

## Nutrient intake during lactation in Australian women

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(Received 17 January 1966—Accepted 15 March 1966)

1. The dietary intakes of forty-one mothers were investigated during lactation, between the 6th and 20th weeks after delivery. The group comprised thirty primiparae and eleven multiparae. 2. The women studied were apparently lactating satisfactorily, as the infants were judged healthy and their average weekly weight gain was 193 g (6.9 oz). 3. The average daily intakes of nutrients by the mothers were compared to those listed in *Dietary Allowances for Australia*. Intakes of calories, protein, calcium, iron and ascorbic acid were  $514 \pm 75$  (16%),  $17.0 \pm 2.7$  g (17%),  $725 \pm 75$  mg (36%),  $5.2 \pm 0.43$  mg (31%) and  $21 \pm 5.3$  mg (21%) respectively below the allowances for these nutrients. It is suggested that the allowances for calories, protein, calcium, iron and ascorbic acid may have been set at too high a level. 4. The incidence of successful breast-feeding in western countries compared with others is briefly discussed. It is concluded that diet plays a minor part and that the dominant factors are cultural and social.

In this study, dietary intakes were observed in a group of healthy women of known body-weight and known degree of activity, who were successfully feeding their infants. When this study began, no Australian figures were available for the dietary intake of such women. Subsequently, Hankin, Symonds & Cellier (1965) have published the results of a survey of lactation in a group of Australian women. They concluded that a daily diet containing 2500 kcal, 70 g protein and 800 mg calcium was adequate for the maintenance of lactation.

The cultural pattern of Australians and New Zealanders is similar to that of the peoples of western Europe and the USA. However, only a few dietary studies on lactating women in these areas of the world have been carried out, several of which have been concerned with specially selected women. For example three mothers in the USA studied by Shuckers, Macy, Nims, Donelson & Hunscher (1932) were 'wet nurses' all of whom had remarkably high milk yields, the average daily yield of one being 3.13 l. The average daily energy intake of these subjects was 4233 kcal. Deem (1931) studied a group of five unmarried mothers in a New Zealand institution, who spent a considerable part of the day performing heavy manual labour; the average daily energy intake observed was 3132 kcal. Twelve multiparae studied in the USA by Kaucher, Moyer, Williams & Macy (1946) were under strict dietary control, so that the average intake of 2928 kcal which was observed may not have been representative of mothers in the USA in general. Bransby, Cooper, Kon, Mawson, Rudall, Sinclair & Wagner (1950) and Hytten & Thomson (1961) have studied more representative groups in the United Kingdom. The former, in three separate studies of a total of 120 women, reported average daily intakes of 2410, 2448 and 2314 kcal. The average intake of a group of eleven primiparae, studied in Edinburgh by Hytten & Thomson (1961), was 2600 kcal.

A number of surveys have been made to determine the dietary intakes of lactating women in other cultures. Pasricha (1958), Karmarkar, Kapur, Deodhar & Ramakrishnan (1959), Karmarkar, Rajalakshmi & Ramakrishnan (1963), Belavady, Venkatachalam & Gopalan (1961) and Deb & Cama (1962), in studies of Indian women, observed energy intakes varying from 1300 to 2279 kcal. Oomen & Malcolm (1958), Whiteman (1965) and Hipsley & Kirk (1965) have reported the dietary intakes of New Guinean mothers, which also appear to be lower than those usually observed in western countries. However, unless body-weights and the degree of physical activity are considered, interpretation of the significance of such levels is not possible. The average daily nutrient intakes reported in all the studies mentioned above are given in Table 1.

The need for further information about the actual food consumption of healthy people was recognized at the Tenth Pacific Science Congress (1963). (Resolution 46 of this Congress states: 'There is insufficient information on the dietary intakes of apparently "healthy" people living on the ordinary food indigenous to many of the Pacific areas, though such information is essential to any further understanding of dietary standards and the balance between food supply and the expanding populations of the Pacific area. RESOLVED that all Pacific countries be urged to collect for presentation at the next Pacific Science Congress data relating to food and nutrient consumption of "specified groups" of "healthy" people living on the foods readily available in their ecosystem.') Dietary recommendations of such bodies as the (USA) National Research Council: Food and Nutrition Board (1964), the (Australian) National Health and Medical Research Council: Nutrition Committee (1961) and the Canadian Council on Nutrition (1964) appear to have been based mainly on physiological considerations. In the present study differences between the actual calorie and nutrient intakes of lactating women and those recommended by the (Australian) National Health and Medical Research Council: Nutrition Committee (1961) are discussed.

#### EXPERIMENTAL

A 7-day diet record was kept by forty-one lactating women (thirty primiparae and eleven multiparae), who were not suffering at the time from any recognizable disease. Fifteen of the subjects were participating in a longer study of dietary habits covering a reproductive cycle; the remaining twenty-six were studied for 1 week only. Records were obtained between the 6th and 20th weeks after delivery. If the weekly weight gain of the infants is taken as the criterion, all the subjects appeared to be lactating satisfactorily.

Because of alterations in diets at weekends, it was decided that the survey should cover a period of 7 days, with three interviews in the subject's home at intervals during this period. At the first, the method of keeping the record was explained; at the second, the dietary record was checked and the subject questioned concerning her normal day's activity; at the third, the completed dietary record was checked and collected. The reported birth weight of the infant, its present weight, the present weight of the subject and her statement of her usual weight before pregnancy were

Table 1. Daily nutrient intakes of lactating women recorded in the literature

Subjects	No.	Calories (kcal)	Protein (g)	Calcium (mg)	Iron (mg)	Vitamin A (i.u.)	Thiamine (mg)	Riboflavin (mg)	Nicotinic acid (mg)	Ascorbic acid (mg)	Reference
Primiparae, UK	11	2579	83	1020	—	6896	1.4	2.1	13.7	73	Hyttén & Thomson (1961)
Primiparae and multiparae, UK	36	2410	88	800	17	2775	1.4	—	—	39	Bransby <i>et al.</i> (1959)
	23	2448	84	1000	15	4037	1.7	2.0	—	32	
	50	2403	89	1200	12	3114	1.4	—	—	63	
Multiparae (under dietary control), USA	12	2951	11	—	—	3.4 mg	1.3	3.2	7.0	—	Kaucher <i>et al.</i> (1946)
Wet nurses, USA	3	4233	158	2870	—	—	—	—	—	—	Shuckers <i>et al.</i> (1932)
Primiparae, New Zealand	5	3132	87	—	—	—	—	—	—	—	Deem (1931)
Poor multiparae, India	70	1858	43	299	22	—	—	—	—	—	Pasricha (1958)
Upper middle class	49	2279	55	1089	21	—	—	—	—	—	Karmarkar <i>et al.</i> (1959)
Middle class	57	1906	47	701	22	—	—	—	—	—	
Poor class	50	1872	46	676	26	—	—	—	—	—	
Very poor class	54	1439	40	279	28	—	—	—	—	—	Karmarkar <i>et al.</i> (1963)
Very poor class, India	60	1300	21	—	—	—	0.2	0.2	—	2	
Poor class, India	14	1900	45-55	—	—	—	—	—	—	—	Belavady <i>et al.</i> (1961)
Poor class, India	20	1850	41	—	—	—	—	—	—	—	Deb & Cama (1962)
Pregnant and lactating women, New Guinea	31	1395	22	358	10	—	—	—	—	—	Oomen & Malcolm (1958)
Lactating women, New Guinea, Pari	7	1680	22	868	13	17360	1.6	1.0	9.1	427	Hipsley & Kirk (1965)
Lactating women, New Guinea, Kaporaka	8	1435	31	162	10	290	1.0	0.6	6.2	81	Whiteman (1965)
Lactating women, New Guinea, Not given	Not given	2035	40	1180	16	9559	—	—	—	1638	
Lactating women, New Guinea, Mar-July	—	1157	24	1117	29	28396	—	—	—	1657	—

also recorded. The subjects were invariably found to be 'weight-conscious' and none had difficulty in recalling their weight before pregnancy.

The average daily intakes of calories, protein, fat, calcium, iron, vitamin A, thiamine, riboflavine, nicotinic acid equivalent, ascorbic acid and fibre were calculated from the dietary records, the food composition tables of Osmond & Wilson (1961), Wilson (1961) and Bowes & Church (1952) being used. Since no significant differences were found between the primiparae and multiparae studied, they were treated as one group.

#### RESULTS

*Meal pattern.* In general, the meal pattern comprised three meals daily, with between-meal snacks. Breakfast usually consisted of cereal or eggs or meat, sometimes served together, with toast and a beverage. Fruit or fruit juice was only occasionally taken at breakfast. Sandwiches, or a salad of meat or cheese, lettuce, tomato and other salad vegetables comprised the usual lunch. The evening meal normally consisted of meat served with potato and other vegetables, followed by a dessert of fruit and custard or ice-cream. Snacks between the meals were often taken; these varied but frequently included milk, fruit or biscuits. The food consumption pattern of the wife did not appear to differ significantly from that of her husband. One subject supplemented her diet by taking a 'mineral, multivitamin' tablet once a day.

*Nutrient intake.* The intake of nutrients is given in Table 2. The Australian dietary allowances for lactation are included for comparison, and the average height and weight of the subjects are also given. The observed intakes of the subjects for calories, protein, calcium, iron and ascorbic acid were below the allowances for lactation; those of other nutrients were of the same order or above. The calorie equivalent of the food consumed was  $514 \pm 75$  kcal (16%) below the allowance and the protein intake was  $17.0 \pm 2.7$  g (17%) lower. Calcium, iron and ascorbic acid intakes were  $725 \pm 75$  (36%),  $5.2 \pm 0.43$  (31%) and  $21 \pm 5.3$  mg (21%) respectively below the allowances for these nutrients.

*Physical activity.* An attempt was made to assess the energy expenditure of each subject, from information obtained concerning her usual 24 h activity. An average of 8.5 h was spent in sleeping and 2.5 h was spent resting, while feeding her infant; 9 h was occupied by dressing, general housework, cooking, washing, shopping and walking; 4 h, mostly during the evening, was spent sitting, talking, listening to the radio or reading. The subjects occasionally gardened, but few engaged in any active sport. This degree of activity appears to be similar to that described for the Reference Woman quoted in the National Health and Medical Research Council: Nutrition Committee (1961). ('The Reference Woman is a healthy woman, that is, she is free from disease and exhibits a normal degree of physical fitness. She is aged 25 years, weighing 55 kg (121 lb) and lives in the warm temperate zone at a mean external annual temperature of 18° C (64° F). She is engaged in general household duties, including the care of small children, or in light industrial work. Non-working activities include a daily walk of from 5 to 10 km (3 to 6 miles) and two hours spent out of doors. At times she engages in activities such as gardening and non-strenuous sports.')

Table 2. Daily intake of nutrients by Australian women during lactation

(Mean values with their standard errors)

Subjects Group	No.	Weight (kg)	Height (cm)	Age (years)	Pro- tein (g)	Fat (g)	Ca- lories (kcal)	Cal- cium (mg)	Iron (mg)	Vita- min A 'value' <sup>*</sup> (i.u.)	Thia- mine (mg)	Ribo- flavine (mg)	Nico- tinic acid equi- valent (mg)	Ascor- bic acid (mg)	Fibre (g)
Primiparae	30	58.8 ± 1.3	165.5 ± 1.21	24.4 ± 0.67	84.7 ± 3.40	120.4 ± 4.49	2600 ± 92	1319 ± 95	11.9 ± 0.51	9293 ± 994	1.2 ± 0.06	2.4 ± 0.17	27 ± 1.0	80 ± 7.0	4.4 ± 0.28
Multiparae	11	58.9 ± 2.5	162.6 ± 1.85	28.7 ± 2.20	78.4 ± 4.22	110.3 ± 5.81	2548 ± 128	1153 ± 112	11.5 ± 0.92	9607 ± 964	1.1 ± 0.06	2.1 ± 0.26	23 ± 2.7	75 ± 6.4	4.5 ± 0.43
Combined group	41	58.8 ± 1.1	164.7 ± 1.02	25.26 ± 0.79	83.0 ± 2.74	117.7 ± 3.64	2586 ± 75	1275 ± 75	11.8 ± 0.43	9377 ± 787	1.1 ± 0.04	2.33 ± 0.14	26 ± 1.0	79 ± 5.3	4.1 ± 0.23
Australian dietary allowance† (1961)		55	—	25	100	—	3100	2000	17	5000†	1.2	1.8	20	100	—

\* Vitamin A and carotene.

† National Health and Medical Research Council: Nutrition Committee (1961). To facilitate comparison the 1954 allowance (National Health and Medical Research Council: Nutrition Committee, 1954) for vitamin A 'value' is given instead of the 1961 allowance, which is quoted as vitamin A 'activity'.

*Weight changes of the subjects.* Of the group of fifteen subjects studied from 6 to 8 weeks *post partum* to the cessation of lactation, ten lost weight, and five gained; there was an average weekly weight loss of 120 g during this period. This would represent a daily withdrawal of 110 kcal from body stores, on the assumption that the loss of 1 kg body-weight is equivalent to the release of 6500 kcal (Hyttén & Thomson, 1961). At the time of the dietary study, the average weight of the group was 1.2 kg above the estimated pre-pregnancy weight, indicating a residual store of 7800 kcal of energy at this stage of lactation. The average body-weight of the twenty-six subjects who were studied for only 1 week during lactation (weeks 6–20 *post partum*) was found to be 1.3 kg (representing a residual storage of 8450 kcal) above the estimated pre-pregnancy weight.

*Weight changes of the infants.* The average birth weight of the forty-one infants in this study was 3.3 kg (7 lb 3 oz). Their average daily weight gain was 27.6 g (1.0 oz). At the time of the study, thirty-five of the infants were fully breast-fed, but four others received a daily supplement of about 10 g dry cereal plus about 15 g cow's milk and two were given this cereal and milk supplement and in addition about 28 g cooked vegetables. The average age of the infants when supplementary feeding was commenced was 3 months.

*Duration of lactation.* The average duration of lactation of the fifteen subjects was 5.8 months (range 3–10 months).

*Duration of lactation and the calorie and protein value of the mothers' diet.* When the diets of the fifteen subjects were graded according to calorie and protein values, no relationship was found between the grades and the length of lactation.

## DISCUSSION

### *Comparison of observed nutrient intakes during lactation with Australian dietary allowances*

The average calorie equivalent of the food consumed was approximately 500 kcal below the Australian dietary allowance. This difference could be interpreted in several ways. It could indicate underfeeding, an unusually low level of physical activity, or the setting of the dietary allowance at an unnecessarily high level. It is unlikely that underfeeding is the correct explanation since, not only did the subjects eat enough to satisfy hunger, but also the average body-weight was 1.2 kg above the usual level. The present observations suggest that the degree of physical activity during lactation was similar to activity during the pre-pregnancy period and that this approximated to the activity level of the 'Reference Woman'. Therefore it must be concluded that the calorie allowance for lactation has been overestimated. The dietary increment allowed for lactation has been estimated from theoretical calculations based on certain questionable assumptions concerning milk production.

The observed intake of protein was  $17 \pm 2.7$  (17%) below the dietary allowance. It should be noted that the allowance for lactation is 45 g (82%) above the amount allowed for a non-lactating woman. Since the subjects and infants were healthy, and

both showed satisfactory weight trends, it was concluded that the protein intake was adequate.

Calcium, iron, and ascorbic acid intakes, though 725, 5 and 21 mg (36, 31 and 21 %) respectively below the dietary allowances for these nutrients, were considered adequate for the same reasons. The allowances of these nutrients, as well as of protein, may also have been set at unnecessarily high levels.

The Australian dietary allowances are designed to afford a 'margin of safety' above average physiological requirements to cover variations among essentially all individuals in the general population. For some nutrients such as ascorbic acid, this margin appears to have been set at 100%, or more, above average physiological requirements; for others such as protein and the B group of vitamins it is 50%; whilst for calories no margin is allowed. Unfortunately, although these considerations were in the minds of the authors of *Dietary Allowances for Australia*, they are not implied in the title and appear to be frequently overlooked by those who use the allowance tables.

#### *Relation between maternal diet and the efficiency of lactation*

A lactating mother and her infant form a unified biological organism, and the diets of both are integrated through the metabolic mechanisms of the mother. The mother's milk supply is adjusted to the demands of her infant. This demand varies, not only because the growth of the infant is not uniform throughout the lactating period, but also because foods other than mother's milk are often introduced into the infant's diet from about 1 month onward ( $2\frac{1}{2}$ –3 months in Australia). Recommendations for diets during lactation take no account of these considerations. They give no indication of the interaction of these variable factors of the infant's diet—for example, by stating the stage of lactation to which the recommendations apply. For these reasons, quite apart from the fact that most tables of dietary allowances take insufficient account of the variability of activity of the mother, it must be concluded that dietary recommendations for lactation hitherto published have a very limited usefulness.

There may have been a tendency in Australia to overemphasize the importance of diet as a factor in successful lactation, and perhaps to attribute the commonly occurring failure of lactation to failure to 'meet' the dietary allowances. The present study clearly shows that what is regarded as successful lactation in this country has been achieved when the dietary intakes were considerably lower than the dietary allowances. Hankin *et al.* (1965) reported, in their study of lactation and diet in a group of 174 Australian women, that the length of lactation was greater in subjects with a higher antenatal dietary rating, and with better postnatal diets. However, they also pointed out the difficulty of assessing the influence of diet *per se* on lactational performance, considering the complexity of social and other factors which undoubtedly influence lactation.

Since lactation is judged to be 'remarkably satisfactory' until the infants are 3–4 months of age in many areas where undernutrition and malnutrition are believed to be widespread (WHO, 1965), it is difficult to believe that there is a close relationship between diet and lactational performance. Gopalan & Belavady (1961) reported that

the breast milk of South Indian women seemed adequate to meet the demands of the infants up to 6 months of age even in poor socio-economic groups. They also noted that there was no great difference, with respect to content of energy-yielding nutrients, between the milk of these poorly fed women and that of better-fed mothers in other areas of the world. Hipsley & Kirk (1965) commented on the apparent success which the New Guinean mother achieves in breast-feeding her infant—despite her consumption of a diet low in protein and often in energy value.

It has been suggested by Illingsworth & Stone (1952) that the feeding on demand practised by most mothers in Eastern countries, by causing more frequent emptying of the breast, has a favourable effect on the establishment and maintenance of lactation. Hytten (1958) suggested that some sort of natural selection for lactational ability may have operated in countries other than those where a considerable number of mothers are unable to produce sufficient milk to nourish their infants. Although it is difficult to believe that in a matter of one or two generations genetic adaptations could have occurred to produce a race of women who have difficulty in feeding their babies, the transmission of acquired characteristics from mother to offspring by a cumulative maternal effect has been demonstrated to occur in mice adapted to life at temperatures below freezing (Barnett, 1961). A similar inheritance of lactational ability by poorly fed mothers is a distinct possibility.

It is likely that much of the success of breast-feeding has to do with the way of life of the woman and her own and society's attitude to breast-feeding. Hipsley (1964) has suggested that in Western people, the reluctance to feed more frequently on demand, the training of the infant to eliminate its demand during the night, plus the easy availability of cow's milk, all lead directly to failed lactation as they abolish the most effective stimulus to lactation, namely emptying of the breast.

In poor socio-economic groups in many countries, and where artificial substitutes are not available, there is no choice to make between breast and artificial feeding. There are usually no social or economic barriers to feeding on demand and the incidence of successful breast-feeding is high. In a study of socio-economic groups in India, Gopalan (1958) has reported an inverse relationship between the adequacy of the lactational performance of a community and its position on the social scale. Among the poorest classes, failure to breast-feed the infants for a period of 6 months was almost unknown. However, less than 20% of the highly educated women of the highest socio-economic groups were breast-feeding their infants at 6 months.

In their study of diet and lactation in Australia, Hankin *et al.* (1965) reported that at 6 weeks after delivery 45% of subjects were wholly or partially breast-feeding. The number was reduced at 3 and 6 months to 25 and 8% respectively. It would appear that lactation by Australian women is following the pattern seen in other affluent communities, where the proportion of women who breast-feed their infants may not exceed 20% and where lactation is often of short duration (WHO, 1965). In Australia, as elsewhere, it is probable that social and other cultural factors are far more important determinants of lactational performance than dietary and nutritional factors.

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[*Note added in proof.*] Since this paper was written the dietary allowances for Australians have<sub>2</sub> been revised (*Med. J. Aust.* (1966), p. 1041).