

Dietary intake and nutritional status of women and pre-school children in the Republic of the Maldives

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Abstract

Objective: Malnutrition and poor nutritional status among children are common problems in the Republic of Maldives, a small island nation in the Indian Ocean. The aim of this study was to determine possible macro- and micronutrient deficiencies in the traditional Maldivian diet.

Design: In five atolls, 333 women with children aged between 1 and 4 years who were no longer breast-fed were interviewed, using a 24-hour recall. Additionally, the weights and heights of both the women and children were measured, and blood samples from 15 women were collected for measurements of vitamins A and E, β -carotene, homocysteine, cholesterol and haemoglobin.

Results: Of the women, 22% had a body mass index (BMI) below 18.5. Of the children, 41% were stunted, 14% were wasted and 51% were underweight. The women's and children's diets were sufficient in protein (14%) and carbohydrates (67%) but deficient in fat, which contributed only 19% to the total energy intake. Consumption of dietary substances that depend on vegetable and fruit intake (e.g. β -carotene, vitamin C, dietary fibre and folic acid) was low. The low intake of β -carotene was underlined by low plasma concentration. The estimated iron intake was low, although blood haemoglobin levels were normal.

Conclusions: Marginal nutritional status and marginal malnutrition are due to low fat intake and selected micronutrient deficiency. Higher intakes of locally available vegetables and fruits and fat (especially for children) on a regular basis might reverse the deficits documented on the atolls.

Keywords
Nutritional status
Dietary nutrient intake
24-hour recall
Anthropometry
Pre-school children
Women
Maldives

Malnutrition is a world-wide problem; both the impact on public health and its clinical form are seriously considered in communities. Children especially suffer from a marginal deprivation, or a mild chronic deficiency, of certain macro- and micronutrients resulting in growth retardation, loss of weight and proneness to infections.

Growth retardation among children is also a well-known problem in the Republic of Maldives, a small island nation in the Indian Ocean. Despite a variety of locally available foods, the Maldivian diet might be described as monotonous, consisting mainly of fish (tuna fish and sometimes reef fish), rice and *rosbi* (a kind of bread). Rice, flour, sugar, oil (except coconut) and milk powder are imported. Vegetables and fruit are rarely consumed; they are preferably sold if available^{2,3}. The outlined dietary habits might result in micronutrient deficiency; iron² and iodine deficiency⁵ are usual health

problems. One-fifth of Maldivian children have a low birth weight (<2.5 kg)⁴, and the prevalence of malnutrition is reported to increase with age of the children^{1,2}. Diarrhoea, acute respiratory infections and intestinal parasites are common associated diseases that have a negative impact on nutritional status^{3,6}.

Although semi-quantitative data about food intake of women and children below 5 years old obtained by food-frequency level (weekly food consumption without asking for portion sizes) are reported², quantitative information is not available. The present paper is the first attempt to appraise Maldivian food consumption patterns and nutrient intake. We used a retrospective, quantitative method (24-hour recall) in combination with a nutritional computer program, anthropometric measurements and, in a selected number of subjects, analyses of pertinent micronutrients and cholesterol in the plasma and haemoglobin in the blood were performed.

Subjects and methods

Study population

The investigation was carried out in five of the 20 administrative atolls (Haa Dhaal, Kaaf, Laam, Meem and Gnaviyani) on a representative territorial basis selected throughout the Republic. In each atoll, one island was randomly selected. In certain instances an additional island, which was easy to reach from the randomly selected island, was included during the fieldwork. To be included in the study the criteria were women and children aged between 1 and 4 years who were no longer being breast-fed. The list of all households was prepared by the island administration office on each island. The first household on the list was taken randomly; the following households were taken systematically by selecting, for example, every second household on the list, depending on the total number of households required. In cases where the women had more than one child within the selected age group, the youngest child was chosen.

In total, 333 women aged 18–48 years (average: 29 ± 6.5 years) were interviewed. This included a representative number of children from the five atolls. Further analyses were possible in 307 women; 26 were excluded due to pregnancy. The distribution of the children was as follows: of a total of 333 children, 18 were aged one, 68 were aged two, 140 were aged three, and 107 were aged four. The children were assigned to two groups (1–3-year-old and 4-year-old children) according to WHO RDA groupings^{8,9}. Only 312 children appeared for the measurement of weight and height (cf. also Table 1).

Blood samples after overnight fasting from 15 women in one atoll (Kaaf) could be collected for determination of iron, homocysteine, vitamins and cholesterol in the plasma, and haemoglobin in the blood. Informed consent was obtained. The inclusion criteria for the women were that they should be healthy, not more than 30 years old, not pregnant or breast-feeding, not taking vitamin or mineral supplements, and not using oral contraceptive agents.

Table 1 Percentage of children below -2 SD from the reference median (NCHS) according to height-for-age (HFA), weight-for-height (WFH) and weight-for-age (WFA)

	Percentage of children < -2 SD		
	HFA (%)	WFH (%)	WFA (%)
All children ($n = 312$)	40.9	14.4	51.1
Sex			
Male ($n = 171$)	37.8	15.2	47.4
Female ($n = 139$)	43.9	13.8	53.2
Age (years)			
1 ($n = 15$)	20.0	20.0	31.3
2 ($n = 61$)	30.2	11.3	44.3
3 ($n = 133$)	44.4	18.9	56.3
4 ($n = 103$)	45.1	9.7	49.0

Dietary assessment

One complete 24-hour recall of food intake was carried out on each woman and her child. The 24-hour recall was modified to allow for Maldivian conditions. To help the women remember everything that had been consumed, they were asked to report systematically on their intake of beverages and food. For this purpose, common household vessels or utensils were used, such as a glass, cup, teaspoon, tablespoon or the special spoons normally used for rice or curry, and a measurement in inches for fish pieces. Amounts of sugar and milk powder were noted separately.

The questionnaire was pre-tested on one additional island and translated into the national language, Dhivehi. The interval of fieldwork was three months from December to the end of February. The compliance during the pilot phase as well as during the study period was very good. Altogether, only one family refused to participate in the survey. The interviews and measurements were supervised by one permanent survey team (nutritionist and a community health worker). In addition, there were two other trained teams that changed in every atoll, and which consisted mainly of students from whichever academic grades were the highest on that particular island (grades 7–10).

Food analyses

The estimated nutrient contents were computed at the University of Hohenheim (Stuttgart, Germany) with Ebis (FEP, Esslingen, Germany), a standard nutritional computer program. For this purpose the program was modified for the Maldivian conditions. Main preference was given to the Indian food composition table⁷ that was entered into the nutrient database of the Ebis program, because many Maldivian and Indian foods are comparable. Nutrients from commercial products were taken from the label. The recipes for common dishes were collected and entered as ingredients. The commonly used portion sizes were measured in grams with a weighing scale (Ovelys electronic kitchen scale, Tefal, Offenbach am Main, Germany) in some additional households.

The 24-hour recalls were compared with the WHO/FAO recommendations^{8–12}. If these were not available, the Indian recommended dietary allowances (RDA)⁷ and, for the children, the USA RDA¹³ for vitamin E were applied. The energy requirements for the women were calculated individually according to their age, measured weight and height, plus an additional physical activity level for their work at home.

Anthropometric assessment

The weights of the women and children were measured whilst they were dressed in light clothes. For weight measurements the SECA personal weighing scale (used by UNICEF) was employed. The heights of the women, and of children above 90 cm, were measured with a height-

measuring device. The length of children below 90 cm was measured with an infantometer. Weight was recorded to the nearest 100 g, and height or length to the nearest 0.1 cm.

The National Center for Health Statistics (NCHS, Hyattsville, MD) reference growth data were taken as comparisons for the children. The share of children exhibiting growth retardation is defined as median (NCHS) minus two standard deviations (SD). The calculations were done with Epi Info 6.0.

For classification of the body mass index (BMI), the definition used by WHO/FAO was used to identify women who were underweight¹⁴ and overweight¹⁵.

Laboratory analysis

The blood samples were collected into tubes containing ethylene diaminetetraacetic acid (EDTA), immediately centrifuged and frozen at -20°C until transported to the Institute of Biochemistry and Nutritional Science, University of Hohenheim, Stuttgart, Germany. The plasma samples were kept at -80°C until analysed. The methods of Erhardt *et al.*¹⁶ were used. The haemoglobin concentration in the whole blood was estimated in the field with an electronic device called a 'HemoCue' (Ängholm, Sweden; haemoglobin–cyanide method). All variable coefficients of the integrated controls were below 6%.

Statistical analyses

For statistical analyses, SPSS for Windows, version 7.5.2G, was used. The normality of the distribution of values was examined by using the Kolmogorov–Smirnov test (normal distribution, if $P > 0.05$). In case of normal distribution the *t*-test for independent comparison was used; otherwise the Mann–Whitney *U*-test was applied. A difference was considered as significant if the *P* value was < 0.05 . The results are expressed as mean \pm SD.

Results

Nutritional status of the children and their mothers

Forty-one per cent of the children had low height-for-age (stunted, Table 1), 14% had low weight-for-height (wasted) and 51% had low weight-for-age (underweight). No significant differences between boys and girls were

observed. For weight-for-height the trend showed an increasing prevalence of stunting with age, although the difference was only significant between the second and the fourth year.

The average anthropometric values for the women were 48.6 ± 9.4 kg for weight, 149.4 ± 5.5 cm for height and 21.8 ± 4.0 kg m⁻² for the BMI. In total, 22.0% of the women had a BMI below 18.5. Of these, 11.3% were classified as mildly underweight (BMI = 18.5–17 kg m⁻²), 6.2% as moderately underweight (BMI < 17–16 kg m⁻²) and 4.5% as severely underweight (BMI < 16 kg m⁻²). The majority of women (58.4%) were found to be within the normal range (BMI = 18.5–25 kg m⁻²). Furthermore, 16.5% of the women were possibly overweight (BMI = 25–30 kg m⁻²) and 3.1% were overweight (BMI > 30 kg m⁻²). The BMI did not show any relationship to age.

Average plasma levels of the women

The results of selected biochemical variables in plasma are given in Table 2. The mean plasma retinol concentration was normal ($1.14 \mu\text{mol l}^{-1}$), whereas the mean plasma β -carotene concentration ($0.11 \mu\text{mol l}^{-1}$) was low ($< 0.3 \mu\text{mol l}^{-1}$). The average homocysteine ($13.5 \mu\text{mol l}^{-1}$) and α -tocopherol (148 mg l^{-1}) plasma levels were borderline high. Mean plasma concentration of cholesterol was normal. The haemoglobin level of $13.5 \mu\text{mol l}^{-1}$ was in the normal range of 12.2–15.9 g/100 ml, well above the values recommended by WHO (> 12 g/100 ml).

Dietary intake of the women

The results of the 24-hour recalls of the women concerning their requirements are listed in Table 3 and compared with the RDAs from WHO or India. The average energy requirement of the Maldivian women was calculated to yield about 1900 kcal. In contrast, the actual mean energy intake was 1266 kcal, providing only 67% of the energy requirement. The percentage of protein in the diet was 14%, 17% for fat and 69% for carbohydrates. Protein consumption was 43 ± 19 g day⁻¹, well within the range of the recommended protein allowance (41–48 g). The average fat intake was very low (24 ± 12 g). The total carbohydrate intake was 215 ± 78 g, 46 g derived from

Table 2 Haemoglobin and plasma concentration of selected vitamins and cholesterol

Nutrient	Normal value	Maldivian women	
		Mean \pm SD	Range
Retinol ($\mu\text{mol l}^{-1}$)	1.05–2.27 ³³	1.14 ± 0.40	(0.50–2.00)
β -Carotene ($\mu\text{mol l}^{-1}$)	≥ 0.3 ³⁴	0.11 ± 0.16	(nd*–0.50)
Homocysteine ($\mu\text{mol l}^{-1}$)	5–13.4 ^{35,36}	13.5 ± 5.7	(6.54–26.44)
α -Tocopherol ($\mu\text{mol l}^{-1}$)	15.3–34.8 ^{37,38}	15.3 ± 4.1	(9.18–23.26)
Cholesterol (mg l ⁻¹)	120–240 ³⁹	148.3 ± 16.6	(108.55–176.19)
Haemoglobin (g/100 ml)	12.0–16.0 ²⁶	13.5 ± 1.1	(12.2–15.9)

* Not detectable.

Table 3 Nutrient intakes of the women. Mean values \pm SD, minimum and maximum values. As a comparison, WHO RDA and percentages of the recommended amounts are given

Nutrient	Maldivian women			RDA	Percentage of RDA
	Mean \pm SD	Minimum intake	Maximum intake		
Energy (kcal)	1266 \pm 468	299	3568	1930*	67
Protein (g)	43 \pm 19	8	99	41–48†	
Fat (g)	24 \pm 12	3	73		
Carbohydrates (g)	215 \pm 78	48	693		
Sucrose (g)	46 \pm 30	1	217		
Dietary fibre (g)	8.3 \pm 6.6	1.4	40.1	40‡	21
Vitamin A (μ g)	458 \pm 395	3	3925	500	92
Retinol (μ g)	399 \pm 307	2	3459		
Carotene (mg)	0.36 \pm 1.35	0	20.54	2.4‡	15
Vitamin E eq. (mg)	4.8 \pm 2.7	0.3	16.1	7.5–98§	64
Vitamin B ₁ (mg)	0.72 \pm 0.31	0.08	2.52	0.9	80
Vitamin B ₂ (mg)	0.53 \pm 0.36	0.07	2.23	1.3	41
Vitamin B ₆ (mg)	1.01 \pm 0.45	0.17	2.75	2‡	51
Folic acid eq. (μ g)	34 \pm 24	5	152	170	20
Vitamin C (mg)	21 \pm 29	0	221	30	70
Iron (mg)	8.7 \pm 3.3	1.9	31.7	16 [¶]	54

* Average calculated energy requirement according to weight, height, age plus the physical activity level.

† Depending on digestibility and amino acid score⁹.

‡ Indian RDA⁷.

§ Acceptable daily intake: 0.15–2 mg/kg body weight¹².

¶ Diet of high iron availability⁸.

|| Equivalent.

sucrose, 4 g from milk powder and the rest (165 g) from complex carbohydrates, mainly acquired from rice and flour. On average the diets contained 8 g of dietary fibre, providing only 21% of the RDA.

The vitamin A intake (458 \pm 395 μ g) was mainly covered through retinol (399 \pm 307 μ g) acquired from fish and milk powder, corresponding to 92% of the RDA. A small amount was provided by carotene (0.36 \pm 1.35 mg) and contributed 15% of the RDA. The average vitamin E intake was calculated to yield 5 mg, the main sources being oil and fish. For the water-soluble vitamins, the average thiamine (B₁) intake was about 0.7 \pm 0.3 mg, riboflavin (B₂) was 0.5 \pm 0.4 mg and pyridoxine (B₆) was 1 \pm 0.45 mg, covering 80%, 41% and 51% of the RDA, respectively. The intake of folic acid was 34 \pm 24 μ g, corresponding to only 20% of the RDA. Vitamin C consumption varied greatly (21 \pm 29 mg), covering about 70% of the RDA. In one atoll (Gnaviyani) the women's food consumption was significantly richer in vitamin C (41 \pm 38 mg) and carotene (0.57 \pm 1.30 mg) compared with the second highest atoll (Kaaf; 28 \pm 15 mg and 0.37 \pm 0.44 mg, respectively). The iron intake was 9 \pm 3 mg per day, providing 54% of the RDA.

Food intake of the women

Estimated amounts of major food items are listed in Table 4. A high consumption of carbohydrates is to be noted: 430 g of rice, 65 g of *rosbi* (a kind of bread) and 36 g of sugar in tea on average have been consumed. Important protein sources were fish (80 g) and milk powder (11 g). The share of vegetable intake (mainly

yam, onions and potatoes) was low (53 g). The reported intake of fruit and green leafy vegetables was also low, 14 g day⁻¹ and 2 g day⁻¹, respectively.

Dietary intake of the children

The average nutrient intakes of the groups of 1–3-year-old and of 4-year-old children are shown in Table 5 in comparison to the RDA from WHO or India.

The energy derived from carbohydrates, fat and protein expressed as the percentage of the total energy intake was: protein, 14% for all children's diets; fat, 21% (children aged 1 to 3 years) and 19% (4-year-old children); carbohydrates, 65% and 67%, respectively. The mean total protein intake was 33 \pm 13 g for the 1–3-year-old children, covering well the RDA (14–23 g) for this group of children. The average fat consumption was 22 \pm 11 g, covering only 63% of the RDA. The mean total carbohydrate intake was 148 \pm 50 g. Nearly 40% of the

Table 4 Mean estimated food intake (g day⁻¹)

Food intake	Amount (g)
Rice (parboiled)	430
<i>Rosbi</i> *	65
Sugar in tea	36
Milk powder	11
Fish (mainly tuna)	80
Vegetables†	53
Fruit	14
Green leafy vegetables	2

* Made of wheat, flour, oil and salt.

† Mainly yam, onions and potatoes.

Table 5 Average intakes of the 1–3-year-old and 4-year-old children. Mean values \pm SD, WHO RDA and percentage intake of RDA are given for comparison

Nutrient	1–3-year-old children			4-year-old children		
	Average intake \pm SD	RDA	% of RDA	Average intake \pm SD	RDA	% of RDA
Energy (kcal)	936 \pm 318	1250	75	872 \pm 308	1510	58
Protein (g)	33 \pm 13	14–23*		30 \pm 13	18–26*	
Fat (g)	22 \pm 11	35†	63	19 \pm 10	42†	45
Carbohydrates (g)	148 \pm 50			144 \pm 49		
Sucrose (g)	57 \pm 28			53 \pm 27		
Dietary fibre (g)	4.9 \pm 4.0			4.7 \pm 2.9		
Vitamin A (μ g)	500 \pm 315	400	125	365 \pm 220	400	91
Retinol (μ g)	461 \pm 270			332 \pm 206		
Carotene (mg)	0.29 \pm 1.03	1.6†	18	0.24 \pm 0.43	1.6†	15
Vitamin E eq.§ (mg)	3.1 \pm 1.7	6¶	52	3.5 \pm 2.2	7¶	50
Vitamin B ₁ (mg)	0.48 \pm 0.21	0.5	96	0.42 \pm 0.19	0.7	60
Vitamin B ₂ (mg)	0.79 \pm 0.51	0.8	99	0.51 \pm 0.31	1.0	51
Vitamin B ₆ (mg)	0.68 \pm 0.28	0.9‡	76	0.62 \pm 0.29	0.9†	69
Folic acid eq.§ (μ g)	33 \pm 17	40	83	25 \pm 13	53	47
Vitamin C (mg)	20 \pm 30	20	100	15 \pm 15	20	75
Iron (mg)	4.7 \pm 1.9	5‡	94	4.8 \pm 1.8	5‡	96

* Depending on digestibility and amino acid score⁹.

† Indian RDA⁷.

‡ Diet of high iron availability⁸.

§ Equivalent.

¶ US RDA¹³.

carbohydrates was consumed as sucrose (57 \pm 28 g), whereas dietary fibre was low (5 g). The mean vitamin A intake of 500 μ g was adequate (125% of the RDA), whereas the average carotene intake was very low (0.3 \pm 1.0 mg), corresponding only 18% of the RDA. The mean vitamin E content of the diet was 3.1 \pm 1.7 mg. Thiamine (0.5 \pm 0.2 mg), riboflavin (0.8 \pm 0.5 mg) and vitamin B₆ (0.7 \pm 0.3 mg) corresponded to 96%, 99% and 76% of the RDA, respectively. Folic acid intake (33 \pm 17 μ g) covered 83% of the RDA. On average, the vitamin C intake fulfilled the RDA (100%). The diet contained about 5 \pm 2 mg of iron, corresponding to about 94% of the RDA.

The average energy intake (872 \pm 308 kcal) of the 4-year-old children was not significantly different from the energy intake of the 1–3-year-old children (936 \pm 318 kcal). The same or even lower intakes were found for micronutrients in the older children. Vitamins A and B₂ were significantly lower in the diets of the 4-year-old children (365 \pm 220 μ g and 0.51 \pm 0.31 μ g, respectively) than in the diets of the 1–3-year-old children (500 \pm 315 μ g and 0.79 \pm 0.51 mg, respectively).

The average milk powder intake of all the children was 32 g day⁻¹ with great variations between the atolls and depending on the age of the children. Milk powder contributed, on average, 17.5% of the children's energy intake, 42% of their fat and 26% of their protein intake.

Vitamin supplements were not considered in these evaluations. Seventy-one per cent of the women reported no vitamin supplements, whereas 29% used supplements for the reference child. The supplements given consisted

mainly of vitamins A and D, and C. Rarely were iron supplements reported.

Discussion

Nutritional status of the children and their mothers

The average BMI of non-pregnant women in the present study (21.8 \pm 4.0 kg m⁻²) corresponded highly with a BMI of 21.3 \pm 3.8 kg m⁻² observed in a previous national survey².

The percentage of children below -2 SD for height-for-age was, however, higher in the present study (41%) than in the Multiple Indicator Cluster Survey (MICS, 32%) from 1996¹. This survey reported a higher percentage of wasted children (19%), compared with 14% found in the present study. The percentage of underweight children (49% as against 51% in this survey) was however similar. It should be noted that children aged from 0 to 60 months were enrolled in the MICS survey, whereas in the present study only a few children aged 1 and 2 years could be considered. Therefore, the higher percentage of low height-for-age children observed in the present study might be explained by the increasing prevalence of stunting as the children grow older^{1,2}.

Plasma analysis of the women

The plasma samples could be collected in one atoll only and they thus represent a small share of the women participating in the study (15 women). However, the results derived from this selected group of women are the first plasma studies from the Maldives, and they confirm convincingly the estimated intakes of nutrients.

Retinol is stored in the liver and regulated in the blood homeostatically by that organ, even in the presence of a marginal deficiency. Therefore, plasma retinol levels hardly indicate a marginal deficiency^{17,18}. Generally the borderline concentration of $0.70 \mu\text{mol l}^{-1}$ is considered as the level below which retinol deficiency might be accounted for^{19,20}. In the present study, all of the women except two had adequate plasma concentrations. This indicates that the majority of women might not be at risk for vitamin A deficiency, except when insufficient amounts of fish (in combination with milk powder) are consumed. The very low concentrations of β -carotene suggest that β -carotene-rich vegetables and fruit were rarely consumed despite their availability in the Maldives. It is assumed that β -carotene plasma levels of $\geq 0.4 \mu\text{mol l}^{-1}$ indicate protective effects²¹. This level may correspond to an intake of 2–5 mg β -carotene per day and could easily be reached by the Maldivian women.

Homocysteine is an intermediary metabolite in the metabolism from methionine to cysteine; folic acid, pyridoxine and vitamin B₁₂ are necessary cofactors in this pathway. A deficiency of one or more of these vitamins leads to an extracellular accumulation of homocysteine²². Although in the present study the mean value was within the normal range, five out of 15 women showed high homocysteine plasma levels which might be due to low folic acid and vitamin B₆ intakes; intake of both vitamins were low in the nutritional surveys.

The plasma cholesterol levels in the lower normal range (average 148 mg/100 ml) might be due to the very low fat intake. It is well known that, in adults, α -tocopherol plasma levels are closely correlated with cholesterol and total lipid concentrations^{23,24} as well as to the intake of polyunsaturated fatty acids (PUFA)²⁵. The plasma concentration of α -tocopherol in the Maldivian women was low, which is also explained by the extremely low intake of fat (energy) in the diet.

The main characteristic of the third and final stage of iron deficiency is a reduction in the concentration of haemoglobin in the red blood cells. None of the women measured was found with a level below 12 g/100 ml (WHO recommendation), indicating that they were not at risk for iron deficiency due to a reduction of haemoglobin²⁶. This observation was surprising because anaemia is reported to be a problem in the Maldives. According to a recent survey done in 1994, 62% of the non-pregnant women had levels below the WHO-recommended value². Our finding might be due to the use of iron tablets in this atoll, which was not recorded during the study. Iron folate tablets are regularly distributed to pregnant women by the health centres.

Dietary intake of the women

To interpret the nutritional intake of the women and children, the provision of the recommended dietary

intake was assessed by setting the reference value for an insufficient supply at 75%, according to Houshiar-Rad *et al.*²⁷.

The results of the present study indicate that most women had a balanced energy intake and expenditure (58% of the women had a BMI between 18.5 and 25). The finding that the BMI did not increase or decrease with age also underlines this assumption. It is conceivable that the women were adapted to lower caloric intake from childhood onwards due to their small height (149 cm). Yet a noticeable number of women were still underweight (22%). This can indeed be a risk factor, especially during episodes of illness, pregnancy and lactation²⁸. The low estimated energy intake might also be influenced by underestimation or erroneous definitions of portion sizes, factors that represent general problems in retrospective nutritional interviews²⁹. To limit this effect, the reported energy intake was compared with the calculated energy needs as suggested by Hambraeus³⁰. However, corrections to reach the calculated energy demand of 1930 kcal did not normalise the intakes up to the range of the recommended requirements. This was especially true for β -carotene, folic acid, dietary fibre, iron and vitamin B₂. The energy percentage of fat of the women's diet (17%) was also below the FAO requirement for women of child-bearing age, which might lead to a deficiency of essential fatty acids³¹.

Vitamin C and carotene intakes varied greatly among the women, because different amounts of vegetables and fruit were consumed. In one atoll (Gnaviyani) the women's food consumption was richer in vitamin C and carotene. Due to a lower availability of fresh fish and a more fertile soil on that island, fresh fish was more likely to be consumed with vegetables, as an ingredient of vegetable curry, rather than as a plain fish curry or as boiled fish. Indeed, the low intakes of vitamin C and β -carotene are surprising considering that a high intake of these vitamins could easily be achieved by consuming larger amounts of certain tropical vegetables and fruit, like papaya or mango (for β -carotene) and guava, papaya or lemon (for vitamin C), all of which are available in the Maldives or even grown in home gardens. Besides vitamin C and β -carotene, other active substances in plant foods like phytochemicals were also lacking.

The Maldivian diet might yield high iron availability because fish (15% iron absorbed) is often part of the meal⁸. Despite this, the intakes acquired from the 317 women were low and corresponded to only 54% of the RDA. Additionally, non-nutritional factors known as public health problems in the country, like parasites and infections, exert a negative influence on iron status^{3,6}. Therefore, low haemoglobin blood levels would be expected in the majority of the women². Surprisingly, however, this was not the case in the 15 women whose blood samples were investigated.

Dietary intake of the children

The diet of the 1–3-year-old children seemed to be better than that of the 4-year-old children and the women, especially with respect to milk powder vitamin constituents. This was the case for vitamin A, folic acid, and vitamins B₂ and B₆. In general, the 1-year-old children received more milk powder than the 4-year-old children, which was not always compensated for by increasing amounts of staple foods. The 4-year-old children, therefore, seemed to achieve the same or a slightly lower intake of micronutrients than the younger children, although their need is increased. Also, vitamins and nutrients that are mainly covered through vegetables and fruit (β -carotene, dietary fibre) were low in both the 1–3-year-old and the 4-year-old children. Vitamin A seemed to be sufficient in the diets of all children (125% and 91% of the RDA, respectively) due to the use of milk powder, consumption of tuna fish and imported fortified foods like biscuits. Importantly, therefore, vitamin A deficiency is probably not a general problem among Maldivian children.

The adequate protein intake and the low fat content of the Maldivian diet is partly due to tuna fish, especially when the tuna fish is consumed as *garudiya* fish (boiled fish) or fish curry with rice or *rosbi*, rather than as fried fish or fried snacks. The major fat sources were vegetable oil, coconut and milk powder. Considering that breast milk provides between 50 and 60% of energy as fat, great caution should be exercised to prevent subsequent deficiency during and after the weaning period. Notably, only 21% of the total energy intake was fat for the 1–3-year-old children in the present study instead of the required 30–40%³¹. Certainly the low fat intake is probably one of the most important influencing factors in the high prevalence of malnutrition in Maldivian children³².

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