1·0	0·1–1·9	1·1	0·2–2·3	1·4	0·6–3·8	9	0·4–16·0	13	5–25
							Recall method								
40	18	337	107–955	922	73–6194	1·0	0·1–3·6	1·0	0·4–2·3	1·2	0·4–3·5	9	3–32	11	5–28
72	23	357	0·0–1089	1091	46–8044	1·0	0·0–4·6	1·0	0·2–2·1	1·2	0·2–2·8	10	1–29	12	3–23
40	28	362	61–860	1554	43–8808	1·1	0·1–4·9	1·1	0·2–2·6	1·3	0·3–3·2	10	3–19	12	4–27
23	33	368	53–734	1620	47–11875	1·0	0·4–2·7	1·0	0·2–2·8	1·1	0·4–3·3	9	3–37	11	4–46
11	38	317	123–546	1682	46–7902	1·1	0·2–2·9	1·1	0·6–1·9	1·3	0·7–2·1	10	4–17	12	8–18
							RDA*								
— —	— —	UK 750^{RE}	USA I 1000^{RE} 750	— —	— —	UK 10	USA I 10 5^{h}	UK 1·0	USA I 1·4 1·3	UK 1·6	USA I 1·5 1·4	UK 18^{NE}	USA I 15^{NE} 17^{NA}	— —	— —
							Other studies†								
— —	— —	A N 7545^{IU} 1269	EL Is 1326 2210^{IU}	— —	— —	N 2·3	EL 4·1	A N 1·2 1·0	EL Is 1·0 1·3	A N 1·7 1·6	EL Is 1·6 0·7	A N 12 14	EL Is 14 15	— —	— —
							Intake at 18 weeks compared with RDA‡								
— —	— —	% $-6·6^{RE}$				% −90·0	SD score −22·5	% 10	SD score 0·2	% −25·0	SD score −0·8	% $16·6^{NE}$			
							Extra intake at 38 weeks compared with intake at 18 weeks§								
— —	— —	% $-8·2^{RE}$				% 0·0	SD score 0·0	% 0·0	SD score 0·0	% 16·7	SD score 0·4	% $4·8^{NE}$			

										Folic acid							
	Stage of pregnancy	C (mg)		E (mg)		B_6 (mg)		B_{12} (μg)		Free (μg)		Total (μg)		Pantothenate (mg)		Biotin (μg)	
n	(weeks)	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
								Weighed method									
17	18	44	1–221	2·8	0·3–10·3	1·0	0·2–2·3	3·0	0·1–48·8	65	11–218	128	21–552	3·4	0·8–8·1	24	4–167
17	23	53	1–307	2·5	0·2–6·4	1·0	0·3–2·4	1·9	Tr–4·8	67	20–226	119	38–320	3·1	0·8–6·9	21	4–57
26	28	65	5–264	2·7	0·3–10·0	1·0	0·4–2·5	2·2	0·1–9·0	74	14–208	134	23–365	3·4	1·1–8·8	21	5–64
9	33	48	2–175	2·5	0·3–7·9	1·1	0·5–3·1	2·3	0·2–8·3	78	24–243	130	38–339	3·4	1·6–9·4	22	8–67
8	38	49	3–398	2·4	1·2–4·7	1·0	0·2–1·8	2·4	1·1–7·3	60	24–137	121	31–229	3·6	2·1–7·7	24	9–51
								Recall method									
40	18	44	3–129	2·5	0·7–8·7	1·0	0·4–2·4	2·1	Tr–7·8	62	23–175	113	41–247	3·2	1·3–7·9	20	6–47
72	23	46	3–283	2·4	0·3–6·4	1·0	0·2–2·3	2·3	0·0–20·4	67	22–168	120	32–310	3·4	1·1–6·6	22	4–58
40	28	50	2–174	2·1	0·2–3·9	1·0	0·2–2·5	2·3	0·1–7·1	65	10–152	111	26–280	3·3	0·9–7·5	20	4–48
23	33	38	2–174	2·7	0·3–7·7	0·9	0·4–2·7	2·2	0·2–16·5	64	18–193	126	45–389	3·1	1·1–9·4	20	6–61
11	38	42	7–110	2·5	1·0–3·9	1·0	0·6–1·8	1·9	1·1–4·1	60	42–93	134	75–245	3·4	2·4–4·9	22	10–37
								RDA*									
—	—	UK	USA I	—	USA	—	USA	—	USA I	—	—	UK	USA I	—	USA	—	USA
—	—	60	80 50	—	$10^{\alpha TE}$	—	2·6	—	4·0 1·5	—	—	500	800 150–300	—	4‖	—	100‖
								Other studies†									
—	—	A N	EL Is	—	—	N	EL	—	—	—	—	—	EL	—	—	—	—
—	—	61 55	73 38	—	—	1·3	1·4	—	—	—	—	—	395	—	—	—	—
								Intake at 18 weeks compared with RDA‡									
—	—	%	SD score	—	—	%	SD score	%	SD score	—	—	%	SD score	—	—	—	—
—	—	−26·7	−0·3	—	—	−61·5	−4·0	−25·0	−0·3	—	—	−74·4	−10·6	—	—	—	—
								Extra intake at 38 weeks compared with intake at 18 weeks§									
—	—	%	SD score	%	SD score	%	SD score	%	SD score	%	SD score	%	SD score	%	SD score	—	—
—	—	11·4	0·1	−14·3	−0·4	0·0	0·0	−20·0	−0·19	−7·7	0·1	−5·5	−0·1	5·9	0·2	—	—

Tr, trace; RE, retinol equivalent (1 RE = 1 μg retinol or 6 μg carotene or 12 μg other biologically active carotenoid); IU, international unit (1 IU = 0·3 μg retinol or 0·6 μg β-carotene); NA, nicotinic acid; NE, nicotinic acid equivalent (1 NE = 1 mg available NA or 60 mg tryptophan); h, converted from IU; αTE, α-tocopherol equivalent (1 mg α-D-tocopherol = 1 αTE).

* RDA, recommended daily amounts: UK, RDA for food energy and nutrients for groups of people in the UK for women aged 18–54 years plus extra for pregnancy (Department of Health and Social Security, 1979); USA, RDA in the USA for women aged 23–50 years plus extra for pregnancy ((US) National Research Council, 1980); I, RDA in India for moderately active women plus extra for later half of pregnancy (Gopalan *et al.* 1974).

† Nutrient intakes by weighed method recorded in other studies of pregnant women: A, 279 women, social classes IV and V, in Aberdeen during 7th month (Thomson, 1958); N, 435 women, national UK sample, during 6th–7th month (Darke *et al.* 1980); EL, 67 women in East London during 2nd trimester (Doyle *et al.* 1982); Is, 17 women in Islamabad during 3rd–7th month (Afzal & Hussain, 1972).

‡ Intake of all women (weighed method) at 18 weeks compared with UK or USA RDA:

$$\% = \frac{(\text{Intake at 18 weeks} - \text{RDA for mid-pregnancy}) \times 100}{\text{RDA}}, \quad \text{SD score} = \frac{\text{Intake at 18 weeks} - \text{RDA for mid-pregnancy}}{\text{SD of intake at 18 weeks}}.$$

§ Extra intake of all women at 38 weeks (weighed method) compared with intake at 18 weeks:

$$\% = \frac{(\text{Intake at 38 weeks} - \text{intake at 18 weeks}) \times 100}{\text{Intake at 18 weeks}}, \quad \text{SD score} = \frac{\text{Intake at 38 weeks} - \text{intake at 18 weeks}}{\text{SD of intake at 18 weeks}}.$$

‖ Minimum value quoted for 'estimated safe and adequate daily dietary intake' for non-pregnant adults.

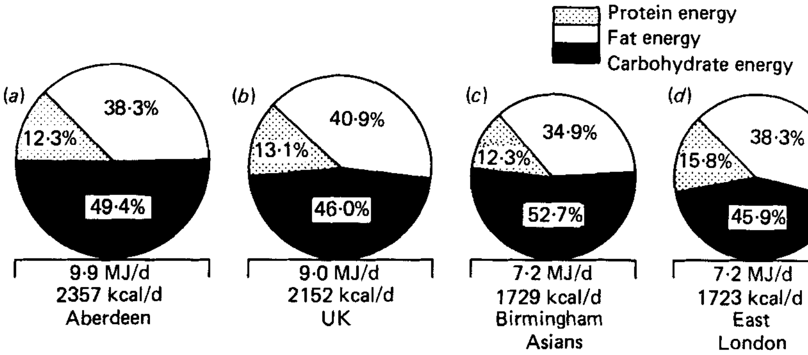

Fig. 1. Energy intake of pregnant women and contribution of energy from three proximates in the present study and three other studies: (a) Aberdeen social classes IV and V (Thomson, 1958), (b) United Kingdom (Darke *et al.* 1980), (c) Birmingham Asians (weighed method; present study), (d) East London (Doyle *et al.* 1982).

Comparison with dietary recommendations

Table 2 compares the weighed intake at 18 weeks of all women with the RDA of the UK (Department of Health and Social Security, 1979) or, if no value was available, the US RDA has been used ((US) National Research Council, 1980). Total energy was moderately below the RDA (−1·3 SD; −26%) even after adjustment for the lower weight of our women. The mean intakes of most nutrients were therefore also below the RDA but the intakes of vitamin D, total folate, vitamin B_6, Zn and magnesium were particularly low (below −2 SD and below 50% RDA). Fe and protein intakes deviated little from the RDA and the mean intakes of calcium, thiamin and nicotinic acid were above the RDA. Broadly similar observations apply to the recall values.

Changes during pregnancy

Table 2 compares the weighed intakes at 18 and 38 weeks.

There was only a small increase (0·2 SD; 5%) in total energy intake and no nutrient intake increased by more than 17% or 0·5 SD (Ca). Indeed, the change in nutrient intake varied only from −0·4 to +0·5 SD or −25% to +17% even though RDA increase in later pregnancy. The recall method recorded slightly greater increases (e.g. energy +14%).

DISCUSSION

Apart from providing previously unavailable information concerning the nutrient intakes of pregnant Asian women in the UK, the main point of note from the present study is the low nutrient intakes of the Asian women when compared with either most other studies or the RDA of various authorities. Energy intakes by some women were extremely low; 1364 kJ (326 kcal)/d in one instance, yet this woman was not particularly underpriviledged according to the social measurements we used nor was she fasting. On the other days on which her intake was measured, energy intake ranged from 3343 to 8418 kJ (799 to 2012 kcal)/d.

The lower intakes of nutrients may be partly explained by the women's smaller size, but even after adjusting the intakes for maternal weight they were below the UK RDA (see Table 2). The intakes were broadly similar to those consumed by pregnant women in the East End of London (Doyle *et al.* 1982), another socially underpriviledged group.

During the Dutch famine, an effect of undernutrition on birth weight was not noted until energy intake fell below 6276 kJ (1500 kcal)/d (Stein *et al.* 1975), and Naismith (1981), in his review of the literature, has concluded that 7113 kJ (1700 kcal)/d is a 'threshold level' below which restriction in fetal growth may occur. Many of the women consumed less than this. Clearly normal pregnancies in many individuals can proceed despite what might be regarded as 'low' intakes of food; Naismith (1980) and Prentice *et al.* (1981) have commented on this previously. Nevertheless, considering the group of women as a whole, the low dietary intakes suggest that compared with a national sample of women, more Asian women in Birmingham are likely to experience nutritional stress during pregnancy. Although few low-birth-weight babies (< 2·5 kg) were produced by the mothers in the present study, the mean birth weight of the babies, as we have noted previously (Wharton *et al.* 1980), was somewhat below that of European babies even after allowing for the shortness of the Asian mothers. Other work from this hospital has shown anthropometric and biochemical evidence of nutritional stress in Asian mothers having poorly-grown babies (Bissenden *et al.* 1981) and an increase in birth weight when these mothers receive a protein–energy supplement in the second trimester (Viegas *et al.* 1982*a*).

Besides the overall low intakes, some nutrients were particularly limited, either in comparison with the UK national sample (Darke *et al.* 1980) (e.g. vitamin B_6) or in comparison with the RDA (e.g. vitamin B_6, vitamin D, folate, Zn and Mg). It may be that estimates of folate consumption are mistakenly low (Phillips *et al.* 1982) and certainly very few women living in Britain could achieve the RDA for vitamin D without supplementation. Deficiencies of vitamin B_6 and Zn have been implicated in poor fetal growth, however, (Reinken & Dapunt 1978; Meadows *et al.* 1981) and Zn deficiency in early pregnancy may be teratogenic (Jameson, 1976). A possibly beneficial factor was the low daily intake of Na (e.g. 2 g compared with a UK intake of 6·6 g or more (Bull & Buss, 1980)). True Na intakes are difficult to estimate but table salt was never seen, and high-Na-containing foods, e.g. bacon and tinned meats, were rarely eaten. Previous work at this hospital has noted a lower prevalence of hypertension in expectant Asian mothers than in expectant European mothers (Wharton *et al.* 1980; Bissenden *et al.* 1981).

The change in intake during pregnancy was not very great and yet the RDA for some nutrients increase in later pregnancy. It seems the increase in RDA is based more on theoretical (albeit reasonable) considerations rather than observation of individual women.

The authors wish to thank Mr H. N. Mansfield and Mr P. G. Needham for allowing them to study their patients, Mr O. A. C. Viegas and Mrs J. King who helped in the obstetric care, and Mrs Hashmi, Mrs Islam, Mrs Mirzah, Mrs Nadeem, Miss Sheik and Miss Robinson who helped with interpreting. P.M.E. and P.A.W. received grants from Birmingham Inner City Partnership Scheme, Department of Health and Social Security, and Beecham Products. Nutrient analysis was performed on the computer of the Dunn Nutrition Laboratory.

They are grateful also to Miss Snow of the Department of Medical Illustration, Birmingham Children's Hospital.

REFERENCES

Afzal, Z. & Hussain, M. A. (1972). *Pakistan Journal of Health* **XX**, 4.59.

Bissenden, J. G., Scott, P. H., King, J., Hallum, J., Mansfield, H. N. & Wharton, B. A. (1981). *British Journal of Obstetrics and Gynaecology* **88**, 999–1008.

Bull, N. L. & Buss, D. H. (1980). *Proceedings of the Nutrition Society* **39**, 30A.

Darke, S. J., Disselduff, M. M. & Troy, G. P. (1980). *British Journal of Nutrition* **44**, 243.

Department of Health and Social Security (1979). *Report of Committee on Medical Aspects of Food Policy* no. 15. London: H. M. Stationery Office.

Doyle, W., Crawford, M. A., Laurance, B. M. & Drury, P. (1982). *Human Nutrition: Applied Nutrition* **36A**, 95.

Gopalan, C., Rama Sastri, B. V. & Balasubramanian, S. C. (1974). *Nutritive Value of Indian Foods.* Hyderabad, India: Institute of Nutrition, Indian Council of Medical Research.

International Biological Programme (1969). *Human Biology, a Guide to Field Methods. International Biological Programme Handbook* no. 9.
Jameson, S. (1976). *Acta Medica Scandanavica* **1** (Suppl.), 593.
Marr, J. W. (1971). *World Review of Nutrition and Dietetics* **13**, 105–158.
Meadows, N. J., Ruse, W., Smith, M. F., Day, J., Keeling, P. W. W., Scopes, J. W., Thompson, R. P. H. & Bloxham, D. L. (1981). *Lancet* **ii**, 1135–1136.
Naismith, D. J. (1980). *Proceedings of the Nutrition Society* **39**, 1–11.
Naismith, D. J. (1981). In *Applied Nutrition*, vol. 1, pp. 1–3. [E. C. Bateman, editor]. New York: John Libbey.
National Research Council (1980). *Food and Nutrition Board Recommended Dietary Allowances*, 9th ed. Washington DC: National Academy of Sciences.
Paul, A. A. & Southgate, D. A. T. (1978). *McCance and Widdowson's The Composition of Foods*, 4th ed. London: H. M. Stationery Office.
Phillips, D. R., Wright, A. J. A. & Southgate, D. A. T. (1982). *Lancet* **ii**, 605.
Prentice, A. M., Whitehead, R. G., Roberts, S. B. & Paul, A. A. (1981). *American Journal of Clinical Nutrition* **34**, 2790–2799.
Reinken, L. & Dapunt, O. (1978). *International Journal of Vitamin and Nutrition Research* **48**, 341–347.
Stein, Z., Susser, M., Saenger, G. & Marolla, F. (1975). *Famine and Human Development*. New York: Oxford University Press.
Thomson, A. M. (1958). *British Journal of Nutrition* **12**, 446–461.
Viegas, O. A. C., Scott, P. H., Cole, T. J., Eaton, P., Needham, P. G. & Wharton, B. A. (1982*a*). *British Medical Journal* **285**, 592–595.
Viegas, O. A. C., Scott, P. H., Cole, T. J., Mansfield, H. N., Wharton, P. & Wharton, B. A. (1982*b*). *British Medical Journal* **285**, 589–592.
Watney, P. J. M., Chance, G. W., Scott, P. & Thompson, J. M. (1971). *British Medical Journal* **ii**, 432–436.
Wharton, B. A., Smalley, C., Millns, C., Nirmal, J., Bissenden, J. G. & Scott, P. H. (1980). In *Topics in Perinatal Medicine*, pp. 141–151. [B. A. Wharton, editor]. London: Pitman Medical.
Wharton, P. A., Eaton, P. M. & Day, K. C. (1983). *Human Nutrition: Applied Nutrition* **37A**, 378–402.
Wharton, P. A., Eaton, P. M. & Wharton, B. A. (1984). *British Journal of Nutrition* **52**, 469–476.

Printed in Great Britain