The calcium and phosphorus intakes of rural Gambian women during pregnancy and lactation

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The Ca and P intakes of 148 pregnant and lactating women in a rural village in The Gambia, West Africa, have been estimated by direct weighing of food on a total of 4188 d. The Ca and P contents of local foods were determined by analysis of raw ingredients, snack foods and prepared dishes. Information about the contribution of mineral-rich seasonings was obtained. Efforts were made to discover unusual sources of Ca that might not be perceived as food by subject or observer. The main contributors to daily Ca intake were shown to be leaves, fish, cereals, groundnuts and local salt. Cow's milk accounted for only 5% of Ca intake. Unusual sources of Ca were discovered, namely baobab (*Adansonia digitata*) fruit and selected earths, but these were consumed infrequently and their contributions to Ca intakes were small. Cereals and groundnuts were the main sources of P. Ca and P intakes (mg/d) were shown to average 404 (SD 110) and 887 (SD 219) respectively. Seasonal changes in the availability of leaves, cereals and groundnuts resulted in variations in Ca and P intakes. The rainy season was associated with increased Ca intakes (by 16%) but decreased P consumption (by 15%). No difference was observed in Ca intake between pregnant and lactating women but P intake in lactation was 11% higher than that in pregnancy during the post-harvest season. The implications of these low Ca intakes require investigation.

Calcium: Phosphorus: Pregnancy: Lactation

Ca intakes are reputed to vary widely between different regions of the world (Food and Agriculture Organization/World Health Organization, 1962; Prentice, 1991). The lowest intakes are reported from communities where animal milks are scarce or not habitually consumed, as is the case in many parts of Africa and Asia (Prentice, 1991). Dietary surveys in these areas indicate that average Ca intakes by adults may be as low as 300–500 mg/d (7·5–12·5 mmol/d). In addition, the amount of Ca absorbed from predominantly vegetarian diets may be low due to high intakes of phytates and oxalates (e.g. Food and Agriculture Organization/World Health Organization, 1962; Allen, 1982; Hongo *et al.* 1989; Pun *et al.* 1991). Such intakes are considerably below current recommendations (Truswell *et al.* 1983; Department of Health, 1991). This is particularly striking for women in traditional societies who have elevated requirements for many years due to repeated pregnancies and long lactational periods.

The ability of standard dietary surveys to assess accurately Ca intakes in traditional societies has been challenged (Harris, 1945; Baker & Mazess, 1963). A number of unusual

* For reprints.

Ca-rich dietary components have been identified that could make significant contributions to Ca intakes. Examples include wild leaves, fruits and roots eaten by certain Australian, African and American tribes (Wehmeyer, 1966; Wehmeyer *et al.* 1969; Brand *et al.* 1982; Norton *et al.* 1984; Eaton & Nelson, 1991) and pica and ash eaten by South American Indians (Baker & Mazess, 1963). It is claimed by some authors that, as a result, Ca intakes in such communities are high (Eaton & Konner, 1985) and that this may account for the low incidence of osteoporosis in these areas. However, these claims are based primarily on qualitative estimates and little detailed information is available on the frequency or quantities of these foods consumed.

Mandinka women in rural parts of The Gambia, West Africa, are pregnant or lactating for much of their early adult lives. Their diet is based primarily on cereals and groundnuts and, as milk is rarely consumed, it would be predicted that their habitual Ca intakes would be low. The aim of the present study was to combine a comprehensive investigation of the Ca and P contents of local foods with quantitative information on the dietary intakes of rural Mandinka women during pregnancy and lactation. Emphasis was placed on the identification and analysis of unusual foods that might contribute little to energy or protein intakes but that might enhance mineral consumption significantly. The present detailed investigation demonstrated that the daily Ca intakes of rural Gambian mothers are indeed very low, averaging about 400 mg/d (10 mmol/d), and that the predominant sources of Ca in this region are leaves and fish.

METHODS

The study took place in the rural, farming community of Keneba, The Gambia. This Mandinka village has been the centre of intensive nutritional studies by the Dunn Nutrition Unit since 1974 (Prentice, 1985). The investigators had a thorough knowledge of the dietary practices of the villagers due to long periods spent in the village and to the able assistance of Gambian field staff.

The diet in Keneba is predominantly vegetarian, based on rice (mano, *Oryza sativa*), millets (sanyo, *Pennisetum typhoideum*; suno, *Pennisetum gambiense*; kinto, *Sorghum margaritiferum*; findo, *Digitaria exilis*) and groundnuts (tio, *Arachis hypogaea*). Animal milk (cow and goat) is consumed only occasionally, either fresh or soured. Meat (cow, goat, sheep, chicken) is eaten rarely, usually on special occasions, but fish, fresh or dried, is consumed regularly. Most plant foods are grown by the village; the main exception being rice, most of which is purchased as imported, polished rice. The soil of the region is predominantly laterite except for the salt flats adjacent to the rivers. Full details of foods consumed in Keneba and their methods of preparation have been described by McCrae & Paul (1979). A brief glossary of Mandinka cooking terms is given in Table 1.

The diet in this area is highly seasonal. The year can be divided into three periods: the rainy season from July–October, the dry, post-harvest season from November–March and the hot, dry pre-farming season from April–June. The rainy season is characterized by low stocks of cereals and groundnuts, high agricultural work-loads, high infection rates and weight loss by pregnant and lactating mothers. Wild leaves and fruits are plentiful at this time of year. During the dry, post-harvest season, cereal and groundnut supplies are good, farm work is light and the nutritional status of the mothers improves. The supply of bush food stops, but in years when water is plentiful the women grow vegetables such as tomato, onion, okra (*Hibiscus esculentus*) and chili pepper (*Capsicum frutescens*). Cereal and groundnut stocks begin to be limited in the hot, pre-harvest season. The women are occupied in preparing farm land for the rains, the supply of garden vegetables ceases but mangoes are plentiful.

Table 1. *The frequency of consumption of major food categories by pregnant and lactating Gambian women May 1978–April 1979*

Main ingredient	Gambian dishes*	Frequency† (%)
Staple dishes‡ (*n* 7476)§		
Rice	Fajiringo, nyankatango	57
Findo	Nyelengo, futo (nyankatango)	16
Sanyo	Nyelengo, futo (serengo, nyankatango)	9
Kinto	Nyelengo, futo (serengo, nyankatango)	9
Maize	Nyelengo, futo, roasted cobs (nyankatango)	5
Cassava	Boiled, raw	2
Wheat	Cracked wheat‖, bread	2
Sauces‡ (*n* 5042)§		
Groundnut	Tia durango	70
Leaf	Jambo, kucha	24
Flour	Bukolo	1
Others	e.g. oil stew, palm fruit stew	5
Porridges‡ (*n* 2061)§		
Rice	Mono, sato, bero, churo, tiakere churo	33
Sanyo	Mono, sato	25
Kinto	Mono, sato	19
Wheat‖	Mono	13
Findo	Mono, sato	5
Maize	Mono, sato, bero	3
Cassava	Mono	1
Locust bean	Mono	1

* Water content (g/kg) shown in parentheses; for further details, see McCrae & Paul (1979) and Hudson *et al.* (1980): staples: fajiringo, serengo, steamed and boiled (660); nyankatango, steamed, boiled + groundnuts (630); nyelengo, steamed + dried baobab leaf (630); futo, steamed, dry + dried baobab leaf (390); sauces: tia durango, roast groundnuts, tomato, ± fish/meat, ± vegetables (800); kucha, kucha leaf, ± fish, ± vegetables (870); jambo, fresh leaf not kucha, ± groundnuts, ± fish, ± vegetables (780); bukolo, cereal flour, tomato, ± onions, ± fish (880); dajiwo, thin soup (950); porridges: mono, thin porridge (880); sato, bero, thicker porridge (860); churo, thick porridge (830); tiakere churo, thick porridge + groundnuts (830); uncommon dishes are shown in parentheses.

† Frequency as a percentage of all foods of the same category.

‡ Most dishes contain salt; all porridges are made with water but milk may be added.

§ Total no. of records per food category.

‖ An aid-food to The Gambia in 1978.

Calcium content of Gambian foods

Samples of many raw ingredients and prepared dishes were collected for analysis during the period 1976–90. The samples were frozen or dried to constant weight in a microwave oven before shipment to Cambridge.

The samples chosen for analysis may be divided into three main categories: (1) foods that formed the main-stay of the Keneba diet, (2) seasonings used in the preparation of dishes, and (3) unusual items and snacks, particularly those that might not be perceived as food by either the investigator or the subject. The items for analysis were identified during detailed interviews with village women and from local knowledge. Samples were collected at different times of the year to ensure that examples of highly seasonal foods were obtained. Drinking water was collected from several wells in the village and from domestic clay storage pots.

Quantitative recipe information and the identification of occasional components were obtained by weighing all the ingredients used in the preparation of whole meals. This part

of the study was conducted in the homes of the village women and several hundred meals were observed.

The samples were analysed in Cambridge after dry ashing at 500° and acid digestion, using N_2O atomic absorption spectrometry for Ca and the Fiske-Subbarow method for P (Paul & Southgate, 1978).

Daily calcium and phosphorus intakes of pregnant and lactating mothers

Rural Gambian women have their first baby shortly after menarche, breast-feed each child for about 2 years and continue with regular cycles of pregnancy and lactation throughout their reproductive lives. In order to estimate the daily Ca and P intakes of Mandinka women during pregnancy and lactation, use was made of a database of dietary measurements collected in Keneba between May 1978 and April 1979. Previous analyses of these data had demonstrated marked seasonal variations in energy intakes among Keneba women with low overall energy intakes but no particular deficit in protein intakes (Paul & Muller, 1980; Prentice *et al.* 1981).

All pregnant and lactating women in Keneba between May 1978 and April 1979 had taken part in the dietary study (*n* 148, aged 14–43 years). Each subject was studied for a full day, 1 d every week throughout her pregnancy and lactation. Field workers visited the mother several times daily, weighing and describing all foods eaten at meals and recording any snacks consumed (Paul & Muller, 1980; Prentice *et al.* 1981). Mothers who were pregnant or lactating in May 1978 were included in the study and mothers who become pregnant after this date were enrolled as they were identified. The number of days of dietary estimations performed per individual ranged from 1–47 (median 32 d). Forty-five mothers were studied during one lactational period and during either the preceding or subsequent pregnancy. Three additional mothers were studied during two lactational periods and the intervening pregnancy. The total numbers of pregnancy and lactation periods studied, therefore, were 75 and 124 respectively. The total number of d of dietary measurements was 4188, comprising 17514 separate measurements of food dishes, accompaniments and snacks. Keneba villagers are occasionally the recipients of small quantities of food-aid. In 1978–9 a limited amount of cracked wheat was available. Use of cracked wheat by study subjects was recorded on only sixty-three occasions, representing an insignificant contribution to the diet.

Each food consumed was identified in the database by a two-letter code. Ca and P values were assigned after considering the measured contents in samples of food, as described previously, and the observed frequency of use of occasional ingredients. Additional information for foods not analysed was obtained from Platt (1962), FAO/US Department of Health, Education and Welfare (1968), Paul & Southgate (1978) and West *et al.* (1988).

RESULTS

The Keneba diet in 1978–9

The diet pattern of the pregnant and lactating women in 1978–9 consisted of two main meals daily, eaten in the early afternoon and evening. These meals typically consisted of a cereal dish with a sauce made from groundnuts, leaves or vegetables. Breakfast was eaten by some women but not by all and not at all times of year, and was usually a cereal porridge.

Table 1 details the pattern of food dishes eaten by the women. Rice was eaten on 57% of occasions when the meal included a staple dish, with or without a sauce. Millets (findo, sanyo, suno and kinto) comprised 34% of staple dishes, eaten primarily as nyelengo or futo (Table 1). The use of findo and maize was highly seasonal, occurring towards the end of

the rainy season. Tia durango, a sauce made from roast groundnuts, was prepared on 70% of occasions when sauces were eaten. Leaf-sauces were eaten predominantly in the rainy season and accounted for 24% of all sauces. Porridges were made mainly from rice, sanyo and kinto. The use of milk, usually as an addition to porridge, was recorded on 370 occasions (equivalent to once on 9% of study days), 65% as fresh, powdered or tinned milk, 35% as sour milk.

Records of snacks between meals were common, the main snack foods being groundnuts, handfuls of prepared food and, in season, fruits (e.g. oranges, mangoes), cassava and roast maize cobs.

The calcium and phosphorus content of foods

The measured Ca and P contents of a selection of the raw ingredients and prepared foods collected in Keneba are given in Tables 2–5. The drinking water contained insignificant amounts of either of the minerals (Table 2).

The main sources of P were shown to be cereals, groundnuts and fish. The intake of P by an individual, therefore, would be expected to depend on the quantities of main foods eaten. In contrast, the richest sources of Ca were found to be foods that are used either in small quantities as condiments or only occasionally; dried baobab (*Adansonia digitata*) leaf, dried fish, baobab fruit, local salt, locust beans (*Parkia biglubosa*) and fresh leaves.

Dried baobab leaf is used in a variety of dishes. In particular, it is frequently added to steamed millets (sanyo, suno, kinto and findo) in amounts sufficient to impart a slippery texture. The high Ca content of prepared nyelengo and futo dishes reflects the presence of dried baobab leaf (compare kinti serengo and kinti nyelengo in Table 3). The dry flesh of the baobab fruit (sito) is used occasionally to flavour porridge and, when added, makes a significant contribution to the Ca content.

Dried fish is used as an occasional ingredient of sauces and nyankatango. Dried chalo (Table 4) is used more frequently than other fish. The mineral content of dried fish, as eaten, was shown to be highly dependent on the mode of preparation. Dried furo, a small fish, is prepared by removing the head and tail, then pounding the bones into the flesh. Similar steps are taken for preparing dried chalo, a medium-sized fish, but large bones are also removed. Dried kujalo and other large fish are pounded after the removal of all skin and bones. Consequently dried furo contains approximately ten times more Ca than other dried fish (Table 4).

The preparation of fresh fish was also shown to influence the mineral content of the edible portion (Table 4). Chalo contains numerous whiskery bones that cannot be removed easily and are often eaten. Larger bones are always discarded. Furo has needle-sharp bones; all are picked clean and not swallowed. Kujalo and other large fish are eaten off the bone. As a consequence, boiled chalo flesh, as eaten, contains the greater amount of Ca (Table 4). Tiny furo (kojay-furundingo), that are eaten whole, were found to be highly Ca-rich (Table 4). However, these fish are eaten very rarely, when food is in very short supply, and are likely to make an insignificant contribution to overall Ca intakes.

Fresh leaves are used in leaf sauces and occasionally as minor ingredients in tia durango. The most commonly used leaves are kucha, morongo and jambanduro (Table 5). The preparation of fresh leaves differs between varieties and this was found to modify the mineral content of the food as eaten (Table 5). Jambanduro requires soaking, boiling and draining before use. This procedure reduces the Ca and P content (Table 5). Morongo is usually washed, drained and boiled before use and the cooking water retained for cooking. This reduces the P content with little effect on the Ca content. Kucha leaves are steeped in water for about 30 min and drained before use, leading to some reduction in mineral content. Softer leaves are generally used untreated or after a quick rinse. The three most

Table 2. *Calcium and phosphorus contents of some locally obtained raw ingredients of the Keneba (The Gambia) diet*

(Values are means and standard deviations for indicated no. of separate pooled samples analysed)

Description	Local name	Ca (mg/kg)* Mean	Ca (mg/kg)* SD	P (mg/kg)* Mean	P (mg/kg)* SD	*n*
Rice, polished	Mano	60	10	2490	250	3
Millet, whole grain	Sanyo	90	50	3520	740	3
	Kinto	120	50	3040	880	4
	Findo	350	—	1560	—	1
Groundnuts	Tio	450	90	2600	350	5
Dried baobab (*Adansonia digitata*) leaf	Naa	17500	—	1930	—	1
Baobab fruit powder	Sito	3900	440	350	30	3
Locust bean (*Parkia biglubosa*) seed	Nete tuo	4490	130	2820	330	3
Locust bean-pod powder	Nete munko	1270	—	1600	—	2
Cow's milk (N'dama cattle)	Ninsi nono	1280	—	930	—	1
Local salt	Ko	2750	—	—		1
Sugar	Sukuro	20	—	—		1
Well water	Jio	10	10	0	0	13

* To convert Ca and P results to mmol/kg, divide by 40 and 31 respectively.

Table 3. *The measured calcium and phosphorus content of selected Gambian dishes, as eaten by pregnant and lactating Keneba (The Gambia) women**

(Mean values and standard deviations)

Mandinka name	Description	Ca (mg/kg)† Mean	Ca (mg/kg)† SD	Ca (mg/kg)† *n*	P (mg/kg)† Mean	P (mg/kg)† SD	P (mg/kg)† *n*
Cereal dishes and other staples							
Mani fajiringo	Rice, boiled	60	30	21	340	30	8
Mani nyankatango	Rice + groundnuts, steamed	110	50	14	690	250	16
Mani mono	Rice porridge	50	10	5	120	60	3
Mani mono + nono	Rice porridge + milk	100	70	3	350	—	1
Tiakere churo	Rice & groundnut porridge	60	20	6	290	130	6
Sanyo nyelengo	Millet (sanyo), steamed	310	60	6	950	270	8
Sanyo futo	Millet (sanyo), steamed, dry	570	220	6	1620	140	5
Sanyo mono	Millet (sanyo) porridge	50	10	8	130	110	11
Kinti serengo	Millet (kinto), boiled	40	10	7	280	40	4
Kinti nyelengo	Millet (kinto), steamed	250	180	14	840	560	9
Kinti futo	Millet (kinto), steamed, dry	560	180	14	2190	670	11
Kinti mono	Millet (kinto) porridge	30	20	8	290	170	4
Tubanyo nyelengo	Maize, steamed	300	—	2	880	—	2
Tubanyo futo	Maize, steamed, dry	560	260	6	1690	210	3
Nyambi mono	Cassava porridge	70	20	5	60	—	2
Basic sauces							
Tia durango	Roast groundnut sauce	210	80	22	690	190	16
Jambo	Leaves & groundnut sauce	1330	550	34	910	150	12
Kucha	Kucha leaf sauce	990	430	11	510	200	4
Tio + njeng dajiwo	Groundnut and pumpkin sauce	200	90	10	360	130	5

* Dishes known to contain fish or other special ingredients have not been included; nyelengo and futo generally contain dried baobab leaf.

† To convert Ca and P results to mmol/kg divide by 40 and 31 respectively.

Table 4. *The measured calcium and phosphorus contents of fish, as eaten by pregnant and lactating Keneba (The Gambia) women**

(Mean values and standard deviations)

Mandinka name	Identification		Ca (mg/kg)† Mean	Ca (mg/kg)† SD	P (mg/kg)† Mean	P (mg/kg)† SD	n‡
Chalo	Bonga (Shad), *Ethmalosa fimbriata*	B	900	310	2170	370	7
		D	3950	3340	7280	2400	5
Furo/furundingo	Tilapia, *Tilapia* spp.	B	490	250	1380	400	5
		D	40000	—	27000	—	1
Kojay-furundingo§	Tilapia, *Tilapia* spp.	B	17600	—	9600	—	2
Kujalo	Spanish fish, *Polynemus quadrifilis*	D	1770	630	4090	—	3

B, boiled; D, dried.
* Only edible portions were analysed (see p. 889).
† To convert Ca and P results to mmol/kg divide by 40 and 31 respectively.
‡ Number of separate pooled samples analysed.
§ Extremely small furundingo, eaten whole.

Table 5. *The measured calcium and phosphorus contents of fresh leaves as used in the preparation of sauces eaten by pregnant and lactating Keneba (The Gambia) women*

Mandinka name	Identification	Frequency* (%)	Method of preparation	Ca (mg/kg)†	P (mg/kg)†	n‡
Kucha	Sour leaf (*Hibiscus sabdariffa*)	54	U	3540	490	2
			Wd	2180	370	2
Morongo	African spinach (*Amaranthus* spp.)	15	U	4330	1440	2
			Wr	3900	290	2
Jambanduro	*Cassia tora*	13	U	7050	1240	3
			Wd,B	4330	420	1
Nebedayo	*Morina oleifera*	6	U	3930	3010	2
Naa	Baobab (*Adansonia digitata*)	2	U	3190	890	3
Kanjo	Okra (*Hibiscus esculentus*)	< 1	U	6460	—	2
Nyambo	Cassava (*Manihot esculenta*)	< 1	U	2710	1110	3
Potato	Sweet potato (*Ipomoea batatas*)	< 1	U	3470	620	2
Soso	Cowpea (*Vigna unguiculata*)	< 1	U	2450	—	2
Njengo	Pumpkin (*Cucurbita maxima*)	< 1	U	3640	—	2
Kerenkerengo	*Corchorus olitorus*	< 1	U	3580	—	1

U, untreated; Wd, washed and water discarded; Wr, washed and water retained; B, boiled and water discarded.
* Frequency (%) of each leaf type used in 116 leaf sauces recorded during preparation.
† To convert Ca and P results to mmol/kg divide by 40 and 31 respectively.
‡ No. of separate pooled samples analysed.

commonly used fresh leaves (Table 5) generally contain 2000–4500 mg (50–112 mmol) Ca/kg and 300–400 mg (10–13 mmol) P/kg at the time they enter the cooking pot.

As the richest sources of Ca in the Keneba diet are minor foods and flavourings, the Ca intake of an individual would be predicted to depend more on the cooking habits of the family than on the availability of major food items. Table 6 illustrates the observed frequency of use, and the amounts added, of three Ca-rich ingredients in six common dishes. Local salt, although added in only small quantities, is an ingredient of most dishes and makes a sizeable contribution to foods that otherwise contain very little Ca. Most of

Table 6. *The estimated contribution (mg/kg)* of three calcium-rich flavourings to the Ca content of selected dishes eaten by pregnant and lactating Keneba (The Gambia) women*

			Salt				Dried fish				Dried leaf			
Dish	*n*†	Ca‡	W	F	C	A	W	F	C	A	W	F	C	A
Tia durango	220	140	25	81	70	60	43	13	650	80	9	14	160	20
Kucha	51	900	37	91	100	90	48	22	720	160	21	20	380	80
Jambo	53	1280	18	92	50	50	26	9	390	40	25	4	450	20
Vegetable stew	62	140	52	85	140	120	40	5	600	30	—	0	—	0
Bukolo	23	130	19	83	50	40	16	22	240	50	19	39	340	130
Nyankatango	49	70	12	100	30	30	17	35	260	90	—	0	—	0

W, mean weight (g/kg) of ingredient added, when used; F, percentage of observed preparations that contained the ingredient; C, Ca (mg/kg) contributed by ingredient, when used; A, estimated contribution of ingredient (mg/kg) to average Ca content of dish (C × F/100).

* To convert to mmol Ca/kg divide by 40.

† No. of observed preparations of the dish.

‡ Estimated Ca content (mg/kg) of the plain dish (no salt or other Ca-rich condiments).

the Ca in porridges is derived from added salt. Dried fish and dried baobab leaf increase the Ca content of a dish by several fold. Fresh fish flesh and dried fish increase the Ca content of sauces by a similar amount. Locust beans increase the amount of Ca in a dish by about 200 mg/kg (5 mmol/kg) but as they are used infrequently they contribute little to total Ca intakes. Most other minor ingredients, such as onion, chili, tomato and cereal flour, contribute little to Ca intakes.

Unusual sources of calcium

Two possible sources of Ca that had not been recorded in earlier dietary assessments were identified during interviews with villagers. The first were certain soils that a few individuals, especially children and pregnant women, chew on rare occasions. Samples from three particularly favoured patches of earth had mean and SD mineral content (mg/kg) as follows: Ca 280 (SD 50), P 120 (SD 10) (7·0 (SD 1·3) and 4·4 (SD 0·3) mmol/kg respectively). Two samples of 'edible' material from termite hills had the following values Ca 430, 1960 mg/kg (11, 49 mmol/kg); P 170, 370 mg/kg (5, 12 mmol/kg) respectively. A typical portion size is 5–10 g. The contribution of geophagy to Ca intakes in Keneba is likely, therefore, to be extremely small.

The second possible source was baobab fruit (sito), eaten as a snack. Many women occasionally chew the dry, sherbert-like flesh of the baobab fruit when in season (December–April). The seeds are not eaten. To assess the contribution that baobab fruit might make to Ca intakes, forty-nine pregnant and lactating women were interviewed about the frequency and quantity of sito eaten in season. Of these women, 81% stated that they chewed a small amount of baobab at least once weekly, with 40% having some every day. The average snack size, after removal of seeds, was 13 g. Such a snack provides 50 mg Ca (Table 2). After taking frequency of consumption into account, the maximum likely contribution of baobab fruit to average Ca intakes was estimated at 30 mg/d (0·75 mmol/d) in season or 10 mg/d (0·25 mmol/d) over the year as a whole.

Calcium and phosphorus intakes of pregnant and lactating women in Keneba 1978–9

The daily Ca and P intakes of pregnant and lactating Keneba women in 1978–9 are given in Table 7. The average Ca and P intakes for all women measured over the 12 months were

Table 7. *The estimated daily intake of calcium and phosphorus by Keneba (The Gambia) women in 1978–9*

(Mean values and standard deviations)

	No of subjects	Ca (mg/d)‡		P (mg/d)‡	
		Mean	SD	Mean	SD
All year					
Pregnant women	75	404	133	861	257
Lactating women	124	387	93	903	192
Total	199	394	110	887	219
July–October (rainy season)					
Pregnant women	41	455	158	796	268
Lactating women	85	409	152	765	160
Total	126	424	155	775	201
November–February (post-harvest dry season)					
Pregnant women	51	365**	136	851	262
Lactating women	91	366*	117	975***††	284
Total	142	365***	124	931***	282
March–June (pre-harvest dry season)§					
Pregnant	55	364**	120	850	264
Lactating women	122	363*	81	904***	193
Total	177	364***	94	888***	218

Mean values were significantly different from those obtained in July–October (*t* test): * $P < 0{\cdot}05$, ** $P < 0{\cdot}01$, *** $P < 0{\cdot}001$.

Mean values were significantly different from those of pregnant women in the same season (*t* test) †† $P < 0{\cdot}01$.

‡ To convert Ca and P results to mmol/d divide by 40 and 31 respectively.

§ May–June 1978 and March–April 1979.

394 and 887 mg/d (9·9 and 28·6 mmol/d) respectively. Including an allowance for baobab fruit raised the Ca intake estimate to 404 mg/d (10·1 mmol/d). No significant difference was observed in Ca intake between pregnant and lactating mothers at any time of the year. In contrast, the P intakes of pregnant women were lower than those of lactating women during the dry seasons. The Ca intake of all women was significantly higher in the rainy season than in the two dry seasons, while P intakes were lower.

The contributions of various foods to Ca intakes in 1978–9 are illustrated in Fig. 1. The predominant sources of Ca were leaves, particularly dried baobab leaf, fish, cereals, groundnuts and salt. Cereals, despite low contents of Ca, provided 12% of Ca intakes as a result of the large amounts of these foods consumed. Milk accounted for only 5% of Ca intakes.

Small changes in dietary practice have occurred in Keneba since 1979. In the intervening years rainfall has become less restricted, the cultivation of garden vegetables has increased and rice has become more popular. However, it is unlikely that any of these changes has had any substantial impact on average Ca and P intakes.

DISCUSSION

The present study has demonstrated that the Ca intakes of Keneba women average about 400 mg/d (10 mmol/d) during pregnancy and lactation. These intakes are considerably lower than intakes of pregnant and lactating British women (Black *et al.* 1986; Schofield

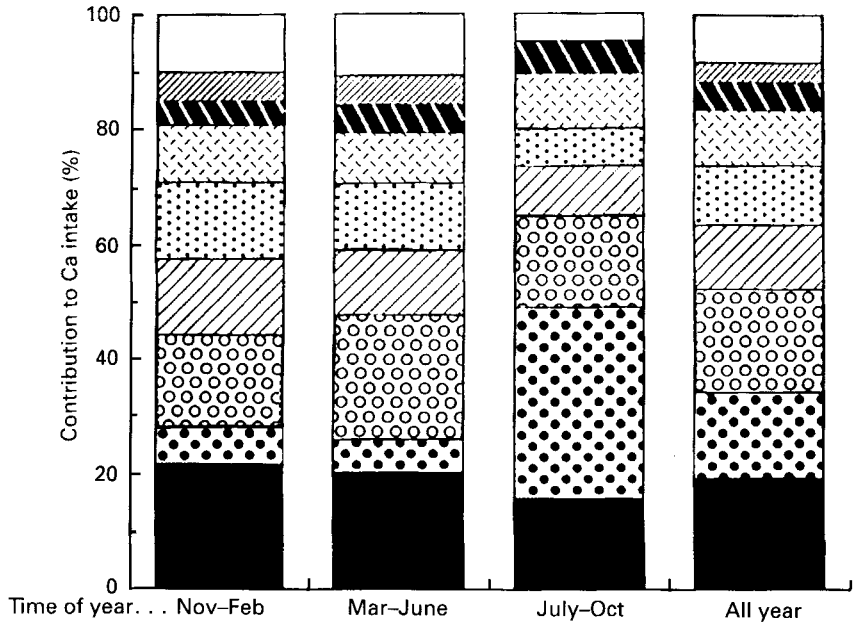

Fig. 1. Contribution of various foods to the Ca intakes of pregnant and lactating Keneba (The Gambia) women, 1978–9. (□), Others; (▨), Baobab (*Adansonia digita*); (▩), Milk; (▦), Salt; (▥), Groundnuts; (▧), Cereals; (▤), Fish, wet + dry; (▣), Fresh leaves; (■), Dried baobab leaf. For details of diet, see Tables 1 and 2 and Results.

et al. 1989) and are only about one-third of the reference values given in the UK (Department of Health, 1991) and by the Food and Agriculture Organization/World Health Organization (1962). Further, as the diet is based on cereals, groundnuts and leaves, foods that are rich in phytates and oxalates, the proportion of dietary Ca absorbed may be low (Allen, 1982).

P intakes in Keneba were shown to average about 900 mg/d (30 mmol/d), a somewhat lower intake than that measured in the UK (1200–1300 mg/d) from household food purchase data (Department of Health, 1991). The intake of P by Keneba women varied between seasons and between pregnant and lactating women in a similar manner to energy intakes (Paul & Muller, 1980; Prentice *et al.* 1981).

Recent studies have shown that, despite the rigorous nature of the dietary assessments, energy intakes measured in Keneba do not agree with estimates based on measurements of energy expenditure (Lawrence & Whitehead, 1988; Singh *et al.* 1989). Dietary estimates are approximately 70% of those based on energy expenditure with the greatest divergence occurring in the wet season. The exact reason for the discrepancy is unclear but is likely to be due to inaccuracies in the intake estimates. It is possible, therefore, that P intakes may be underestimated in the present study by a similar amount since the major energy-providing foods are those that are richest in P (assuming a 30% shortfall raises average P intakes to 1270 mg/d (41 mmol/d)). It is unlikely, however, that Ca estimates are affected to the same extent, as the main dietary sources of energy are not rich in Ca. If, for example, it is assumed that the discrepancy in energy balance was due to under-reporting of the consumption of groundnuts, the most common energy-rich snack food, the measured Ca intake would be raised to 450 mg/d (11·25 mmol/d), while a similar underestimation of the main energy-providing dish, rice and tia durango, would increase the value to 465 mg/d (11·6 mmol/d). If it were assumed, however, that the energy shortfall was due to under-

reporting of all components of the diet, estimated Ca intakes would still only rise to 570 mg/d (14·25 mmol/d). It can be appreciated, therefore, that, despite the likely inaccuracies of the food intake methodology, Ca intakes of rural Gambian women undoubtedly are low throughout pregnancy and lactation.

The consequences of such low intakes of Ca are not known. Recent studies in Keneba have demonstrated that Gambian women attain peak bone mass later (Prentice *et al.* 1991) and have lower breast-milk Ca concentrations and Ca:P values than British women (Laskey *et al.* 1990, 1991). However, the reported incidence of osteoporosis in The Gambia is low (Prentice *et al.* 1991). Detailed supplementation studies are required to determine whether low intakes of Ca during pregnancy and lactation such as those observed in Keneba are sufficient to support optimal foetal and infant growth without compromising the maternal skeleton.

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