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Nutritional Status of mothers and young children in Maldives –

How can it be improved ?

der Fakultät I
Allgemeine und Angewandte Naturwissenschaften
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Abbreviations and explanations

ARI	Acute respiratory infection
BLS	Bundeslebensmittelschlüssel (German food table)
BMI	Body Mass Index
cm	Centimetre
DPH	Department of Public Health
GLV	Green leafy vegetables
HFA	Height for age
kg	Kilogram
NCHS	Polyunsaturated fatty acid
RDA	Recommended Dietary Allowance
SD	Standard deviation
STO	State Trading Organisation
UNICEF	United Nation Children's Fund
WFA	Weight for age
WFH	Weight for Height
WHO	World Health Organization.

Bimbi	Mixture of sugar and millet gruel.
Bottled juice	Here a syrup concentration used with water added to make juice is meant.
Coconut milk	Coconut is actually a diluted product made by adding water to grated coconut and pressing out the liquid.
Curry	Made of tuna, onions, garlic, chilli, spices and coconut milk. When vegetables are included it is called vegetable curry.
DGLV	Dark green leafy vegetables.
Garudiya	Water in which the fish was cooked. This is consumed to rice together with the fish.
Gifili	Fresh holes dug and covered regularly for defecation purpose (UNICEF MALE, 1996).
Kurumba	Liquid from the young coconut.
Mashuni	Dish for breakfast prepared of grated coconut, tuna, onions lemon and chilli.
Parboiled rice	Imported from Burma [CHAKRAVARTY, 1995] and normally cooked with coconut milk.
Rihaakuru	The typical Maldivian fish paste. It is a concentrated residue of garudiya.
Roshi	Kind of bread made from flour, oil, salt and water which is baked.
Short eats	This is the local name given to between meal snacks. There are two basic kinds of short eats: salty and sweet. The salty short eats are mainly made of fish, coconut and flour and is baked or fried. The sweet short eats are made of sugar, flour and coconut.
Tuna	Different kinds of tuna are mainly consumed in Maldives.

1 Introduction

1.1 Study area, population and nutritional situation

The Republic of Maldives is a small island nation in the Indian Ocean. The total population is about 244 600 (1995) living on 201 of 1190 islands [UNICEF MALE, 1996]. The islands are small. Their total land area is less than 300 km^2 [THE WORLD GUIDE, 1997/98] spread over an Exclusive Economic Zone of around 1 000 000 km^2 of sea. The average elevation is 1.6 meters above sea level. It has a tropical climate with an average temperature of 30 °C, high humidity and two monsoon seasons. During the monsoon and other times when the weather is stormy transport within the country can be restricted, especially on remote islands. Because most of the staple foods have to be imported from other countries and distributed to all islands, this is an important factor influencing food security. Rice, flour and sugar are imported and their prices are regulated by the State Trading Organisation (STO). Other imported foods like vegetables and fruit or milk powder are not equally distributed throughout the country. Male, the capital, is the major recipient. [DPH, WHO MALE, UNICEF MALE, 1994]
Soils are rather poor and sandy. The most plentiful agricultural product is the coconut palm. Other locally grown products include banana, breadfruit, mango, papaya, srew-pine, cassava, sweet potato, some millets and green leafy vegetables (GLV) like leave cabbage, etc. In some parts of the country drumsticks, pumpkin, beans, cucumber, yam, red onions and green chillies are grown restricted. The geographical nature lends itself to high fish consumption. Together with shipping and tourism, fishing is the main source of income [DPH, WHO MALE, UNICEF MALE, 1994; CHAKRAVARTY, 1995].

Despite a variety of locally available foods Maldivian diet has been described as monotonous. A typical meal consists mainly of fish with rice or roshi, which is made from wheat flour, oil and water. Rice, wheat flour, sugar, fish, coconut and vegetable oil are the most important staple foods. Different types of tuna fish and sometimes reef fish, which is not accepted in all parts of the country, are consumed. [UNICEF MALE, 1997] Other important protein sources include milk powder, eggs and poultry. Vegetables and fruit are rarely consumed because they are either not available or people prefer to sell them. This behaviour may lead to low intake of some micro nutrients especially in families where fish is not regularly consumed. Studies indicate that iron [DPH, WHO MALE, UNICEF MALE, 1994] and iodine deficiency [PANDAV, 1995] are common problems. Other micro nutrients like vitamin C, folic acid, carotene and riboflavin are assumed to be low in the Maldivian diet and protein-energy-malnutrition seems to play a role in terms of low nutritional status in young children [CHAKRAVARTY, 1995].

1.2 Nutritional and health status

Health and nutrition are closely linked and to assure proper development and life quality they must be adequate from early childhood on. Most vulnerable groups of the society are infants, young children, pregnant and lactating women.
The causes of a child's malnutrition as seen in Figure 1 can be divided into three categories: immediate, underlying and basic causes [UNICEF, 1998].

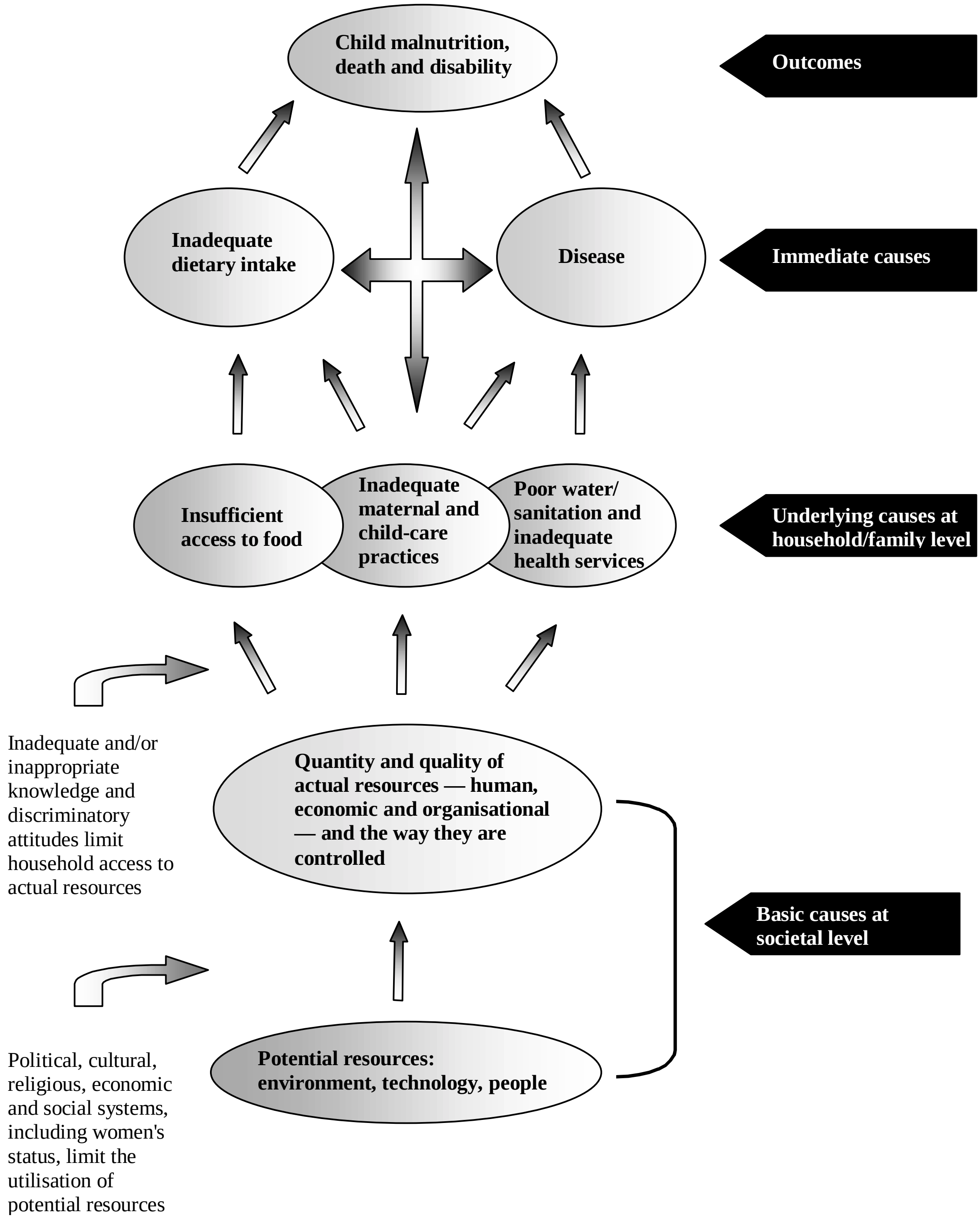

Figure 1: Causes of child malnutrition [Source: UNICEF, 1997a].

Immediate causes are inadequate dietary intake and diseases. Dietary intake often is inadequate due to poor variety of food, limited number of meals and too bulky food. Common diseases in many countries are diarrhoea, acute respiratory infections, measles, malaria, worm infestations and AIDS. Both causes operate in a vicious cycle, as seen in Figure 2. Insufficient nutrient intake undermines the immune system with impact on the susceptibility for infectious pathogens and degree of incidence, severity and duration of the disease. The disease itself suppresses appetite and causes insufficient nutrient absorption. At the same time the needs of the body increase. This in turn leads to inadequate nutrient supply which influences loss of weight, growth, the immune system and absorption. [UNICEF, 1998]

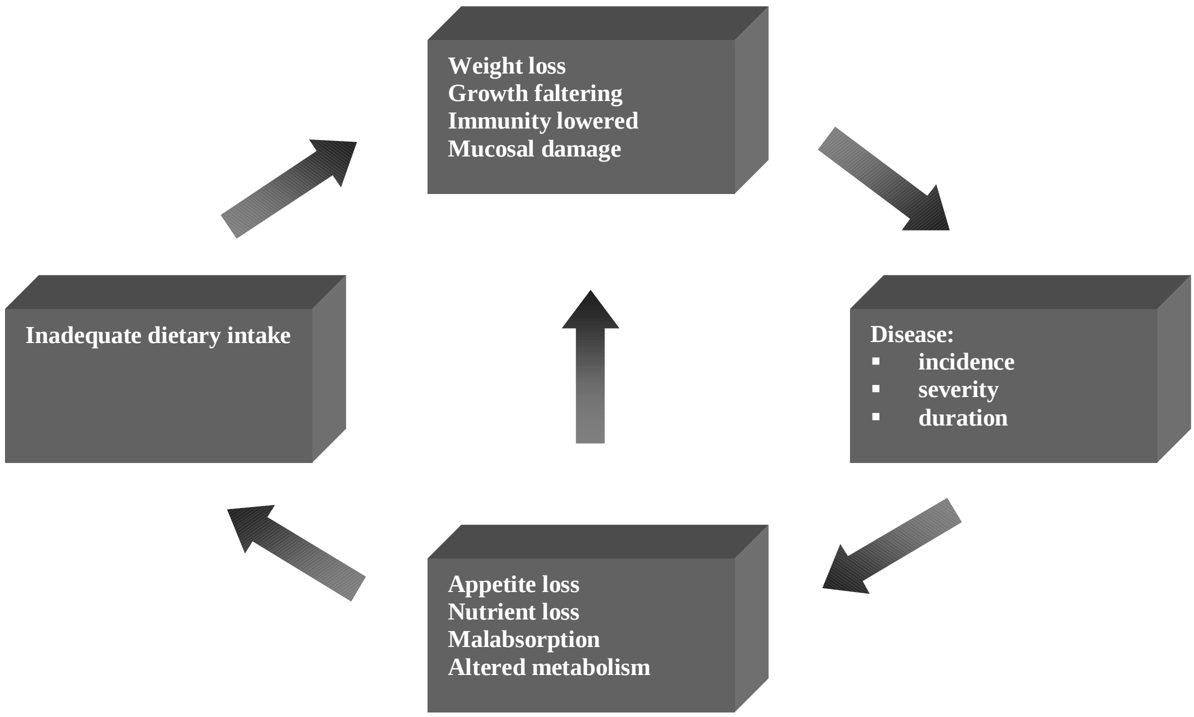

Figure 2: Inadequate dietary intake and disease cycle [Source: Tomkins and Watson, 1998]

Another group of factors belong to the underlying causes at family level. Access to food or water might be insufficient. But even in families with sufficient supply of food, there may be culturally determined factors which can strongly influence family feeding behaviour. Mothers are often the key care taking person for the children. They themselves have to be healthy and need the time, knowledge and the right environment to carry out their duties. Proper care of children includes appropriate hygiene and sanitation, safe food preparation and food storage, successful breast feeding and adequate weaning practice and, last but not least, psychosocial care such as attention, affection and encouragement are important. Good health services and a healthy environment are also important.
The basic political, economic and cultural causes of malnutrition strongly affect the underlying causes.

The nutritional and health status of the mother as described in Figure 3 is of great importance for the health status of the child.

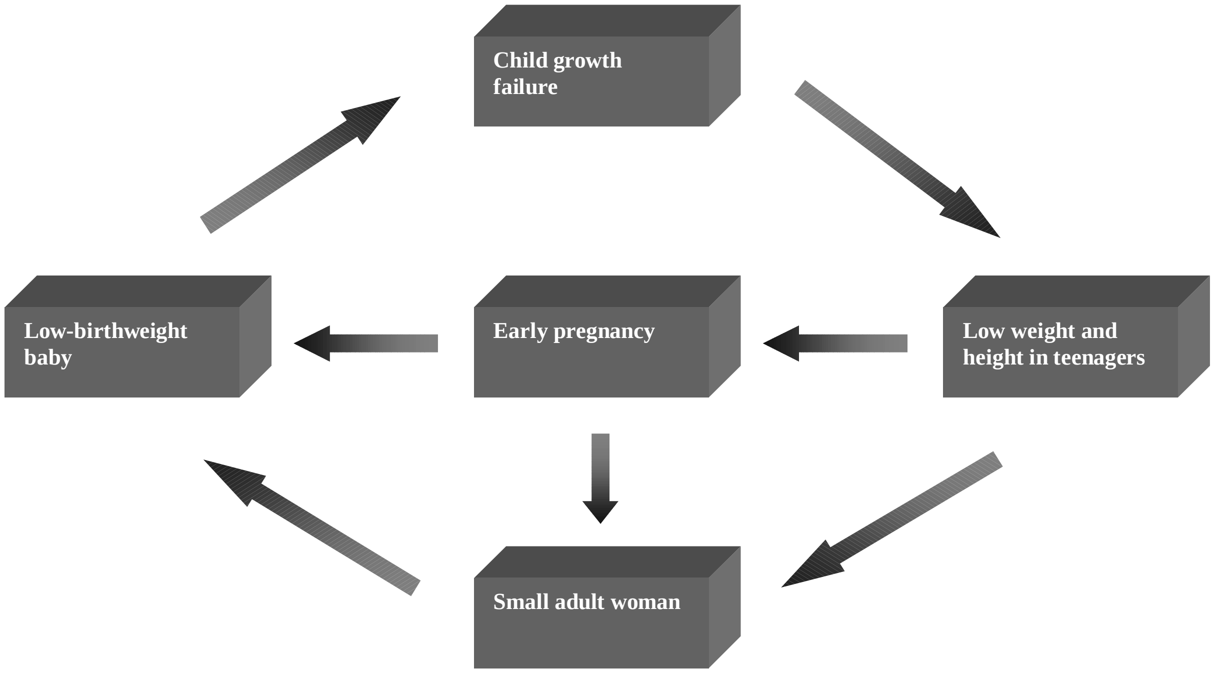

Figure 3: Intergeneration cycle of growth failure [Source: ACC/SCN, 1992]

Poor nutrition is a cycle that can be passed from one generation to the next generation. A mother, who grew poorly in her own childhood and developed into a stunted women herself, is more likely to give birth to a low weight infant, especially if it is a teenage pregnancy. If the infant is a girl, the cycle is likely to continue in the next generation. [UNICEF, 1998]

Comparing this pattern with Maldivian conditions, a poor nutritional status of children seems to start, in fact, with low Body Mass Index of mothers, early marriage, many pregnancies and low birth weights. Low birth weights are reported to be at 20 % of live births [DPH, WHO MALE, UNICEF MALE, 1994], but the country's under-5 mortality rate (61 per 1000 live births) ranks 76 world wide, a surprisingly positive level for South East Asia [UNICEF, 1998]. On the other hand, the prevalence of malnutrition in Maldivian is reported to increase with age [DPH, WHO MALE, UNICEF MALE, 1994; UNICEF MALE, 1996]. The practice of breast feeding is still very prevalent, but the average period of exclusively breast feeding seems to be generally shorter than WHO recommendation [UNICEF MALE, 1996]. Common diseases in Maldives with impact on the nutritional status are diarrhoea, acute respiratory infections and intestinal parasites [UNICEF MALE, 1996; CHAKRAVARTY, 1995]. As already mentioned high rates of anaemia in mothers and children and iodine deficiency also play an important role. Further possible causes of the prevalence of malnutrition in Maldives are reported to be lack of education and knowledge about health and nutritional facts [CHAKRAVARTY, 1995], whereas lack of family income and food availability are not considered to be important influencing factors for the nutritional problems [UNICEF MALE, 1997].

It has to be emphasised that the current government is working on improving the health and nutritional situation of the Maldivian population. Country wide programmes have been started using mass media and training of health personnel. Improvements in sanitation, water supply and immunization coverage have been achieved [UNICEF MALE, 1996]. Progress can be also seen in the children’s education and public health service throughout the country.

1.3 Characteristics of the surveyed islands[1]

1.3.1 Number of inhabitants

The number of inhabitants on the 7 visited islands ranged from 270 in Gaadhoo to 9050 in Foammulah. Dhiffushi and Muli had between 500 and 1000 inhabitants. Mulah, Fonadhoo and Nolhivaram counted between 1000 and 2000 inhabitants (Table 1).

Table 1: Number of inhabitants per island.

Island	Number of inhabitants
Nolhivaram / Haa Dhaal	1738
Fonadhoo / Laam	1578
Gaadhoo / Laam	370
Foammulah / Gnaviyani	9050
Dhiffushi / Kaaf	916
Muli / Meem	712
Mulah / Meem	1388

1.3.2 Electricity

All islands had electricity for 24 hours except Nolhivaram where the people could only use electricity from 6 to 11 p.m. In Gaadhoo they reported having a generator which was not yet in use.

1.3.3 Health facilities

The possibilities for health treatment were quite different on the islands. Dhiffushi, an island with 916 inhabitants, had neither a health centre nor a health worker. People reported going for health treatment to Male, the capital, which is several hours away (Table 2).

Table 2: Health facilities on the islands.

Island	Health centre	Health personal
Nolhivaram / Haa Dhaal	Integrated in island office	2 Family health worker
Fonadhoo / Laam	Private clinic, but health centre to reach with the car	Doctor
Gaadhoo / Laam	Integrated in island office	1 family health worker
Foammulah / Gnaviyani	Health centre, private clinic	Several doctors
Dhiffushi / Kaaf	No health centre	No health worker
Muli / Meem	Regional hospital	Several doctors
Mulah / Meem	Integrated in island office	2 Family health worker

On the islands Gaadhoo, Mulah and Nolhivaram there was at least one family health worker with sufficient education to treating most common diseases. A doctor was available on the neighbour island. Fonadhoo did not have its own government health centre but it is connected with the next island so that the health centre with a doctor could be reached by car. In addition, the island had a private clinic where people had to pay for medical treatment which

[1] This information was gathered from the island administrative office during the field work.

is not the case in the government health centres. Foammulah had a health centre with a doctor and other health personnel like nurses, community health workers and family health workers. The regional hospital in Meem atoll was situated in Muli and staffed with several doctors and other health personnel like nurses, health workers and laboratory assistant.

1.3.4 School

The number of school grades available was not the same on all 7 islands. For example, in Fonadhoo at the time of the survey a 10^{th} grade had just been initiated whereas the island Foammulah already had a 10^{th} grade. In Muli school could be attended until grade 9 (Table 3). Pupils from nearby islands lived temporarily in Fonadhoo and Muli to receive a higher degree of schoolings.

Table 3: School up to grade per island.

Island	School up to grade
Nolhivaram / Haa Dhaal	7
Fonadhoo / Laam	10
Gaadhoo / Laam	6
Foammulah / Gnaviyani	10
Dhiffushi / Kaaf	7
Muli / Meem	9
Mulah / Meem	7

The school in Nolhivaram, Dhiffushi and Mulah went up to grade 7. From Dhiffushi some pupils also lived and attended the school in Male. There is a higher level of school education in the capital because the level is orientated on the O-level of Great Britain. The A-level is also offered there in contrast to the rest of the country.

1.3.5 Shops

The number of shops on each island is shown in Table 4. With the exception of chilli, onions, garlic, lemon and sometimes potatoes, the shops on the islands normally do not sell fresh vegetables. In Dhiffushi 10 of the 15 shops were for tourists who visit the island daily. Because Male is not too far away, things were also bought from time to time in the capital. Because of distance to the capital, inhabitants of the other islands were rarely able to take advantage of this opportunity.

Table 4: Number of shops per island.

Island	Number of shops
Nolhivaram / Haa Dhaal	9
Fonadhoo / Laam	10
Gaadhoo / Laam	3
Foammulah / Gnaviyani	90
Dhiffushi / Kaaf	15
Muli / Meem	14
Mulah / Meem	14

1.4 Design of the study

In the studies cited above several factors influencing the nutritional and health status of women and children have been worked out. The main concern of this survey was to focus on nutritional habits and behaviour aspects influencing the nutritional status.
Food intake on a national level had already been monitored with a semi-quantitative food frequency method in the NATIONAL NUTRITIONAL SURVEY undertaken in 1994 [DPH, WHO MALE, UNICEF MALE, 1994]. This survey is now the first attempt to describe Maldivian food consumption patterns and nutrient intake using a quantitative method in combination with a nutritional computer programme for the analysis. One additional point of interest is to determine the prevalence of vitamin A deficiency which was not clear for the Maldives yet. Because fruit and vegetable consumption seems to be quite low, there is some evidence that other micro nutrients such as vitamin C, folic acid and carotene could be limited. In addition, biochemical plasma analysis and anthropometric measurements were included as further parameters.
The survey was undertaken in different areas of Maldives with the exception of the capital Male. The capital was excluded because one aim of the study was to focus on traditional nutritional habits in rural areas of Maldives.
To reach the most vulnerable groups in the area under study, young children (1-5 years) and their mothers were systematically chosen. Breast fed children were not included because of the known difficulties in calculating quantitative amounts of mother's milk within the nutritional protocol.

1.5 Objectives

General objectives:

- To assess if there are any micro nutrients lacking in Maldivian diet (especially vitamin A, vitamin C, folic acid, carotene and vitamin E).
- To determine the diet of mothers (age 18 to 50) and one of their children from 12 to 59 months. Children still being breast fed above the age of one were excluded.
- To give nutritional recommendations.

Specific objectives:

1. To assess the quantitative calorie and nutrient intake of mothers and children using the 24 h-recall technique.

2. To gather information about some relevant micro nutrients like vitamin A status, vitamin C, folic acid, vitamin E, carotene, cholesterol and haemoglobin by additionally measuring blood levels of a small number of mothers in one atoll.

3. To assess nutritional status of mothers and children using Body Mass Index (BMI) for mothers and weight for age, height for age and weight for height for children.

4. To compare the nutritional status and food intake with economic and household conditions, weaning practice, maternal and child’s characteristics.

5. To compare dietary intake between mothers and children in different age groups and per atoll.

2 Survey methodology

2.1 Survey area

The Republic of Maldives is divided into 19 administrative atolls and can be divided into a northern, middle and southern part of the country (see map in Figure 20). 5 of the atolls were selected for the survey by the Department of Public Health (DPH), situated in the north, central part and south, except the capital.
In each atoll one island was randomly selected with help of UNICEF. During the field work additional islands were included which were easy to reach from the randomly selected islands.

List of selected atolls and islands see chapter 1.3.1 and 2.3.

2.2 Survey population

All households included in the survey had to fulfil the following criteria:
Mothers with children from 12 to 59 months who were no longer being breast fed.

To select the number of households within the criteria group a list of all houses with children between 1 and 5 years was prepared by the atoll or island office. The second important criteria ”not breast feeding” was asked at the beginning of the interview. Mothers with breast fed children were excluded. In cases where the mother had more than one child within the selected age group the youngest child was taken as index child because it was easier to find children not being breast fed in the age group 3 to 4 years than those below that age. In cases where there were 2 mothers in one household who fulfilled the criteria, the mother who had more time was chosen.

On most islands almost all mothers with children in the selected age group were interviewed. In cases where the total number of households was larger than needed, the first household was selected randomly, the following households were taken systematically by selecting every second or third household on the list depending on the total number of households required.

2.3 Sample size

The aim was to interview 70 mothers in each atoll and 350 mothers altogether. This number was determined by using the statistical formula of EPI-info for ”Population survey or descriptive study using random (not cluster) sampling”. To obtain a representative survey, the formula was used to calculate the necessary number of children in the 5 selected atolls. For this the number of children living in the 5 atolls, the percentage of malnourished children taken from previous surveys and the percentage worst acceptable had to be inserted in the formula. The numbers are listed in Table 5.

Table 5: Calculated sample size for the survey

Population size of children below 5 years in selected atolls:	11 087
Expected frequency of children below -2 SD:	40%
Worst acceptable:	50%
Confidence level	Sample size
99.99 %	326

With a confidence level of 99.99 % the sample size was calculated for a number of at least 326 children. Therefore, to be on the safe side, the number of households was fixed at 350 households. The actual number of interviewed households was 333, distributed as seen in Table 6.

Table 6: Number of interviewed households on each island with atolls

Atoll	Island	Number of households
Haa Dhaal	Nolhivaram	73
Kaaf	Dhiffushi	41
Laam	Fonadhoo	70
	Gaadhoo	13
Meem	Muli	24
	Mulah	33
Gnaviyani	Foammulah	79
Together		333

The goal of 70 questionnaires could not be achieved on some small islands because a high number of selected households had mothers who were still breast feeding their children. In such cases, whenever possible, a substitute island was included in the survey during the field work.

2.4 Methods of Collecting Information and Field Period

The study was undertaken in the following steps:

2.4.1 Combination of observation and unstructured interview in 1 atoll and in Male

At the beginning of the survey in November 1997, the investigator lived in a family over a period of almost two weeks to become familiar with the culture, dietary and cooking habits and common traditional dishes in Maldives. At the same time certain aspects of special interest for the questionnaire were observed. Recipes were collected by measuring all ingredients in dishes during cooking with a household weighing scale. This was necessary to modify the nutritional computer programme for Maldivian conditions. For this purpose the island Hinnavaru / Lhaviyani was selected by DPH.

From February to April 1998, the investigator again visited a few families in Male where missing recipes mentioned in the questionnaire were collected. Additionally, commonly used household measurements like teaspoon, tablespoon, cup, glass were defined by using the household weighing scale. To measure portion sizes of meals for mothers and children the weighed food record was used. This was done only for single meals to complement and compare with the results of the questionnaire. All families were visited before lunch or dinner. The mother demonstrated on a plate how much of the prepared dishes she and her child would eat. This amount was then measured with a household weighing scale. The procedure was repeated for the most important meals. The results were interpreted under the limitation that in most cases it was not observed whether the mother and the child actually ate this amount or were eating smaller or larger proportions.

2.4.2 Structured Interview with the help of a questionnaire in 5 atolls

With the information collected on the island Hinnavaru / Lhaviyani atoll, the questionnaire was finalised. Afterwards it was translated and pretested on the islands Hinnavaru and Naifaru in Lhaviyani atoll. The questionnaire was the basis for the interviews conducted on the islands as described in chapter 2.3.
This part of the survey was conducted in December 1997, and in February 1998. The field work was interrupted in January because this was the Islamic fasting month.
For the exact time table see Annex 33.

2.4.3 Direct Measurements

Weight and height of all interviewed mothers and their index child included in the questionnaire were taken as an indicator for the nutritional status and as parameters to be compared with the results of the questionnaire. More detailed information is given in chapter 2.5.3.
A second direct measurement was made by taking venous blood samples of 15 mothers with informed consent on the islands Muli and Mulah / Meem atoll. Originally 30 blood samples were set as a goal but because of a high percentage of mothers using oral contraceptives and a shortage of time only 15 samples could be collected. The biochemical assessment is carried out in chapter 3.

2.5 Parameters of the questionnaire

The questionnaire consisted of the following parts: (see Annex 34)
Demographic distribution
Household questions
Breastfeeding and weaning practice and food habits
Dietary intake with two 24 h-recalls, one for the mother and one for the child
Anthropometric measurements.

2.5.1 Dietary Intake

For assessment of dietary intake the 24-h recall method was chosen. The mother was asked to remember and report all food items and beverages consumed the previous day by herself and her child and to quantify everything in household measurements.

The 24-h recall was modified to adapt to Maldivian conditions. To help a mother remember everything which had been eaten, she was asked systematically to report beverages and food items for all times of the previous day: before breakfast, for breakfast, between breakfast and lunch, for lunch, between lunch and dinner, for dinner and before bed. Amounts of sugar and milk powder (with brand name) were noted separately. Other portion sizes were noted in measurements like glass, cup, teaspoon, tablespoon, special spoons commonly used for rice or curry and inch for fish pieces.
The survey was conducted during 2 months of the year not considering seasonal effects on agricultural production or fishing. It was conducted during all days of the week except Fridays which is the national weekly holiday in Maldives. Special occasions like the Islamic fasting month were also excluded.

2.5.2 Additional parts of the questionnaire

The questionnaire included additional parts to define the interviewed population group and to determine further factors influencing the nutritional status such as:
Demographic profile: family size, ages, education and occupation of the parents, whether or not the mother was pregnant.
Household questions: agricultural products, raising animals, sanitary facilities.
Mother's knowledge about perceived best foods and liquids for the index child.
Breast feeding and weaning practise: duration of breast feeding, time of introducing weaning food, type of weaning food.

2.5.3 Anthropometric Assessment

Weight and height measurements were taken for the index mothers and their child.
The date of birth was copied from the child's individual growth charts during the interview. If the card was not available, the information was collected from the island administration office. Accurate ages were necessary for calculation of the weight-for-age and height-for-age indices.
Height-for-age is an indicator of linear growth. Long-term growth faltering, called stunting, is a measure of chronic malnutrition. ***Weight-for-height*** reflects the body proportion, or the harmony of growth. It is a sensitive index for current growth retardation called wasting. ***Weight-for-age*** reflects a convenient synthesis of both linear growth and body composition called underweight. [DE ONIS ET AL., 1993]. The internationally used National Center for Health Statistics (NCHS) reference data were used for comparison of the nutritional status of Maldivian children. Growth deficits were assessed by analysing percentages of children below minus two standard deviations (SD) from the reference median for weight-for-age, weight-for-height and height-for-age.

The Body Mass Index (BMI) was calculated for all non-pregnant mothers with the following formula:

$$\text{BMI} = \text{weight (kg)} / \text{height}^2 \ (\text{m}^2)$$

Cut off points chosen for non-pregnant women are 18.5 as lower limit and 27.5 as upper limit [GROSS ET AL., 1997].

These measurements were taken every day after the interviews between 4 and 6 p.m. at a public building such as the island office or health centre. The weight of the mothers and children was taken while they were dressed in light clothes (without shoes and socks). To be able to compare the results with previous surveys the clothes was not subtracted later during data processing.

Heights were measured in cm nearest to 0.1 cm, weights in kg nearest to 0.1 kg.

2.6 Tools and Instruments

Anthropometric measurements:
Weight:
- Soehnle, Personal weighing scale (officially calibrated; max. 150 kg; precision d = 100g) used on the island Nolhivaram.
- Seca personal weighing scale (used by UNICEF) used on the remaining islands.

Height for mothers and children over 90 cm:
- Tape measure (Zollstock) from Germany, stuck to the wall with Blue tack.

Length for children below 90 cm:
- Infantometer.

A Seca weighing scale was generally available on the islands. They do not need to be calibrated and can be used for children's weight as well. In Nolhivaram this weighing scale was not available. In this case a German personal weighing scale was used instead.

Children below 90 cm were measured with the infantometer in the lying position because the child can more easily be held in the correct position for reading from the board. If the child slightly refuses the measurement or is scared, this is also the easier position for measurement. The infantometer was 1 m long. Therefore, children over 90 cm were measured with the tape measure.

Weighing food:
- Ovelys Electronic kitchen scale, Tefal (precision 0-1 kg: d = 1 g and 1-3 kg: d = 5 g).

2.7 Survey Teams

One permanent survey team consisting of Mohamed Ismail Didi and the study investigator travelled to all islands to conduct the survey. On each island the atoll or island office provided a list of households with children between 1 and 5 years and recommended certain students for training as additional enumerators, mainly students from one of the highest classes (grade 7–10). After intensive training on how to apply the questionnaire and how to take weight measurements they formed two further teams to visit the households.

Weight was often taken by the enumerators, whereas height or length was always taken by the permanent survey team in order to avoid wide inter-personal variations in height measurement.

2.8 Data Analysis

The data were analysed with different computer programmes.
Information from the 24-h protocols was entered and analysed with Winebis, a nutritional computer programme of the University of Hohenheim, to calculate caloric and certain nutrient intake. It had to be adapted to the Maldivian situation by entering data for specific regional foods from an Indian food table [GOPALAN, 1991]. Nutritional values for special dishes which appeared in the questionnaire were calculated from the ingredients. For commercial foods like milk powder the nutritional value as mentioned on the labels was added to the food table. In cases where the information on the label or in the Indian food table was incomplete, missing data were taken from the German food table. Special portion sizes for Maldivian household measurements were also entered.

The anthropometric data were entered and calculated with Epi Info 6.0.

For the statistical analysis SPSS for windows, version 7.5.2G was used. The results are presented by percentage units, mean values and standard deviations, and sometimes by the median, minimum and maximum values. The normality of distribution of values was examined by using the Kolmogorov-Smirnov test (normal distributed, if significance $p > 0.05$). If the values were normally distributed the T-test for independent sample values was used, otherwise the Mann-Whitney-U-test was taken for calculations. A difference was defined as significant if the n-value was < 0.05. The correlation was calculated according to the Pearson test and was again significant for $p < 0.05$ according to the F-test.

3 Biochemical Assessment

3.1 Sampling method

Blood samples of 15 mothers were taken to determine some vitamins and cholesterol in the plasma. For this purpose Meem atoll was selected because of the laboratory facilities in the regional hospital in Muli which were necessary to handle the blood samples correctly.

The 15 mothers fulfilled the following criteria:
To be healthy
Not more than 30 years old
Not pregnant or breast feeding a child
No use of vitamin or mineral supplements
No use of oral contraceptive agents (for this lowers the vitamin level).

One day after the interview the mothers came early in the morning to the hospital in Muli or island office in Mulah to give fasting blood samples. For this EDTA tubes were used to prevent blood coagulation. Afterwards, the blood was immediately centrifuged for 20 min with 4000 to 5000 revolutions per minute (rpm). Then the plasma at the top was pipetted, filled in Eppendorf cups of 1.5 ml size and stored in the laboratory deep freezer at –20 °C. In Mulah the plasma was cooled and quickly transported to Muli. One day after collecting the last blood samples the plasma was transported in frozen state to Male and stored in a deep freezer at –20 °C. After about 3 weeks the plasma was transported to the Laboratory at the Institute of Biochemistry and Nutritional Science, University Hohenheim, Germany in dry ice and stored in a deep freezer at –80 °C before measurements were made.

3.2 Chemicals

Colour reagents A	Boehringer, Mannheim
Colour reagent B	Boehringer, Mannheim
Cholesterolesterase	Boehringer, Mannheim
Cholesteroloxidase	Boehringer, Mannheim
Peroxidase	Boehringer, Mannheim
NaCl p.a.	Merck, Darmstadt
Standard plasma with a known content of cholesterol	Boehringer, Mannheim
Ethanol p.a.	Merck, Darmstadt
Butylhydroxytoluol p.a.	Sigma, Aldrich, Steinheim
n-Hexan p.a.	Merck, Darmstadt
Dioxan p.a.	Merck, Darmstadt
Acetonitril HPLC-Grade	Merck, Darmstadt
Tetrahydrofuran HPLC-Grade	Merck, Darmstadt
Methanol HPLC-Grade	Merck, Darmstadt
Ammoniumacetat p.a.	Merck, Darmstadt

NIST Standard: Fat Soluble Vitamins in Human Serum, US Department of Commerce, National Institute of Standards and Technology, Gaithersburg MD 20899

H_2SO_4	Merck, Darmstadt
2,4 Dinitrophenylhydrazin p.a.	Sigma Aldrich, Steinheim
Thiourea p.a.	Merck, Darmstadt
$CuSO_4$ p.a.	Merck, Darmstadt
Ascorbic acid p.a.	Merck, Darmstadt
Trichloric acid p.a.	Merck, Darmstadt
7-Flouro-benzo-2-oxa-1,3-diazol-4-sulphonate (SBDF)	Fluka, Buchs, CH
Tri-n-butylphosphine	Fluka, Buchs, CH
N,N-dimethylformamide	Fluka, Buchs, CH
L-Homocysteine	Sigma, Deisenhofen
Na_2EDTA	Sigma, Deisenhofen

3.3 Instruments

Water bath
Centrifuge
Analytical balance
Photometer: Unicam
HPLC:
Pump: Merck/Hitachi L 6200 A Intelligent Pump
Detector: Merck/Hitachi L4250 UV/VIS Detector (for fat-soluble vitamins)
Detector: Merck F1000 Flourescence Spectrophotometer (for homocysteine)

3.4 Solutions and method

3.4.1 Cholesterol

Solutions:

Cholesterolreagent:
50 ml colour reagent A
0.64 ml colour reagent B
0.115 ml cholesterolesterase
0.2 ml cholesteroloxidase
0.02 ml peroxidase
0.325 ml NaCl 0.9%
Standard plasma with a known content of cholesterol

Method:

The enzymatic method of SIEDEL ET AL. (1983) was used for the determination of cholesterol. The concentration is calculated with the following formula:

Cholesterol [mg/dl] = E_{546} * 417.5

Sample preparation and determination

20 µl plasma were mixed with 1000 µl cholesterol reagent and incubated for 15 min at room temperature. The absorbance at 546 nm was measured against pure cholesterol reagent.
The correctness of measurement was proved with a standard plasma.

3.4.2 Fat soluble vitamins (Retinol, α-Tocopherol, ß-Carotene)

Solutions:

Ethanol/Water 2:1
1.6 mmol/l BHT in n-Hexan
Dioxan/Ethanol/Acetonitril (20:20:60)
Mobile Phase: Acetonitril/Tetrahydrofuran/Methanol/1% Ammoniumacetat (684:229:68:28)
Plasmastandards, using 3 different concentrations: NIST standards.

HPLC:

Column: Lichrospher 250-4, 100-5 C18
Flow rate: 2 ml/min

Method:

The method of HESS ET AL. (1991) was used which allows the isocratic separation of retinol, α-tocopherol and ß-carotene.

Sample preparation and determination:

In the first step the proteins in 200 µl plasma were denaturated in a 0.5 ml cup with 500 µl ethanol/ water for 10 sec. Afterwards the fat soluble vitamins were extracted with 600 µl Hexan/BHT through vigorous mixing for 5 min. The mixture was centrifuged for 3 min at 20000 g. Then 400 µl of the supernatant was transferred to a new tube. The solution was evaporated with N_2, the residue dissolved in 50 µl Dioxan/Ethanol/ACN and 20 µl were injected into the HPLC. Retinol was detected at 325 nm, tocopherol at 292 nm and ß-carotene at 450 nm. For quantification the international certified NIST standards was used which is available in 3 different concentrations (low, medium, high).

3.4.3 Vitamin C

Solutions:

2,4 Dinitrophenylhydrazin/thiourea/copper solution (DTCS): 0.4 g thiourea, 0.05 g $CuSO_4$*$5H_2O$ and 3.0 g dinitrophenylhydrazin are filled up with 9 mol/l H_2SO_4 to 100 ml.
10% Trichloroacetic acid (TCA): 100 g/l
H_2SO_4: 12 mol/l

Method:

The slightly modified photometric method of OMAYE ET AL. (1979) with dinitrophenylhydrazin as derivatizing reagent was used for determining vitamin C.

Sample preparation and determination:

900 µl 10 % TCA was added to 100 µl plasma. After centrifugation (10000 g, 3 min) 300 µl of the supernatant were mixed with 100 µl DTCS reagent and incubated at 37° C. After 3 h the solution was mixed with 500 µl cold 12 M H_2SO_4 and the absorbance measured at 520 nm. For quantification a standard curve of ascorbic acid in water was used.

3.4.4 Homocysteine

Solutions:

Tri-n-Butylphosphine, 10% in Dimethylformamide (v/v)
Trichloroacetic acid (TCA), 10 % (w/w) containing 1 mmol/l EDTA
Borate buffer, 2.5 mol/l pH 10.5 containing 4 mmol/l EDTA
Borate buffer, 2.5 mol/l pH 9.5 containing 4 mmol/l EDTA
SBDF, 1.0 g/l in 2.5 mol/l borate buffer pH 9.5

HPLC:

Column: Macherey Nagel 250/4, 100-3 C18 HD
Flow rate: 0.75 ml/min

Method:

For determination of homocysteine the method of FEUSSNER ET AL. (1997) was used.

Sample preparation and determination

100 µl Plasma were mixed on ice for 30 min with 5 µl butylphosphine. 100 µl trichloracetic acid were added to the sample and kept on ice for further 10 min. Protein was removed by centrifugating at 20000 g for 4 min. 100 µl of the supernatant were mixed with 200 µl borate buffer (2.5 mol/l, pH 10.5) and 100 µl SBDF and incubated at 60° C for 60 min. Afterwards the sample was cooled and 20 µl of this solution were injected into the HPLC. For quantification a standard homocysteine calibration curve was used.

3.4.5 Haemoglobin

The haemoglobin in whole blood was estimated in the field at the Regional Hospital / Meem with an electronic device called ”Haemocue” which has been used in previous surveys. The haemoglobin-concentration was determined using the haemoglobin-cyanide method.

4 Results[2]

4.1 Household characteristics

4.1.1 Family size and household size

A family in this survey was defined as a mother, a father and children. Grandparents or other relatives living in the same household were recorded in the number of members per household.

The family size varied between 2 (mother and child) and 13 family members with an average of 6 ± 2 members per family. The average number of living children was 4 ± 2. 62 % of the mothers had between 1 and 4 children. 80 % of these mothers were below 30 years of age. It should be considered that these families had probably not yet had their last child. About one fourth (26 %) of the mothers had 5 or 6 children and 12 % had between 7 and 11 children (Table 7).

Table 7: Number of living children per family.

Number of children	Percent [%]
1 – 2	31.5
3 – 4	30.4
5 – 6	26.4
7 – 8	8.1
9 – 11	3.6

The number of children in relation to the age of the mothers is shown in Table 8.

Table 8: Mean number of children by age of the mother.

Age mother [years]	Number of mothers	Mean number of children	SD
≥ 20	15	1.8	0.7
21-25	107	2.4	1.3
26-30	97	3.9	1.5
31-35	55	5.4	1.7
36-40	38	6.2	2.1
41-50	18	7.1	2.9
Missing data	3		

According to the survey findings an average Maldivian mother has 7 children at the end of her reproductive period. It can be expected that this number will probably decrease in the next decades because of changed perceptions about the advantage of spaced pregnancies, of small

[2] The chosen percentages listed in the following tables as well as in the tables in the appendix (these are counted as annex) always add up to 100 % without the missing values. For completeness, missing data are listed at the bottom of each table.

family sizes and because of nation wide family planning programmes supported by the government.
Often the nuclear families did not live alone. In 37 % of the households at least one grandparent lived with the family at the time of the interview. On average 2 people lived together with the nuclear family in the same household. These people could be the grandparents, other related family members with their family or single persons like school children who were staying with their guest family to be able to go to a local school. 45 % of the families lived alone.
Differences in family and household size between the atolls can be seen in Annex 1 and Annex 2.

4.1.2 Education of the parents

Because of a literacy campaign carried out by the government in the past, the majority of males and females can read and write. The cases of illiterate parents were included in the first category of functional literacy. According to given responses, the mothers seem to have obtained a higher educational level than their husbands (Annex 3, Figure 4). 83 % of the fathers and 69 % of the mothers were literate either having been taught at home by relatives or friends, or attending a school programme for adults, or going to a special school type which was used in the past with standard of grade 3. A higher percentage of mothers attended school until grades 5 and 7 (15 % and 12 %) than their husbands (7 % and 7 %). About 3 % of both had O-level.

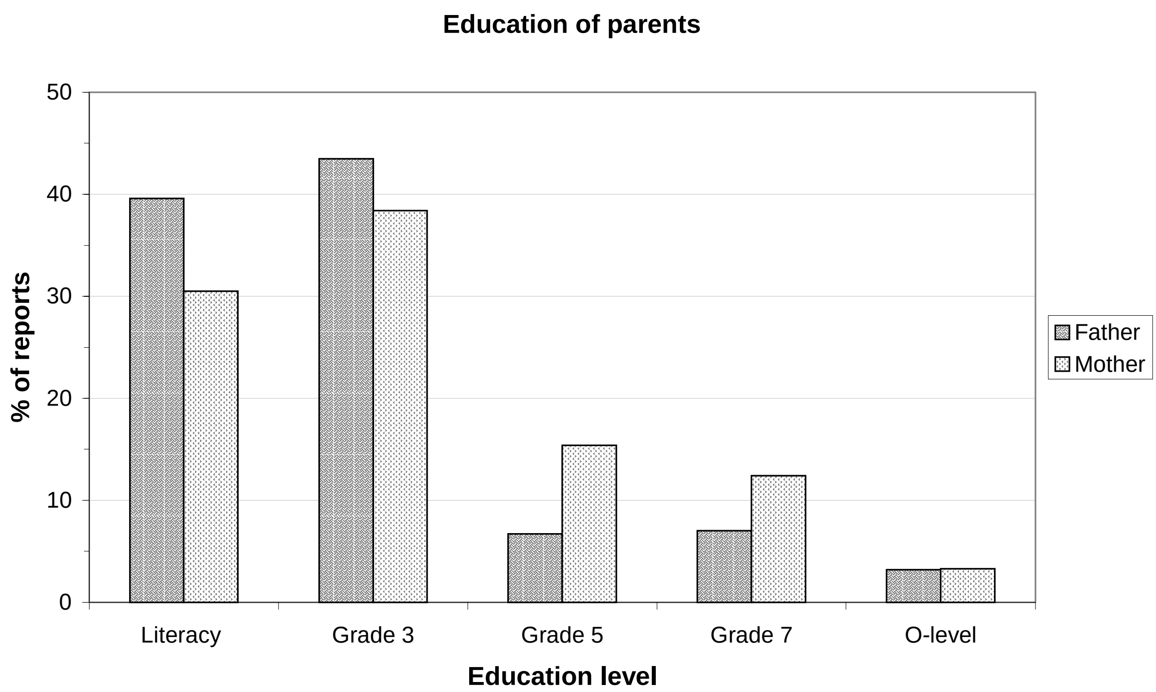

Figure 4: Education of parents

The education level of the parents seemed to differ considerably among the atolls (Annex 4, Annex 5, Figure 13, Figure 14). The highest education level was found in Meem atoll, the lowest in Haa Dhaal atoll.

4.1.3 Occupation of the parents

Figure 5 and Annex 6 show the current occupation of the parents. Only the main occupation was noted when the father had more than one job. If the father worked as a fisherman (22 % of the cases), a trader (7 %), a farmer (4 %), a government worker (22 %) on the home island, he lived primarily with his family. As seen in many cases, if he was a sailor (8 %), a worker on tourism islands (9 %), or a government worker in the capital, the father lived primarily in another place and only visited his family a few times per year. In general, the father's absence might not be of great influence on the child's health and nutritional status if mother and children lived with their grandparents or other relatives. 4 % of the husbands worked as transporter and 6 % as labourers. A further 10 % of the occupations included masons, carpenters, welders, black smiths, engineers, and contractual workers. Fathers with no occupation (2 %) were either older or had adult children who earned money.

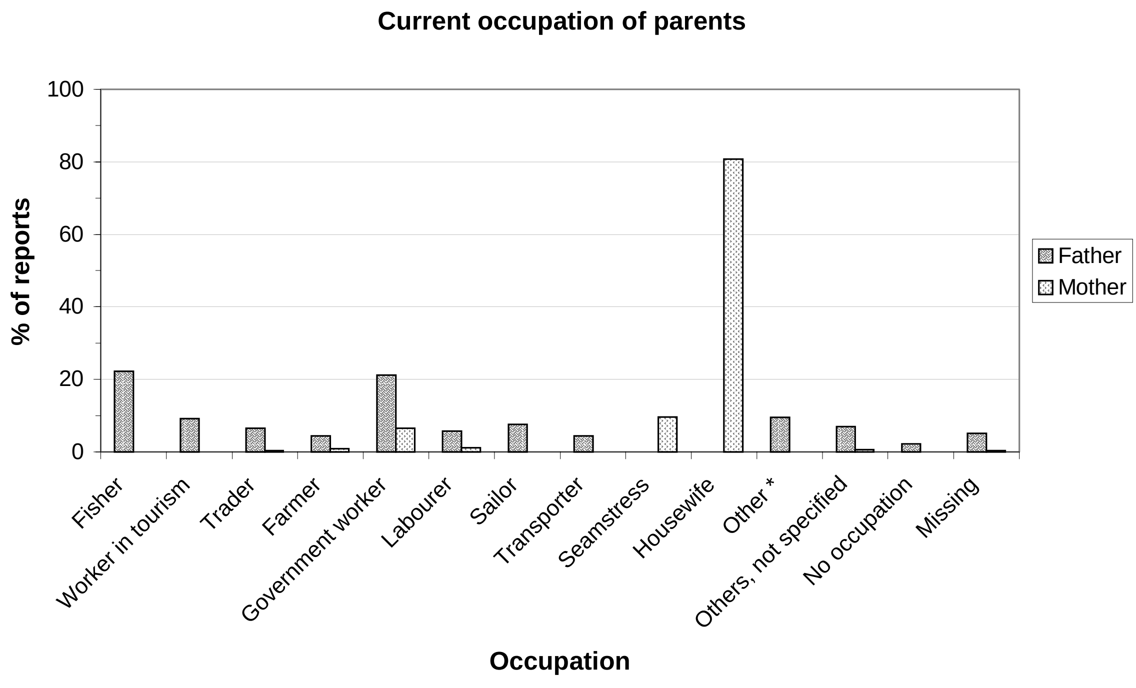

Figure 5: Occupation of the parents.
*** Mason, carpenter, welder, black smith, engineer, contractual worker.**

81 % of the mothers were working at home at the time of the interview and were involved in the home gardening activities. 10 % reported to work as a seamstress in their homes, 0.9 % as farmers and 0.3 % as traders probably together with their husbands. 7 % did government work outside the home as teachers, nurses, health workers, or in government administration. These mothers were normally better educated or had received a special training.

An overview of occupational patterns for the selected islands is as follows (Annex 7, Annex 8 and Figure 15, Figure 16). On the island Nolhivaram 14 % of the husbands worked as fishermen, 18 % as sailors, 13 % as farmers and 11 % as workers involved in inter atoll transport. Another 11 % worked on tourist islands and 10 % in factories. Local government work in the atoll administration and jobs at the nearby airport (47 %) were the main occupations on the two surveyed islands in Laam atoll. Fishing with 6 % was of less importance. Because of the limited number of households in Gaadhoo compared to Fonadhoo the island was not listed separately. The tourism branch (23 %) and government work (10 %), which includes the atoll office and health centre, as well as sailing (10 %) were important sources of income in Foammulah. The percentage of fishing (4 %) was the lowest of all surveyed atolls. Compared to this in Dhiffushi 3 out of 4 men went fishing. The 2 surveyed islands in Meem atoll have to be looked at separately. Fishing with nearly 40 % was the largest occupational sector in Meem atoll. 82 % of this number were living in Mulah which is known as a fishing island. The next highest occupational groups consisted of government workers (21 %) and traders (11%) who lived mainly in Muli (6 of 8 government workers and 5 of 6 traders). The regional hospital and the atoll office were located there.

The percentage of mothers who were currently working at home varied between 66 % in Gnaviyani atoll and 95 % in Kaaf atoll. In Laam atoll and Meem atoll the highest percentage of mothers worked in government service (11 % and 12 %), whereas in Gnaviyani 23 % additionally worked as seamstress.

4.2 Economic characteristics

4.2.1 Agricultural products

All agricultural products reported by the interviewed mothers were grown in gardens around the houses. The amount of each product was not asked about separately, but respondents had to have at least one fruit tree in their garden to be included in the statistics.
Figure 6 and Table 9 show the different agricultural products which were mentioned. In 4 of 5 houses banana was available, coconut in 3 of 4 households and papaya (52 %), guava (49 %) and green leafy vegetables (GLV 46 %) in nearly every second household.

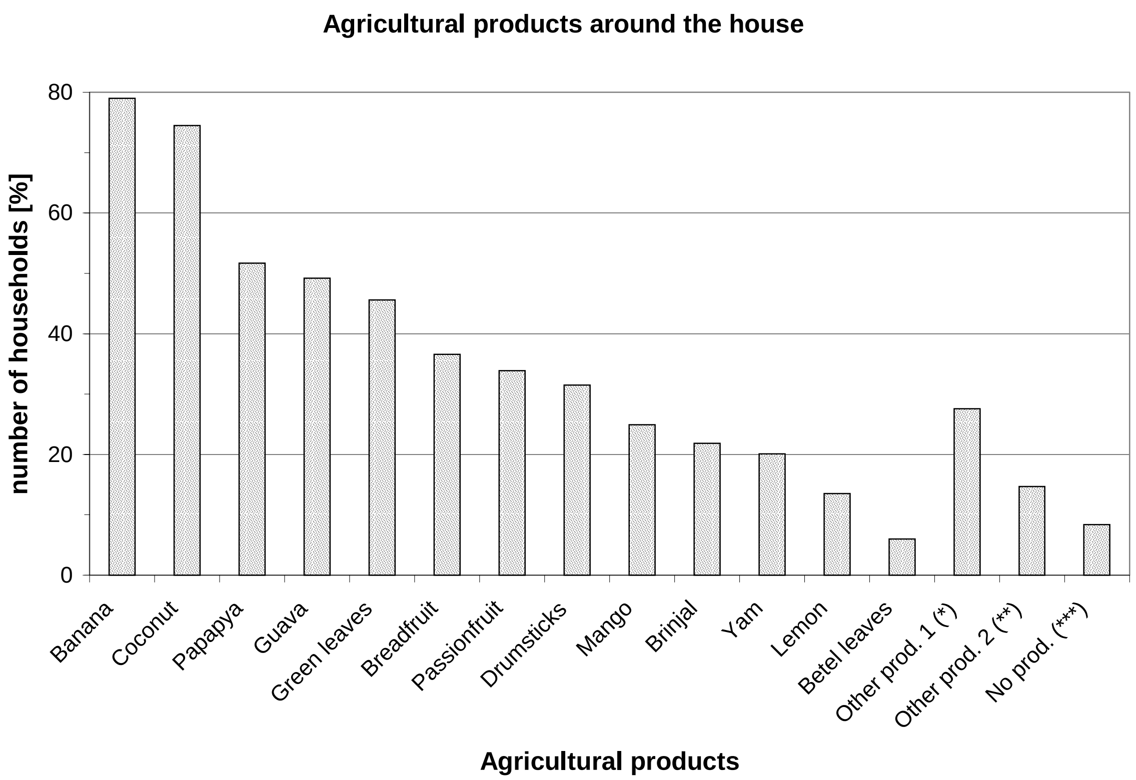

Figure 6: Agricultural products around the house.
***, **, *** see explanation of Table 9.**

Other agricultural products like breadfruit (37 %), passionfruit (34 %), drumsticks (32 %), mango (25 %), brinjal (22 %), yam (20 %) or lemon (14 %) were still grown in 10 to 50 % of the households. Products which were grown between 5 to 10 % or 2 to 5 % are listed in the explanation below Figure 6, all products below 2 % are not listed. 8 % of the households did not do any gardening.

Table 9: List of agricultural products around the house.

Agricultural products	Percentage [%]
Banana	79.0
Coconut	74.5
Papaya	51.7
Guava	49.2
GLV	45.6
Breadfruit	36.6
Passionfruit	33.9
Drumsticks	31.5
Mango	24.9
Brinjal	21.9
Yam	20.1
Lemon	13.5
Betel leaves	6.0
Other products 1 (*)	27.6
Other products 2 (**)	14.7
No agricultural products (***)	8.4

*** Agricultural products grown in 5 to 10 % of the households: chilli, sweet potatoes, Jamburol/ Jambu, pumpkin, pomegranate.**

**** Agricultural products grown in 2 to 5 % of the households: atha, stone apple, chichanda/ thoraa, bilimagu, litchi.**

***** All products below two % are not included in the list.**

A closer look on the atoll level shows big differences among the atolls. The island Foammulah grew the highest percentage of agricultural products, especially yam (72 %) and mango (61 %), but also the percentage for GLV (63 %) and bananas (99 %) was higher than in the other atolls (Figure 17 and Annex 9). Most of the households with brinjal were situated in Meem atoll (39 %) and the highest number of guava was found in Laam atoll (78 %). The island Nolhivaram had the highest level for betel leaves (18 %) and lemon (26 %) but compared to other islands many other products were found in very low quantities.
In order to compare the islands, an index was created by dividing all reported amounts of products by 10, and then adding these figures together for the total product index. The highest index score was for the island Foammulah (69), followed by Laam atoll (55), and Meem atoll (48). The island Dhiffushi (42) and Nolhivaram (37) had the lowest index scores.

4.2.2 Animals

Animals relevant for human nutrition were mainly chicken and ducks. Goats, which sometimes can be seen, were not kept in any of the households selected for the survey. Around 30 % of the households did not keep any animals, the other 70 % raised mainly chicken and sometimes also ducks (Table 10).

Table 10: Animals in the households.

Animals	Percent [%]
No animals	29.3
Chicken	56.2
Ducks and chicken	13.0
Ducks	1.5
Missing	0.6

Comparing the atolls with each other there were wide differences among the atolls. In Haa Dhaal many households kept chicken and ducks. Only a small number of around 5 % of the households had none of these animals (Annex 10). In Laam and Gnaviyani atoll the number was a little higher at 15 % whereas in Meem about 60 % did not keep chicken or ducks. The absolute highest number was found in Kaaf atoll with about 90 %.

4.2.3 Sanitary facilities

The percentage of toilet facilities in the households was 55 % (Table 11). The traditional gifili (fresh holes dug and covered regularly for defecation purpose, UNICEF MALE, 1996) was used by 13 % of the households. 32 % had to use the beach or forest for defecation.

Table 11: Facilities used for defecation.

Sanitary facility	Percent [%]
Toilet	55.3
Gifili	12.7
Beach / forest	32
Missing	0.6

The differences among the islands were great (Annex 11). In Kaaf atoll the majority of families used toilets (90 %) and no respondent answered that the family went to the beach for defecation. This was followed by Gnaviyani atoll with 72 % toilets in the households and 4 % using the beach or forest. The numbers were nearly equal in Laam and Meem atoll. Around 60 % answered that they had toilets and 28 % / 35 % went to the beach or into the forest. In Nolhivaram, where there is a lot of forest around the village, 83 % of the families were using the forest for defecation and a small number of mothers (10 %) reported having a toilet.

4.3 Mother's characteristics

4.3.1 Age of the mothers

Mothers often did not know their own and their child's exact age. Therefore, the reported ages are only an estimation of the mother's and the child's age. On average the largest group of interviewed mothers (about 60 %) were between 21 and 30 years. 4.5 % were 20 years and below, almost 30 % were between 31 and 40, and 6 % were 41 years and older (Table 12). The mean age of all interviewed mothers was 29 ± 6. The range of the reported age reached from 18 to 48.

Table 12: Age of the interviewed mothers.

Age [years]	Percent [%]
≤ 20	4.5
21-25	32.4
26-30	29.4
31-35	16.7
36-40	11.5
41-50	5.5
Missing	0.9
Mean ± SD	29.0 ± 6.4

The average age of mothers was quite constant for all atolls (see Annex 12).

4.3.2 Age of the mother at her first birth

The mother's age at the birth of her first living child was calculated by subtracting the age of the oldest child from the age of the mother.
On average about 20 % of the mothers were 15 years and younger when their first child was born (Table 13). 37 % were between 16 and 18 years and 39 % between 19 and 25 years. Together these groups include around 96 % of the interviewed mothers.

Table 13: Mother's ages, when the oldest child was born.

Age mother at first birth	Percent [%]
< 16	19.9
16-18	36.8
19-25	39.0
26-30	2.8
31-50	1.5
Missing	2.1
Mean ± SD	18.5 ± 4.0

The average age at the mother's birth of her first child was calculated to be 18.5 ± 4. Considering the fact that the numbers are not absolutely correct, the data still indicate that teenage pregnancies and early marriage play an important role in Maldivian culture.

The mean ages of the mothers at their first birth among the atolls did not vary (Annex 13).

4.3.3 BMI, weight and height of non-pregnant mothers[3]

On average the measured weight was 48.6 ± 9.4 kg and ranged from 28.6–93.4 kg. The average height was 149.4 ± 5 cm and ranged from 129.9 cm to 164.3 cm. The BMI is of greater interest, because it relates weight to height. The average BMI of all mothers was 21.8 ± 4.0 with a range from 14.6 to 39.3.

Table 14: BMI of non-pregnant mothers [GROSS ET AL., 1997].

BMI	Percentage of mothers [%]
Below 18.5	22.0
18.5 to 21.9	33.7
22.0 to 27.5	36.4
Above 27.5	7.9

The distribution can be seen in Table 14 and as graphic in Figure 7. 22 % of the mothers were below 18.5, the cut off point for underweight, and 8 % above 27.5 the cut off point for overweight, whereas the majority of women (70 %) was found within the normal range.

The mothers below the cut off point of 18.5 were again formed in different groups to see the extent for the prevalence of malnutrition (Table 15).

Table 15: Distribution of the mothers below a BMI of 18.5 [ROWETT RESEARCH INSTITUTE, 1992].

BMI	Category	Percentage of mothers [%]
< 16 *	Severe malnutrition	20.0
16 - <17	Moderate malnutrition	27.7
17 - < 18.5	Mild malnutrition	52.3

*** According to COLLINS (1995), a BMI of 8.7 for young adults is the cut off index for survival.**

Almost half of these mothers were at risk for mild malnutrition (52 %), 28 % at risk for moderate malnutrition and 20 % belonged to the category of severe malnutrition.

A view at the atoll level shows only slightly differences among the atolls (Annex 14). In Gnaviyani the average height was significantly lower (147.5 ± 5.3 cm) than in the other atolls. The differences among the other atolls were not significant. In Haa Dhaal, Laam and Kaaf the averages were about the same with 150 cm, whereas Meem atoll was a little lower than the other 3 atolls (148.9 cm). The average for weight of Kaaf (46.6 ± 9.1 kg), Meem (46.9 ± 9.2 kg), Gnaviyani (47 ± 8.1 kg) and Haa Dhaal (48.2 ± 9.2 kg) was quite similar with no significant differences. The highest average weight was found in Laam atoll (52.4 ± 9.8 kg). This could be also seen in the different BMIs among the atolls. Laam atoll was significantly higher (23.2 ± 2.0) than the other atolls, whereas the average of Kaaf atoll was the lowest (20.6 ± 3.5), but the difference was not significant. The other three atolls clustered around the average BMI of 21.5.

[3] The Body Mass Index (BMI) can only be used for non-pregnant mothers. Therefore, in all calculations for the BMI and for weight and height the pregnant women were excluded (7.8 %). 4.8 % of the women did not appear for anthropometric measurement or the information was not completely recorded.

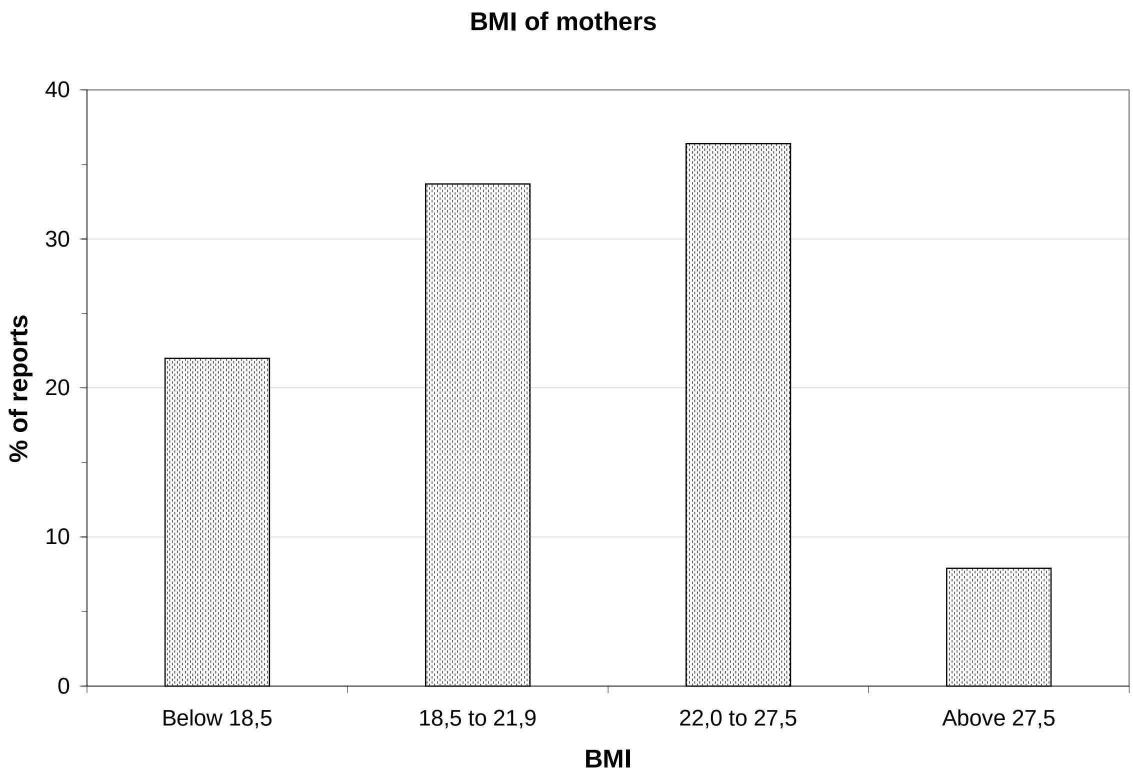

Figure 7: BMI of non-pregnant mothers.

The lowest percentage of mothers with an BMI below 18.5 was found in Laam atoll (10 %), and the highest percentage in Kaaf and Meem atoll (32 % and 30 %). The highest percentage of mothers with BMIs over 27.5 lived in Laam (14 %) atoll and the lowest in Gnaviyani and Kaaf atoll (4 % and 2 %) as seen in Annex 15.

Interesting is the comparison between BMI and age (Annex 17). The young mothers (20 years and below) among the women as a whole had the highest percent with BMI below 18.5 (33 %), but also with BMI above 27.5 (13 %). The results might be influenced by a smaller number of the youngest and oldest mothers. The BMIs did not increase or decrease with age especially above 30 years (Annex 16). The only bigger jump was noted between the group below 20 years (BMI 19.6) and the group above 20 years (BMI about 22).

Further, the BMI of the mothers was compared to the energy intake and the number of children. The reported energy intake fell with increased BMI. With increased number of children the BMI also increased (Annex 18).

4.4 Child's characteristics

4.4.1 Age of the interviewed children

The majority of the children (75 %) included in this survey were between 3 and 4 years because it was more likely to find children who were not being breast fed any more in this age group. Only 5 % of the children were 1 and 20 % 2 years old (Table 16).

Table 16: Child's age.

Age	Percent
1	5.4
2	20.4
3	42.1
4	32.1

The children's age distribution among the atolls is presented in Annex 19.

4.4.2 Duration of breast feeding

In general Maldivian mothers seemed to breast feed their children for a long time. Up to 4 years was not an exception.

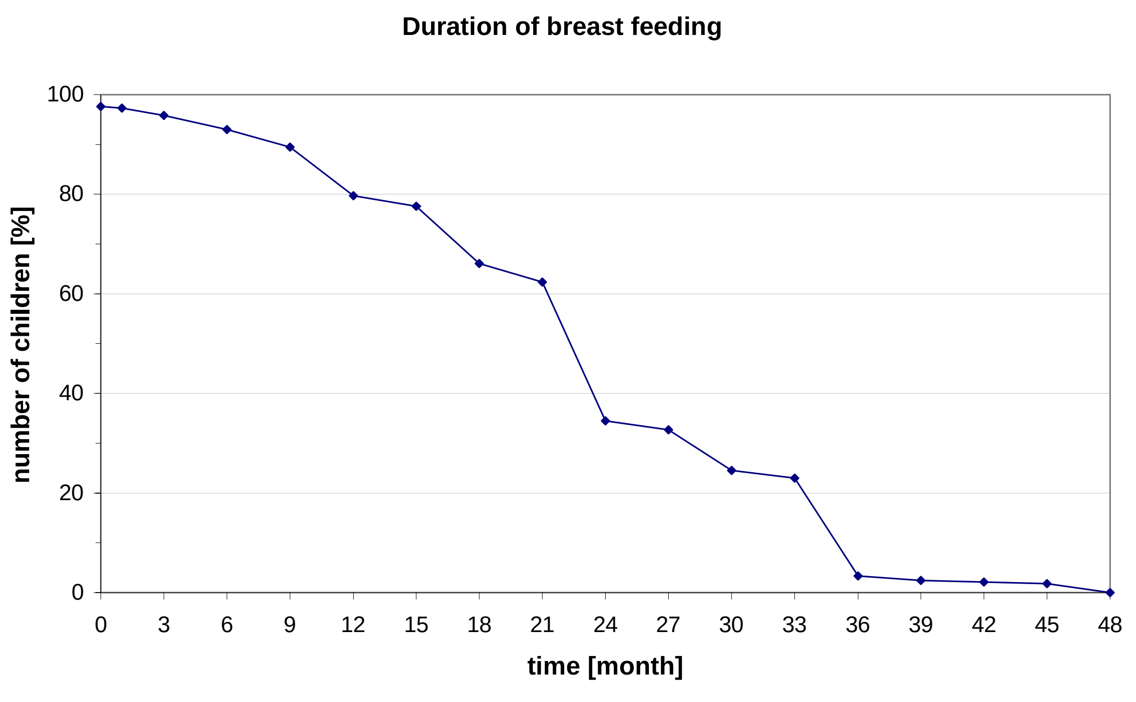

Figure 8: Duration of breast feeding in months.

On some islands almost half of the households on the list with children between one and five years could not be included in the survey because the mother was still breast feeding the child,

especially during the night. One important reason given for cessation of breast feeding was, when the mother was pregnant again. Therefore, the index child was often not the youngest child.
The mean duration of breast feeding in this survey was 23 ± 10 months with a minimum of 0 month and a maximum of 48 months (see Figure 8 and Annex 20).

The average time of breast feeding among the atolls varied between 18 months in Kaaf atoll and 27 months in Laam atoll (Annex 21).

4.4.3 Age of introducing weaning food

Despite the long duration of breast feeding complementary feeding was started quite early.
68 % of the mothers reported that they introduced weaning food at the age of 4 months. The graphic presented in Figure 9 (see also Annex 22) demonstrates a steep rise in the curve between 3 and 4 months. On average the mothers started complementary feeding at the age of 5 ± 3 months. This average was higher than expected because some mothers reported having started late at 12 months and this raised the overall average. Therefore, the median, which was 4 months, is of more interest. The minimum time for introducing weaning food was reported at 0 month and the maximum 24 months.

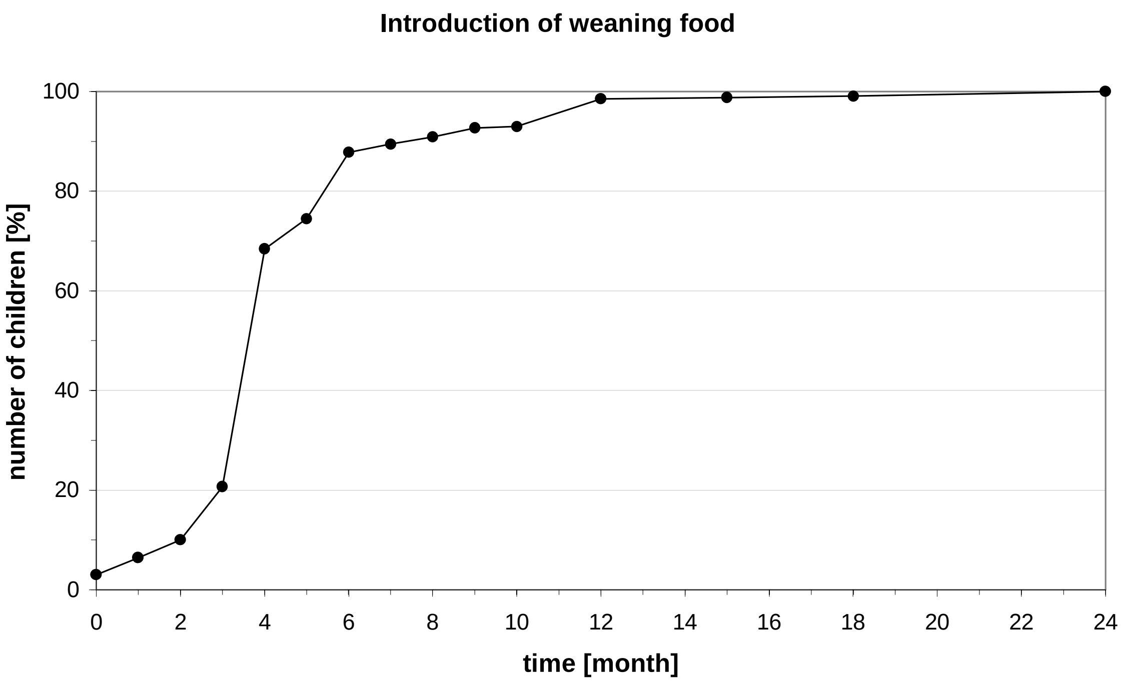

Figure 9: Time of introducing weaning food.

On average in the atolls Haa Dhaal and Laam the mothers reported having started with weaning food at the age of 6 months, whereas in the other three atolls the mothers answered that they already started at 4 months (Annex 23).

4.4.4 Type of weaning food[4]

As shown in Table 17 and Figure 10 the answers to the type of weaning food were grouped for analysis.
57 % of the mothers started with commercial weaning food followed by bananas (19 %) and carbohydrate rich foods (18 %) like rice/soft rice, roshi, yam and noodles. Sweet foods (biscuits and dessert) and garudiya, water in which the fish is cooked, or rihaakuru, the typical Maldivian fish past, were offered by 10 % of the mothers. The traditional weaning food called bimbi, a mixture of sugar and millet gruel, was only mentioned by 7 %, protein rich food (fish, processed fish and eggs) by 6 % and other fruit except bananas by 5 % of the mothers. Different vegetables were only mentioned by 1 % of the mothers.

Table 17: Weaning food and liquids.

Weaning food / liquids	Percent [%]
Commercial food	57.4
Banana	18.9
Carbohydrate rich food **	17.7
Sweet food ****	10.2
Garudiya, rihaakuru	9.9
Protein rich food ***	6.3
Bimbi *	6.6
Fruit	5.1
Do not know	3.3
Family food	1.5
Vegetables	1.2
GLV	0.3
Milk, milk- tea	28.8
Tea / (boiled) water	18.3
Bottled juice	12
Fresh juice / kurumba	4.5
Family liquids	0.3
Do not know	0.3

*** traditional weaning food: sugar and millet gruel**
**** rice/soft rice, roshi, yam, noodles**
***** fish, fish products, eggs**
****** biscuits, dessert.**

The main liquids offered to the young children primarily seemed to be milk or milk tea, followed by tea and water. The percentage of mothers offering bottled[5] juice was higher then fresh juice or kurumba, liquid from the young coconut. 0.3 % of the mothers did not remember and 1.5 % answered ”normal family food”.

[4] The type of weaning food was asked about as an open ended question with no attempt made for completeness. Multiple answers were commonly given.
[5] Here a syrup concentration used with water added to make juice is meant.

4.4.5 Perceived best food for the index child[6]

The mothers were also asked which she considered to be the best foods and liquids for her index child. The answers were different from that given above for actually offered weaning foods (Table 18, Figure 10). Carbohydrate rich foods (rice, roshi, yam and noodles) was with 44 % most often mentioned followed by garudiya and rihaakuru with 23 %. Protein rich food (e.g. fish, fish products, eggs), banana, and fruit were reported within nearly the same proportion (18 %, 17 % and 16 % respectively). 12 % of the mothers reported commercial food, 8 % vegetables and 6 % family food. Sweet foods (biscuits and desserts) and GLV were mentioned by 5 % and 4 % of the mothers. 5 % did not give an answer.

Table 18: Reported best foods and liquids for the young child.

Perceived best food and liquids for the index child	Percent [%]
Carbohydrate rich food **	43.5
Garudiya, rihaakuru	21.6
Protein rich food ***	17.7
Banana	16.8
Fruit	16.2
Commercial food	12.0
Vegetables	8.4
Bimbi *	7.5
Family food	5.7
Sweet food ****	4.8
Do not know	4.8
GLV	4.2
Biscuits	2.4
Bottled juice	38.1
Milk, milk- tea	34.2
Fresh juice / kurumba	25.5
Tea / (boiled) water	19.2
Breast milk	6.3
Family liquids	3.9
Do not know	3.9

***traditional weaning food: sugar and millet gruel**
**** rice/soft rice, roshi, yam, noodles**
***** fish, fish products, eggs**
****** biscuits, dessert**

Bottled juice was given the priority by 38 %, closely followed by milk or milk tea with 34 %. Fresh juice was mentioned by 26 % and tea or water by 19 % of the mothers. 6 % reported breast milk and 4 % the same liquids as the family. 4 % of the mothers did not give an answer.

[6] The question was asked again as open ended question.

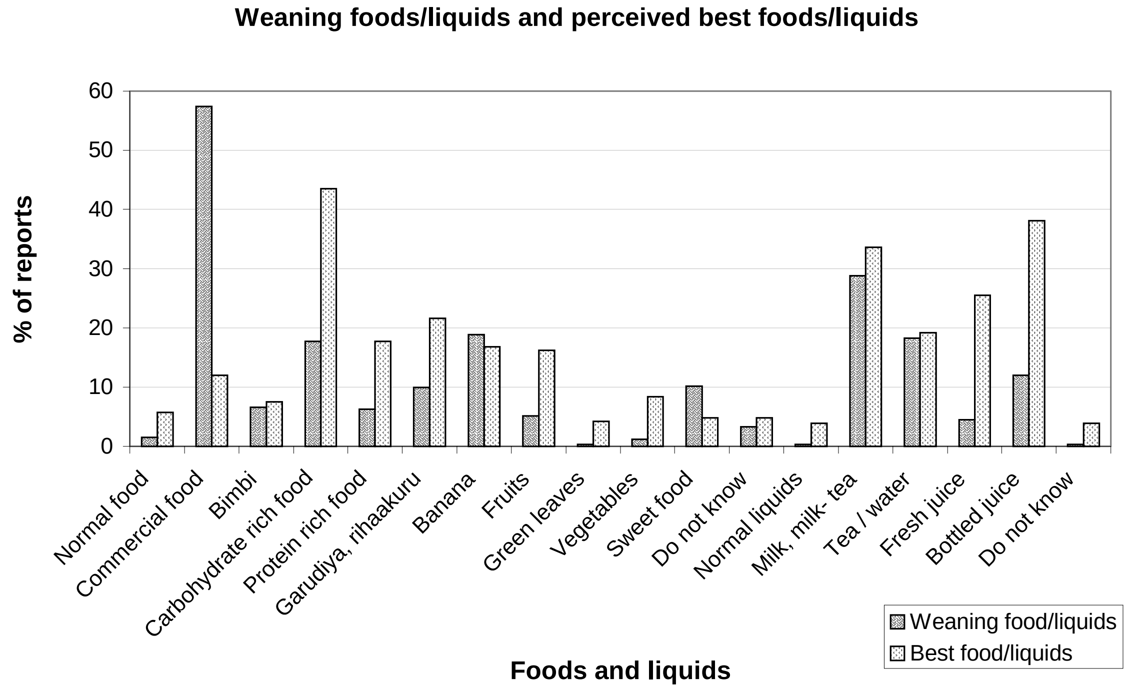

Figure 10: Comparison between the type of weaning food/liquids and perceived best food/liquids for a young child. Specific questions about liquids were not asked separately from weaning foods as a whole. Therefore, the percentages for liquids were lower than for perceived best liquids of the child. Foods and drinks below 1 % were not mentioned.

4.4.6 Anthropometry of the children

The results of the three indices weight for age (WFA), height for age (HFA) and weight for height (WFH) which were calculated from the reported age and measured weight and height

Table 19: Anthropometric mean Z scores and study variables.

Study variables	Number *	WFA	HFA	WFH
All children	312	-1.93 ± 1.05	-1.71 ± 1.31	-1.17 ± 0.98
Sex				
Male	171	-1.95 ± 0.85	-1.67 ± 1.33	-1.20 ±0.90
Female	139	-1.91 ± 1.27	-1.75 ± 1.30	-1.13 ± 1.07
Age (years)				
1	15	-1.54 ± 0.89	-1.48 ± 0.63	-1.15 ± 0.82
2	61	-1.85 ±0.97	-1.33 ± 1.47	-1.15 ± 0.89
3	133	-1.97 ± 1.21	-1.75 ± 1.36	-1.23 ± 1.13
4	102	-2.00 ± 0.89	-1.92 ± 1.17	-1.11 ± 0.84
Atoll				
Haa Dhaal	69	-2.27 ± 1.05	-2.33 ± 1.19	-1.31 ± 0.81
Laam	78	-1.75 ± 0.96	-1.39 ± 1.48	-1.14 ± 0.94
Gnaviyani	73	-1.93 ± 0.84	-1.91 ± 1.24	-0.93 ± 0.98
Kaaf	38	-1.40 ± 1.57	-1.05 ± 1.20	-1.06 ± 1.35
Meem	52	-2.17 ± 0.76	-1.55 ± 0.92	-1.44 ± 0.84

*** Number of complete questionnaires.**

of the children are given as average Z scores ([observed WFA/HFA/WFH minus median WFA/HFA/WFH of the reference] divided by standard deviation of the reference) from the NCHS median and as percentage of children below –2 SD of the from the reference median.
Table 19 gives an overview of the mean values of the Z scores for all children according to sex, age and atolls. The same table was done for children below –2 SD of the NCHS median (Table 20).

Table 20: Percent of children below –2 SD according to study variables.

Study variables	Number*	WFA [%]	Number	HFA [%]	Number	WFH [%]
All children	317	51.1	313	40.9	312	14.4
Sex						
Male	175	47.4	172	37.8	171	15.2
Female	139	53.2	135	43.9	138	13.8
Age (years)						
1	16	31.3	15	20.0	15	20.0
2	61	44.3	63	30.2	61	11.3
3	135	56.3	133	44.4	132	18.9
4	104	49.0	102	45.1	103	9.7
Atoll						
Haa Dhaal	70	67.1	71	67.6	69	20.3
Laam	80	41.3	78	35.9	78	10.3
Gnaviyani	73	46.6	73	38.4	73	9.6
Kaaf	40	35.9	39	20.5	38	10.8
Meem	54	57.4	52	28.8	54	22.2

*** Number of complete questionnaires.**

4.4.6.1 All children

Taking the commonly used cut off point of –2 SD from the reference median as an indicator of malnutrition, 51 % of all measured children were below the cut off point of the weight/age ratio. 41 % of the children were below the same cut off point for the height/age ratio indicating chronic malnutrition and 14 % were found to be below the –2 SD of the height/weight ratio indicating acute forms of malnutrition. The average Z scores of all children according to WFA, HFA and WFH was –1.9 ± 1.1, –1.7 ± 1.3 and –1.2 ± 1.0 respectively.

4.4.6.2 Sex distribution

The differences between males and females as seen in Table 19 and Table 20 were not significant ($p < 0.05$). The mean Z scores for WFA and WFH of the girls (-1.9 ± 1.3 and –1.1 ± 1.1) were slightly better than the Z scores of the boys (-2.0 ± 0.9 and –1.2 ± 0.9), whereas for HFA the boys were better off (-1.7 ± 1.3) compared to the girls (-1.8 ± 1.3). According to the percentage below –2 SD from the NCHS, 53 % of the girls and 47 % of the boys were below the cut off point for WFA, and 44 % of the girls and 38 % of the boys were below the cut off point for HFA. The boys seemed to be more affected by acute malnutrition, whereas more girls suffered from chronic malnutrition.

4.4.6.3 Age distribution:

Differences between the age groups were not significant for the average Z scores, except for HFA between the second and the fourth year. For WFA and HFA the average Z scores decreased from the first to the fourth year of the children (Table 19). For WFH the 3 year old children had the lowest average Z score (-1.2), indicating a slightly higher prevalence of acute malnutrition than the other age groups. The percentage of children below –2 SD for all 3 indices was similar to the Z scores, except for WFA for the 3 and 4 year old children.

4.4.6.4 Atoll differences:

Among the different atolls there were often significant differences, especially between Kaaf atoll and the other atolls and Haa Dhaal and the other atolls. The average Z scores corresponded to the percentage of children below –2 SD, except for HFA in Meem atoll (Table 19 and Table 20).

In contrast, Haa Dhaal atoll had the highest percentage of children below the cut off point of –2 SD for WFA and HFA (67 % and 68 % respectively), whereas the lowest percentage of children (36 % and 21 %) were found in Kaaf atoll. The proportion of children in terms of low WFA increased from Kaaf atoll (36 %) to Laam atoll (41 %), to Gnaviyani atoll (47 %) and Meem atoll (57 %). Considering HFA the proportion of children below –2 SD increased from Kaaf atoll (21 %), to Meem atoll (29 %), to Laam atoll (36 %) closely followed by Gnaviyani atoll (38 %). In Haa Dhaal and Meem atoll the percentage of children below the cut off point for WFH, at 20 % and 22 % respectively, were very similar and about twice as high as on the other atolls (Laam, Gnaviyani and Kaaf atoll with 10 %, 10 %, 11 % respectively).

4.4.6.5 All children divided into more subgroups

In order to give more detailed information and to allow for comparison with previous surveys [DPH, WHO MALE, UNICEF MALE, 1994] more subgroups were formed in SD from the reference median (Table 21).

Table 21: Categories in SD from the NCHS median.

SD	Category
< - 3 SD	Severely malnourished
- 3 SD to < - 2 SD	Moderately malnourished
- 2 SD to < - 1 SD	Mildly malnourished
- 1 SD to 1 SD	Well nourished
> 1 SD to 2 SD	
> 2 SD	

The distribution of the children according to this definition for the three indices WFA, HFA, and WFH are listed in Table 22.

Less than 2 % of the children were above +1 SD and +2 SD from the reference median for all three indices WFA, HFA, WFH respectively. 13 % (WFA), 24 % (HFA) and 38 % (WFH) of the children were in the category of -1 SD to +1 SD of the median. For WFA 35 % of the children were in the category with mild risk, 39 % in the category with moderate risk, and 12 % in the category with severe risk for malnutrition. Considering HFA the percentage of children found in these categories decreased from 33 % (< -2 SD), 26 % (-3 SD to < -2 SD) and 15 % (< -3 SD). Applying WFH, the highest proportion of children (46 %) risked for mild malnutrition, 13 % for moderate, and 2 % for severe malnutrition.

Table 22: Percent distribution of children in SD from the median.

	WFA	HFA	WFH
Number *	316	313	311
< -3 SD	11.7	14.7	1.6
- 3 SD to < –2 SD	38.6	25.9	12.9
- 2 SD to < – 1 SD	35.4	32.6	46.0
-1 SD to 1 SD	13.0	24.0	37.6
> 1 SD to 2 SD	0.9	1.6	1.3
> 2 SD	0.3	1.3	0.6

*** number of questionnaires**

If the WFA indices of the Maldivian children are converted into a Z- score distribution (Figure 11), the shape of the curve is skewed to the left side (negative SD) compared to the reference curve. The HFA and WFH curves are shown in the appendix (Figure 18 and Figure 19). All three curves of the Maldivian children have their maximum on the left side of the reference curve (between –1.5 and –2 SD) indicating different extents of malnutrition depending on which of the three indices is used.

Figure 11: Z-Score distribution for: WFA.

```
-5.0:   #
 -4.5:  #
 -4.0:  #****
 -3.5:  #******
 -3.0:  #************************
 -2.5:  *#************************************
 -2.0:  ****#*************************************
 -1.5:  ************#*****************************
 -1.0:  ********************** #
 -0.5:  **************                    #
 0.0:   **                                     #
 0.5:   **                                #
 1.0:   **                     #
 1.5:   **          #
 2.0:       #
 2.5:    #
 3.0:   #
 3.5:   #
 4.0:   #
 4.5:   #
 5.0:   #
```

4.5 Blood samples

Vitamin C, retinol, α-tocopherol, β-carotene, cholesterol, homocysteine, and haemoglobin were measured in the collected plasma of the 15 mothers in Meem atoll. Individual results are listed in Table 23, the mean values with SD in Table 24.

Table 23: Serum levels of some selected vitamins and cholesterol.

No. of mothers	Vit. C mg/dl	Retinol µmol/l	Tocopher. µmol/l	ß-Carot. µmol/l	Cholest. mg/dl	Homocys. µmol/l	Hb G/dl
1	0.55	0.96	17.15	0.07	154.06	11.04	15.9
2	0.48	1.27	23.26	0.26	150.72	8.51	13.8
3	0.40	2.00	16.83	Nd*	164.08	9.59	15.5
4	0.38	1.26	17.20	Nd*	142.37	9.10	12.9
5	0.91	1.20	15.92	0.50	159.07	11.41	14.5
6	0.56	1.28	17.89	0.15	156.56	11.56	12.4
7	0.95	1.14	20.73	0.30	160.74	10.92	12.9
8	0.50	1.29	10.64	0.02	137.36	18.37	13.3
9	0.60	0.50	10.00	Nd*	146.96	22.09	14.1
10	0.63	0.72	13.34	Nd*	154.48	11.22	12.7
11	0.48	0.87	11.95	Nd*	176.19	15.06	13.3
12	0.73	1.68	18.76	0.27	148.21	6.54	13.7
13	0.53	1.01	11.88	0.01	108.55	11.20	12.2
14	0.65	0.54	9.18	Nd*	123.16	26.44	12.4
15	0.65	1.32	14.35	0.01	142.37	19.95	12.6

*** Nd = not detectable.**

Table 24: Mean values with SD of the plasma levels.

Serum level of	Mean value ± SD
Vitamin C (mg/dl)	0.60 ± 0.16
Retinol (µmol/l)	1.14 ± 0.40
Tocopherol (µmol/l)	15.3 ± 4.1
ß- Carotene (µmol/l)	0.11 ± 0.16
Cholesterol (mg/dl)	148.3 ± 16.6
Homocysteine (µmol/l)	13.5 ± 5.7
Haemoglobin (g/dl)	13.5 ± 1.1

4.5.1.1 Vitamin C:

The vitamin C plasma levels can be divided in the groups listed in Table 25.

Table 25: Criteria groups for the vitamin C plasma levels; * in GIBSON (1990).

Groups [mg/dl]	Characteristic	Number of women
< 0.2*	Scurvy	0
< 0.50	Insufficient	4
0.50 - 0.74	Acceptable	9
0.75 – 1.0	Acceptable	2
> 1.0	Good	0

The cut off point of vitamin C for scurvy is 0.2 mg/dl. None of the mothers was below that level. 4 mothers were found with a good supply between 0.20–0.50 mg/dl. The remaining 11 mothers had an acceptable, but not optimal, supply of vitamin C between 0.50 mg/dl and 1.0 mg/dl. To see if the mothers were closer to the higher or the lower level, this group was again divided into two subgroups (0.50-0.74 mg/dl and 0.75 - 1.0 mg/dl). Then 9 mothers were in the lower and 2 in the upper group. The average vitamin C level was also situated at the lower end of the acceptable level (0.60 ± 0.16 mg/dl).

4.5.1.2 Retinol:

According to the classification in Table 26 none of the women was below the cut off point of 0.35 µmol/l.

Table 26: Criteria groups for retinol plasma levels [GIBSON, 1990].

Groups [µmol/l]	Characteristic	Number of women
< 0.35	Deficit	0
0.35 – 0.70	Marginal deficit	2
0.70 – 1.75	Acceptable	13

Two mothers had levels between 0.35 and 0.70 µmol/l which indicates marginal deficiency. The remaining 13 mothers had retinol plasma levels in the satisfactory range.
The average of 1.14 ± 0.4 µmol/l was in an acceptable range.

4.5.1.3 α-Tocopherol:

The average α-tocopherol plasma level of the 15 mothers was 15.3 ± 4.1 µmol/l. Three mothers (10.6, 10.0 and 9.2 µmol/l) were below the cut off point of 11.6 µmol/l [GIBSON, 1990]. The highest measured plasma level was 23.3 µmol/l.

4.5.1.4 ß-Carotene:

Plasma values of ß-carotene above 0.30 µmol/l are considered to be sufficient as reflected in Table 27.

Table 27: Criteria groups for ß- carotene plasma levels [BIESALSKI, 1995].

Groups [µmol/l]	Characteristic	Number of women
0	Not detectable	6
< 0.30	Deficit	7
0.30 and above	Normal	2

The average level (0.11 ± 0.16 µmol/) of the women was far below the normal range (≥ 0.3µmol/l). In 13 cases ß-carotene in the plasma was below and in two mothers above this range. In the plasma of 6 mothers ß-carotene was not detectable. The highest measured level of ß-carotene was 0.50 µmol/l.

4.5.1.5 Cholesterol:

All mothers had levels between 109 and 176 mg/dl and the average plasma level was 148 ± 17 mg/dl. According to the German requirement the plasma cholesterol level should not be higher than 200 mg/dl plus age [BIESALSKI, 1995].

4.5.1.6 Folic acid:

Homocysteine can be measured as an indirect parameter for folic acid intake. A high homocysteine level is an indicator of folic acid deficiency and low homocysteine levels indicate sufficient folic acid intake and plasma levels.

Table 28: Criteria groups for homocysteine plasma levels [PIETRZIK, 1996].

Groups [µmol/l]	Characteristic for folic acid	Number of mothers
11 and above	Deficit	10
Below 11	Sufficient	5

According to the cut off point of 11 µmol/l 10 women probably had an insufficient supply and 5 women a good supply of folic acid (Table 28).

4.5.1.7 Haemoglobin:

The haemoglobin level of all mothers was above the WHO cut off point of 12 g/dl [ACC/SCN, 1991]. The average value was 13.5 ± 1.1 g/dl ranging from 12.2–15.9 g/dl.

4.6 Nutrient intake of mothers

4.6.1 Non-pregnant mothers[7]

The percent values in Table 30 describe the proportional fulfillment of the used Recommended Dietary Allowance[8] (RDA).

The energy need of Maldivian mothers was recorded to be 1685 ± 210 kcal. This figure is the average based on individual energy requirement depending on sex, weight, height, age and sedentary work load.
The actual average energy intake of the mothers was about 420 kcal lower than the calculated average energy need which meant that only 75 % of the energy requirement was being met.
The macro nutrient source of energy[9] is shown in Table 29.

Table 29: Source of energy in percent of total intake.

Nutrients	Percent [%]
Protein	14
Total fat	17
Total carbohydrates	69
Sucrose	15
PUFA	4

14 % of the energy intake in the mothers' diet came from protein, 17 % from fat and 69 % from carbohydrates. Sucrose contributed 15 % and the polyunsaturated fatty acids (PUFA) 4 % to the energy intake.
In total, the interviewed mothers had consumed on average about 43 ± 19 g protein which amounts to 88 % of the Indian Recommended Dietary Allowance. The total protein consumption was made up of 56 % animal protein (24 ± 14 g) and 44 % vegetable protein (19 ± 7 g). The SD for vegetable protein was lower compared to the other SD, which indicates a steady consumption of vegetable protein compared to other nutrients. The average fat intake was as high as 24 ± 12 g, the carbohydrate intake was calculated at 215 ± 78 g. 46 g of this amount came from sucrose, 4 g from milk powder and the rest (165 g) were complex carbohydrates. Dietary fibre at 8 g was only about one fifth of the Indian requirement of 40 g.
The vitamin A intake (458 ± 395 µg) was mainly covered through retinol (399 ± 307 µg) and only a little was provided by carotene (0.36 ± 1.35 mg). Compared to the WHO recommendation for vitamin A the mothers' supply was in a good range (92 %). The high standard deviation indicates, however, that some mothers had a very high supply the previous day while others had very little compared to the recommendations. This trend is even more

[7] For calculation of the mother's nutritional intake all pregnant mothers were excluded because food consumption patterns and recommendations are different for non-pregnant mothers. In a few cases where the pregnant status was unknown the mothers were included in the group of non-pregnant mothers.
[8] To obtain a better impression, the food intake was compared with the Indian Recommended Dietary Allowance (RDA). If these data were not available for specific nutrients, the WHO or USA-RDA were used instead [GOPALAN ET AL., 1991; GARROW AND JAMES, 1993].
[9] The total amount of protein and carbohydrates was multiplied with the factor 4.1 kcal/g and fat with the factor 8.9 kcal/g. The received energy was then divided by the total amount of energy.

pronounced for carotene. With the Indian RDA as a reference retinol reached 67 % and carotene 15 % of the recommendation. The average vitamin E intake was calculated at 5 mg.

Table 30: Average nutrient intake of mothers; number of questionnaires: 307.

Nutrients	Requirem.	Mean ± SD	Percent [%] of requirem.	Minimum	Maximum
Calc. Ener. (kcal) **		1684 ± 211	75	1182	2435
Energy (kcal)	1875	1266 ± 468	68	299	3568
Water (g)		2060 ± 648		538	3771
Protein (g)	50	43 ± 19	86	8	99
Veg. Protein (g)		19 ± 7		5	67
An. Protein (g)		24 ± 14		1	77
Fat (g)	20	24 ± 12	120	3	73
Carbohydr. (g)		215 ± 78		48	693
Sucrose (g)		46 ± 30		1	217
Dietary fibre (g)	40	8.3 ± 6.6	21	1.4	40.1
PUFA (g)		5.8 ± 3.2		0.3	18.9
Cholesterol (mg)		56 ± 52		0	556
Uric acid (mg)		325 ± 142		49	955
Vitamin A (µg)	500*	458 ± 395	92	3	3925
Retinol (µg)	600	399 ± 307	67	2	3459
Carotene (mg)	2.4	0.36 ± 1.35	15	0	20.54
Vit. E? (mg)	8**	4.8 ± 2.7	60	0.3	16.1
Vitamin B1 (mg)	0.9	0.72 ± 0.31	80	0.08	2.52
Vitamin B2 (mg)	1.1	0.53 ± 0.36	48	0.07	2.23
Vitamin B6 (mg)	2	1.01 ± 0.45	51	0.17	2.75
Folic ac. eq. (µg)	100 / 170*	34 ± 24	34/20	5	152
Vitamin C (mg)	40	21 ± 29	53	0	221
Potassium (mg)	2000***	1040 ± 619	52	174	3599
Calcium (mg)	400	317 ± 213	79	59	1304
Magnesium (mg)	350**	150 ± 60	43	38	371
Phosphor. (mg)	800**	592 ± 272	74	94	1600
Iron (mg)	30/12.5°	8.7 ± 3.3	29/70	1.9	31.7
Zinc (mg)	6.5°°	6.0 ± 2.1	92	1.7	18.4

α-tocopherol
** **Calculated average energy requirement based on individual need according to weight, height, age and sedentary work**
* **WHO (1988) safe level**
** **USA-RDA (phosphorus for 25-50 years old women: 800 mg and for 11-24 years old women: 1200 mg)**
*** **USA minimum requirement**
° **WHO median basal requirement on intermediate bioavailability diet**
°° **WHO (1992) normative requirement on diet of moderate zinc availability (women15-18 years:10.2 mg)**

For the water soluble vitamins, the average thiamine (B1) intake was about 0.7 ± 0.3 mg, riboflavin (B2) 0.5 ± 0.4 mg and pyridoxine (B6) 1 ± 0.5 mg covering 80 %, 48 % and 51 % of the Indian RDA respectively. The intake of folic acid at 34 ± 24 µg was not high only covering 34 % of the Indian RDA and 20 % of the WHO safe level. For vitamin C the standard deviation was higher than the average value (21 ± 29 mg) which indicates a great variance between low and high intake. The average intake was 53 % of the Indian RDA.
The intake of minerals deviated considerably from the recommended requirements. The calculated average of zinc (6 ± 2 mg) was 92 % of the used recommendation, calcium (317 ±

213 mg) 79 %, potassium (1040 ± 619 mg) 52 % and magnesium (150 ± 60 mg) 43 %. The iron intake was calculated at 9 ± 3 mg. This would make 29 % of the Indian RDA and 70 % of the WHO requirement.

Comparing the findings of the permanent survey team, who visited all islands, with the findings of the enumerator teams from the islands, the actual recorded energy intake was higher in the permanent survey team than in all survey team groups together (1399 kcal and 1272 kcal, respectively), although calculated energy needs between the groups was quite similar (1643 kcal and 1678 kcal, respectively). The difference was about 130 kcal (Annex 24). The average nutrient intake measured by the permanent survey team was in general a little higher. All macro nutrients, except vegetable protein, had higher values, especially the carbohydrates (236 g and 216 g). Because of a higher fat intake in the permanent team's survey, the PUFA and vitamin E were also higher as were retinol (483 µg and 399 µg) and potassium (1130 mg and 1040). For vitamin C and carotene the permanent survey team registered slightly lower intake (vitamin C 19 mg and 21 mg, carotene 0.27 mg and 0.36 mg). These differences were significant for energy intake, protein, carbohydrates, PUFA , vitamin E , vitamin B 6 and zinc ($p < 0.05$).

4.7 Comparison between different groups of mothers

4.7.1 Nutrient intake of mothers per age

The average calculated energy demand of the mothers below 30 years (1678 kcal) and above 30 years (1685 kcal) was nearly the same. The decreased energy demand for younger age groups seemed to be compensated for by the lower BMI of the mothers below 20 years. As expected, all nutrients were consumed in a slightly lower amount by older mothers compared to the younger mothers, e.g., for energy (1225 kcal and 1294 kcal respectively) except for carotene which on average was higher for mothers of ≥ 30 years (Annex 25). All differences were not significant, except for retinol, riboflavin and calcium ($p < 0.05$).

4.7.2 Nutrient intake of mothers per BMI

The energy demand normally increases with weight and higher BMI. Therefore, the average energy consumption would be expected to be higher in mothers with BMI ≥ 23 than with BMI < 23. This is also reflected in the calculated energy demand shown in Annex 26 (BMI < 23: 1580 kcal; BMI ≥ 23: 1860 kcal). Surprisingly, on average the reported food consumption in the group of the mothers with higher BMI was the same, or lower, for all nutrients than of the mothers with lower BMI. The actual energy intake was about 100 kcal lower because of lower reported fat intake, animal protein and carbohydrate consumption. Other bigger differences between the mothers with a higher and a lower BMI were in retinol (328 µg and 443 µg), carotene (0.2 mg and 0.46 mg), potassium (895 mg and 1104 mg) and in calcium (257 mg and 350 mg) intake. All differences were significant except for vegetable protein, carbohydrates, sucrose, dietary fibre, PUFA and vitamin E.

4.7.3 Nutrient intake of pregnant and non-pregnant mothers

Pregnant mothers have higher energy and micro nutrient requirements than non-pregnant mothers. During the interviews pregnant mothers reported slightly higher food consumption compared to non-pregnant women (Annex 27). However, their increased food intake was not proportional to the recommendations. This evidence is limited by the small sample number of pregnant women (26) as well as the lack of data on the duration of pregnancy. The average energy intake was about 110 kcal higher than in the group of non-pregnant women which is about one-third of the additional amount proposed by the Indian RDA. The other nutrient increases were rather small. None of the differences were significant.

4.7.4 Average food intake of some selected foods per atoll

Table 31 reflects the average intake of selected foods consumed the previous day calculated for each atoll.

Table 31: Average food intake of mothers per atoll.

Foods	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem
Rice (g)	482	378	353	544	464
Roshi (g)	28	69	75	83	80
Noodles (g)	0	9	20	7	4
Yam (g)			110		
Sweet potatoes (g)					4
Sugar (in tea) (g)	27	28	35	37	57
Tuna (g)	37	22	37	91	87
Mashuni (g)	4	< 1	7	2	3
Rihaakuru (g)	4	3	1	4	4
Fish curry (g)	30	63	14	9	54
Salty short eats (g)	47	18	14	64	59
Chicken (curry, egg) (g)	4	23	3	5	0
Vegetable curry (g)	11	23	50	15	6
Vegetables (onion, no chilli) (g)	2	2	7	24	4
Fruit (g)	3	13	16	5	5
Lemon (g)	< 1	< 1	2	12	2
Leaves (g)	< 1	< 1	6	< 1	< 1
Kurumba (g)	6	3	15	0	0
Milk powder (g)	5	6	21	19	9

On average the mothers in Kaaf atoll reported the highest amount of rice (544 g, about 7 full rice spoons) and roshi, made of wheat flour, oil and salt, (83 g, nearly 3 roshi) per day. Noodles did not play an important role (7 g). In Haa Dhaal the amount of rice was about 60 g (about 1 rice spoon) lower than in Kaaf atoll but rice was the main carbohydrate rich staple food. The reported amount of roshi used was by far the lowest of all atolls (28 g, about 1 roshi). In Laam atoll the average rice intake was reported to be about 378 g or 165 g lower than in Kaaf atoll, roshi was eaten for at least one meal (69 g, little more than 2 roshi). Rice consumption was the lowest in Gnaviyani atoll. Other carbohydrate rich staple food was yam (110 g), which was not consumed in the other atolls, roshi (75 g or 2 ½ roshi), and noodles (20g) with the highest intake of all atolls. In Gnaviyani atoll the high yam consumption contributed some additional micro nutrients to the diet. For example, 100 g of yam contains about 14 % dietary fibre, 25 % vitamin C, 10 % vitamin B6, 40 % folic acid, 20 % potassium respectively of the mothers’ RDA for India. These numbers do not include the micro nutrient losses which occur during the cooking process. In Meem atoll some mothers consumed sweet potatoes in addition to rice and roshi which is even more nutritious than yam. Sweet potatoes are especially high in carotene (350 %), vitamin C (75 %), vitamin E (55 %) and also contain folic acid, the B vitamins, dietary fibre and minerals like magnesium, some iron, zinc and calcium. However, with only an average of 4 g per mother sweet potatoes were not an important staple food in Meem atoll.

In Kaaf atoll garudiya fish was highly preferred (91 g). Therefore, fish curry consumption was the lowest in this atoll (9 g). Vegetable curry consumption was also quite low (15 g). In Laam atoll the situation was just the reverse. Fish curry (63 g) was consumed more often than garudiya fish (22 g). Vegetable curry was also eaten (23 g). In Gnaviyani atoll, fish was most often prepared with vegetable curry (50 g). In Kaaf, Meem and Haa Dhaal fish was additionally consumed as salty short eats together with scraped coconut and flour (64 g, 59 g and 47 g respectively). The amount was about 2–4 short eats per day, depending on the size and kind of short eat. Taking in account all kinds of prepared fish, Gnaviyani atoll had about the lowest fish intake followed by Haa Dhaal and Laam atoll, whereas reported fish consumption was much higher in Meem and Kaaf atolls. The consumption of chicken products (chicken curry and eggs) was the highest in Laam atoll (23 g).

Vegetables and fruit were rarely consumed in all atolls. In Kaaf atoll the reported 24 g of vegetables came mainly from onions (17 g, about ¼ of a onion) and lemon intake was highest of all atolls (12 g, more than ½ lemon). Although lemon and onion are consumed with garudiya fish, which was usually consumed rather than curry, the amount of onion and lemon seem to be overestimated. On average ½ a lemon a day for each mother seems to be too high when commonly 1/8 or even less of a lemon is usually consumed with garudiya fish. Altogether, the mothers in Gnaviyani atoll reported the highest vegetable consumption, mainly in the form of vegetable curry and yam. Fruit consumption was (without lemon) slightly higher in Gnaviyani and Laam atoll (16 g and 13 g respectively) than in the other atolls. Fruit intake in Laam atoll came mainly from bananas. But 16 g or 13 g of fruit is still low considering that half of a Maldivian mango weighs 40 to 50 g or a banana about 50 g. This indicates that only a smaller proportion of mothers consumed fruit the previous day. GLV in small amounts seemed to be an integrated part of the diet in Gnaviyani (6 g) for more than one meal.

The highest level of consumption of kurumba which is the liquid of the young coconut and mashuni which is a mixture of fish, grated coconut, onions and chilli was reported in Gnaviyani. Coconut milk[10], e.g., in rice and grated coconut in short eats or other recipes are not considered in this calculation. The use of milk powder was reported most often in Kaaf and Gnaviyani atoll (19 g and 21 g, respectively).

4.7.5 Nutrient intake of mothers per atoll

The average nutrient intake of the mothers per atoll is listed in Table 32. The reported caloric intake was lowest in Haa Dhaal (1016 kcal) and Laam (1032 kcal) atoll and highest in Kaaf atoll (1567 kcal). The difference was more than 500 kcal, which supposes either too high proportions in one atoll or too low portion sizes in the other atoll. Due to the highest recorded amounts of rice and roshi as well as high amounts of fish in Kaaf atoll, the calculated protein, fat and carbohydrate intake (60 g, 31 g, 258 g) was nearly the same or higher as in Meem (54 g, 28 g, 247 g) and Gnaviyani atoll (46 g, 32 g, 238 g). The different B vitamins (vitamin B1, B2 and B6) were also highly consumed in Kaaf atoll (0.96 mg, 0.77 mg, 1.35 mg) because of the high intake of tuna and milk powder. But the differences were not significant ($p < 0.05$) compared to the second highest atoll (Gnaviyani), except for thiamine. The highest average intake of carotene was found in Meem atoll (0.66 mg). About half of the carotene came from sweet potatoes which were only consumed by a small number of mothers. These mothers probably had a recently sufficient intake of carotene, whereas the intake of the majority of mothers was probably insufficient.

[10] Coconut milk is actually a diluted product made by adding water to grated coconut and pressing out the liquid.

Table 32: Nutrient intake of mothers per atoll.

Atoll Nutrients	Haa Dhaal Mean ± SD	Laam Mean ± SD	Gnaviyani Mean ± SD	Kaaf Mean ± SD	Meem Mean ± SD
Number ***	63	81	68	41	53
Cal. en. (kcal) **	1706 ± 229	1755 ± 219	1634 ± 168	1650 ± 207	1636 ± 200
Energy (kcal)	1016 ± 461	1032 ± 306	1439 ± 451	1567 ± 508	1466 ± 340
Water (g)	1662 ± 585	1774 ± 551	2483 ± 589	2219 ± 588	2303 ± 494
Protein (g)	35 ± 17	33 ± 11	46 ± 16	60 ± 21	54 ± 17
Veg. Protein (g)	16 ± 8	16 ± 5	22 ± 7	24 ± 8	20 ± 5
An. Protein (g)	19 ± 12	17 ± 9	24 ± 11	36 ± 16	34 ± 14
Fat (g)	16 ± 9	19 ± 9	32 ± 14	31 ± 13	28 ± 9
Carbohydr. (g)	179 ± 87	180 ± 52	238 ± 76	258 ± 84	247 ± 58
Sucrose (g)	30 ± 19	39 ± 23	49 ± 34	47 ± 30	73 ± 29
Dietary fibre (g)	5.1 ± 2.9	5.8 ± 2.6	15.0 ± 10.4♦	9.1 ± 3.9	7.0 ± 1.7
PUFA (g)	3.7 ± 2.4	5.0 ± 2.5	6.7 ± 2.9	7.5 ± 4.0	7.3 ± 2.8
Vitamin A (µg)	290 ± 201	328 ± 403	530 ± 330	640 ± 337	621 ± 520
Retinol (µg)	270 ± 187	302 ± 394	434 ± 209	584 ± 319	514 ± 244
Carotene (mg)	0.13 ± 0.22	0.16 ± 0.29	0.57 ± 1.30	0.37 ± 0.44	0.66 ± 2.81
Vitamin E* (mg)	3.0 ± 2.2	4.2 ± 2.1	5.5 ± 2.5	6.0 ± 3.5	6.0 ± 2.7
Vitamin B1 (mg)	0.65 ± 0.33	0.53 ± 0.19	0.82 ± 0.30	0.96 ± 0.33♦	0.79 ± 0.23
Vitamin B2 (mg)	0.34 ± 0.21	0.34 ± 0.27	0.72 ± 0.35	0.77 ± 0.42	0.60 ± 0.31
Vitamin B6 (mg)	0.82 ± 0.40	0.75 ± 0.31	1.16 ± 0.42	1.35 ± 0.53	1.17 ± 0.37
Folic ac. eq. (µg)	21 ± 10	23 ± 14	56 ± 34	42 ± 17	35 ± 11
Vitamin C (mg)	8 ± 19	12 ± 29	41 ± 38	28 ± 15	18 ± 21
Potassium (mg)	703 ± 335	711 ± 369	1597 ± 802	1284 ± 513	1040 ± 338
Calcium (mg)	201 ± 108	224 ± 176	474 ± 208	421 ± 225	315 ± 195
Magnesium (mg)	116 ± 50	117 ± 42	185 ± 61	187 ± 62	166 ± 40
Phosphor. (mg)	454 ± 211	434 ± 196	739 ± 261	807 ± 288	641 ± 200
Iron (mg)	8.1 ± 4.1	7.1 ± 2.0	9.3 ± 3.1	11.1 ± 3.4	9.5 ± 2.4
Zinc (mg)	5.2 ± 2.3	5.0 ± 1.5	6.7 ± 1.9	7.5 ± 2.1	6.5 ± 1.4

***α-tocopherol**
**** Calculated average energy requirement based on individual need according to weight, height, age and sedentary work**
***** Number of questionnaires.**
♦ Significant difference ($p < 0.05$).

Due to a general consumption of yam and higher consumption of vegetables, in form of vegetable curry, the dietary fibre intake (15 g) and vitamin C (41 mg) intake was highest in Gnaviyani. The consumption of dietary fibre was significantly the highest in this atoll. Additionally, the high amount of milk powder used per day contributed to the highest intake of folic acid (56 µg), potassium (1597 mg) and calcium (474 mg) in Gnaviyani. This was not significant compared to the second highest atoll (Kaaf). The differences between iron and zinc intake were not big among the atolls. The highest amounts of these micro nutrients were found in Kaaf atoll (iron: 11 mg; zinc: 8 mg).
Generally, the nutrient intake of Haa Dhaal and Laam atolls was similar and much lower than in the other atolls, whereas the intake of Gnaviyani, Kaaf and Meem atoll was also similar due to similar energy intake. Between Haa Dhaal and Meem atoll the differences in all nutrients was significant. This is influenced by the results taken by the permanent survey team (Annex 28) where recorded energy intake increased as the study progressed from atoll to atoll.

Another influencing factor might be a result of the variations recorded by the additional enumerators finding higher or lower energy intake compared to the permanent survey team (Annex 28).
In order to see which island had the highest nutrient density independent from actual energy intake the nutrient density for 1300 kcal was calculated, which was about the average caloric intake of all atolls. The results are listed in Table 33.

Table 33: Nutrient density of mothers per atoll for 1300 kcal.

Nutrients	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem
Number **	63	81	68	41	53
Protein (g)	45 ± 11	41 ± 8	42 ± 7	50 ± 9	47 ± 9
Veg. Protein (g)	21 ± 3	21 ± 3	20 ± 3	20 ± 3	18 ± 2
An. Protein (g)	24 ± 13	21 ± 9	22 ± 8	30 ± 10	30 ± 10
Fat (g)	21 ± 7	23 ± 6	28 ± 8	25 ± 6	24 ± 5
Carbohydr. (g)	230 ± 24	228 ± 18	216 ± 21	215 ± 17	219 ± 16
Sucrose (g)	40 ± 20	48 ± 23	43 ± 23	37 ± 19	65 ± 21
Dietary fibre (g)	6.5 ± 2.3	7.2 ± 1.8	13.7 ± 8.8	7.5 ± 1.5	6.3 ± 1.3
PUFA (g)	4.6 ± 2.4	6.4 ± 2.5	6.1 ± 2.3	5.9 ± 2.0	6.4 ± 2.1
Vitamin A (µg)	367 ± 225	400 ± 414	479 ± 256	525 ± 206	568 ± 620
Retinol (µg)	343 ± 213	369 ± 407	392 ± 145	482 ± 204	447 ± 161
Carotene (mg)	0.15 ± 0.24	0.19 ± 0.34	0.52 ± 1.18	0.28 ± 0.35	0.74 ± 3.48
Vit. E (mg)*	3.8 ± 2.2	5.4 ± 2.3	5.0 ± 2.1	4.7 ± 2.0	5.4 ± 2.6
Vitamin B1 (mg)	0.83 ± 0.15	0.68 ± 0.14	0.74 ± 0.13	0.81 ± 0.16	0.70 ± 0.11
Vitamin B2 (mg)	0.44 ± 0.27	0.40 ± 0.22	0.65 ± 0.22	0.63 ± 0.28	0.52 ± 0.18
Vitamin B6 (mg)	1.05 ± 0.22	0.95 ± 0.22	1.06 ± 0.21	1.11 ± 0.25	1.04 ± 0.24
Folic ac. eq. (µg)	27 ± 11	28 ± 12	51 ± 27	35 ± 10	31 ± 7
Vitamin C (mg)	10 ± 21	14 ± 35	38 ± 33	23 ± 12	17 ± 21
Potassium (mg)	900 ± 222	872 ± 254	1458 ± 586	1064 ± 242	922 ± 211
Calcium (mg)	265 ± 125	270 ± 136	435 ± 151	357 ± 184	275 ± 124
Magnesium (mg)	150 ± 20	148 ± 28	169 ± 28	157 ± 24	148 ± 16
Phosphor. (mg)	585 ± 147	537 ± 133	670 ± 128	683 ± 160	566 ± 98
Iron (mg)	10.3 ± 1.5	9.2 ± 1.6	8.5 ± 1.5	9.4 ± 1.3	8.4 ± 1.1
Zinc (mg)	6.7 ± 0.8	6.3 ± 1.0	6.2 ± 1.0	6.4 ± 0.8	5.8 ± 0.6

*** α-tocopherol**
**** number of questionnaires.**

The proportion of carbohydrates was then slightly higher in Haa Dhaal and Laam compared to the other three atolls. The amount of animal protein in the diet of Kaaf and Meem atolls was higher than in the other atolls. In Gnaviyani vegetable and fruit intake was highest. This is reflected in dietary fibre intake which is almost twice as high as compared to the other atolls. Folic acid and vitamin C intake was also the highest, whereas in Haa Dhaal and Laam carotene, folic acid and vitamin intake was in the lowest range. In Haa Dhaal the diet was highest in iron and zinc. In Kaaf atoll the B vitamins were highly consumed mainly through fish and milk powder. Calculated potassium, calcium and magnesium intake was highest again in Gnaviyani.

4.8 Nutrient intake of children

4.8.1 Age group 12 to 47 months[11]

The average nutrient intake with minimum and maximum values, the recommended nutritional intake and the fulfillment of the recommendation of the one to three year old children are listed in Table 35. The reported average energy intake was calculated at 936 ± 318 kcal. This would make 75 % of the Indian RDA.
Table 34 shows energy intake broken down according to macro nutrients.

Table 34: Source of energy in percent of the total intake for the 1 to 3 year old children.

Nutrients	Percent [%]
Protein	14
Total fat	21
Total carbohydrates	65
Sucrose	25
PUFA	3

Protein contributed 14 % to the energy intake, fat 21 % and carbohydrates 65 %. 25 % of the energy came from sucrose and 3 % from PUFA.
The total protein intake was calculated at 33 ± 13 g. The Indian RDA of 22 g was on average covered through the animal protein intake (23 ± 12 g). The vegetable protein intake was about half of the animal protein intake (10 ± 5 g). The average fat consumption came to 22 ± 11 g, the total carbohydrates to 148 ± 50 g. Nearly 40 % of the carbohydrates were eaten as sucrose (57 ± 28 g). Dietary fibre was low with 5 g.
The calculated retinol intake of 461 µg and vitamin A intake of 500 µg were above the Indian RDA for retinol (115 %) and the WHO recommendation for vitamin A (125 %). The average carotene intake was low (0.29 ± 1.0 mg). It only reached 18 % of the Indian RDA. The vitamin E content of the diet was calculated at 3.1 mg.
Thiamine (0.48 ± 0.21 mg), riboflavin (0.79 ± 0.51 mg) and vitamin B6 (0.68 ± 0.28 mg) reached 80 %, 113 % and 76 % of the Indian RDA. The calculated folic acid intake (33 ± 17 µg) was sufficient according to the Indian RDA (110 %), whereas it only reached 66 % of the WHO recommendation. Together with carotene vitamin C had a high SD (20 ± 30 mg), indicating a broad range between low and high intake. On average it covered half of the recommendation.
With respect to the calculated mineral intake, the diet of the children contained about 1010 ± 525 mg potassium, 520 ± 346 mg calcium, 120 ± 47 mg magnesium, and 4 ± 1.5 mg zinc. On average this intake was higher than the recommendation, except for zinc, which was 78 % of the recommendation. The iron intake was about 5 mg. This is 39 % of the Indian RDA and nearly covers the WHO recommendation (94 %).

[11] The children were divided into 2 age groups according to the Indian and WHO-RDA for these age groups.

Table 35: Requirement, average with standard deviation, median, minimum and maximum nutrient intake of the 1 to 3 year old children and percent intake of the requirement; Number of interviews: 226.

Nutrients	Requirem.	Mean value ± SD	Percent [%] of requirem.	Minimum value	Maximum value
Energy (kcal)	1240	936 ± 318	75	234	2077
Water (g)	-	1594 ± 474		471	2917
Protein (g)	22	33 ± 13	150	5	82
Veg. Protein (g)	-	10 ± 5		1	31
An. protein (g)	-	23 ± 12		0.4	75
Fat (g)	25	22 ± 11	88	2	78
Carbohydr. (g)	-	148 ± 50		40	335
Sucrose (g)	-	57 ± 28		8	154
Dietary fibre (g)	-	4.9 ± 4.0		0	24.7
PUFA (g)	-	3.6 ± 1.9		0.2	9.7
Cholesterol (mg)	-	71 ± 60		1	517
Uric acid (mg)	-	165 ± 81		0	499
Vitamin A (µg)	400*	500 ± 315	125	6	2143
Retinol (µg)	400	461 ± 270	115	6	1957
Carotene (mg)	1.6	0.29 ± 1.03	18	0	10.96
Vit. E* (mg)	6**	3.1 ± 1.7	52	0.2	9.8
Vitamin B1 (mg)	0.6	0.48 ± 0.21	80	0.10	1.22
Vitamin B2 (mg)	0.7	0.79 ± 0.51	113	0.05	2.94
Vitamin B6 (mg)	0.9	0.68 ± 0.28	76	0.13	1.38
Folic ac. eq. (µg)	30 / 50*	33 ± 17	110 / 66	5	121
Vitamin C (mg)	40	20 ± 30	50	0	363
Potassium (mg)	1000***	1007 ± 525	101	146	3248
Calcium (mg)	400	522 ± 346	131	59	2338
Magnesium (mg)	80**	117 ± 47	146	30	322
Phosphor. (mg)	800**	581 ± 303	73	66	2344
Iron (mg)	12 / 5.0°	4.7 ± 1.9	39 / 94	0.9	11.3
Zinc (mg)	5.5°°	4.3 ± 1.5	78	1.2	9.3

*** α-tocopherol**
*** WHO (1988) safe level**
**** USA-RDA**
***** USA minimum requirement**
° WHO median basal requirement on intermediate bioavailability diet
°° WHO (1992) normative requirement on diet of moderate zinc availability.

A comparison of the findings between the permanent survey team, who visited all islands, and all interviewing survey teams shows compatibility about the nutrient intake in this age group. Some micro nutrients were on average a little lower in the permanent survey team than from all survey teams together (Annex 29). The differences were not significant.

4.8.2 Age group 48 to 59 month

In general, the results of the nutritional protocols of the 4 year old children were below the recommendations (Table 37). But it has to be kept in mind that these recommendations are intended as requirements for children in the age group of 4-6 years, and the actual survey only included 4 year old children. Therefore, recommendations made specifically for 4 year old children would be lower than the recommendation for the age group 4-6 years, which were used here, especially for energy. Never the less, there are some visible tendencies.

The average energy intake calculated from the interviews was 872 ± 308 kcal and covers about 50 % of the Indian RDA. Table 36 shows energy intake broken down according to macro nutrients.

Table 36: Source of energy in percent of the total intake for the 4 year old children.

Nutrients	Percent [%]
Protein	14
Total fat	19
Total carbohydrates	67
Sucrose	25
PUFA	4

Protein contributed 14 % of the energy intake, fat 19 % and the total amount of carbohydrates 67 %. 25 % came from sucrose and 4 % from the PUFA.

Table 37 Requirement, average with standard deviation, minimum and maximum nutrient intake of the 4 year old children and percent intake of the requirement; number of questionnaires: 107.

Nutrients	Requirem.	Mean value ± SD	Percent [%] of requirem.	Minimum value	Maximum value
Energy (kcal)	1690	872 ± 308	52	301	1840
Water (g)	-	1514 ± 442		631	2867
Protein (g)	30	30 ± 13	100	6	65
Veg. Protein (g)	-	11 ± 5		2	28
An. Protein (g)	-	19 ± 10		1	42
Fat (g)	25	19 ± 10	76	4	57
Carbohydr. (g)	-	144 ± 49		35	298
Sucrose (g)	-	53 ± 27		7	150
Dietary fibre (g)	-	4.7 ± 2.9		0.5	13.8
PUFA (g)	-	4.0 ± 2.5		0.4	15.0
Cholesterol (mg)	-	55 ± 53		0	314
Uric acid (mg)	-	177 ± 89		34	459
Vitamin A (µg)	400*	365 ± 220	91	4	949
Retinol (µg)	400	332 ± 206	83	3	829
Carotene (mg)	1.6	0.24 ± 0.43	15	0	2.83
Vit. E* (mg)	6**	3.5 ± 2.2	58	0.5	13.6
Vitamin B1 (mg)	0.9	0.42 ± 0.19	47	0.12	0.98
Vitamin B2 (mg)	1.0	0.51 ± 0.31	51	0.04	1.34
Vitamin B6 (mg)	0.9	0.62 ± 0.29	69	0.15	1.43
Folic ac. eq. (µg)	40 / 50*	25 ± 13	63 / 50	5	70
Vitamin C (mg)	40	15 ± 15	38	0.2	85
Potassium (mg)	1400***	753 ± 368	54	153	1879
Calcium (mg)	400	325 ± 189	81	65	791
Magnesium (mg)	120**	99 ± 39	83	35	229
Phosphor. (mg)	800**	440 ± 209	55	92	1264
Iron (mg)	18 / 5.5°	4.8 ± 1.8	27 / 87	1.3	10.5
Zinc (mg)	6.5°°	3.8 ± 1.3	58	1.7	7.5

*** α-tocopherol**
*** WHO (1988) safe level**
**** USA-RDA**
***** USA minimum requirement**
° WHO median basal requirement on intermediate bioavailability diet
°° WHO (1992) normative requirement on diet of moderate zinc availability.

For the 4 year old children the differences in the assessment of the dietary intake - obtained by all survey teams together compared to the permanent survey team alone - were bigger than for the 1-3 year old children (Annex 30). Here the average nutrient intake assessed by the permanent survey team was the same or higher compared to all survey teams. This was especially obvious for the carbohydrate intake (170 g and 144 g) and sucrose intake (71 g and 53 g). The differences of these two nutrients between the survey teams were significant ($p < 0.05$) in contrast to the other nutrients. For vitamin C it was the reverse but also not significant.

4.9 Comparison between different groups of children

4.9.1 Differences in the nutritional intake per age

As seen in Table 38 the comparison of the average nutrient intake between the first, second, third, and fourth year of age shows some interesting changes in dietary intake.

Table 38: Average nutrient intake by age.

Age Nutrients	1 Mean value ± SD	2 Mean value ± SD	3 Mean value ± SD	4 (all) Mean value ± SD	4 (perman.) Mean value ± SD
Number**	18	68	140	107	
Energy (kcal)	894 ± 337	921 ± 321	949 ± 315	872 ± 308	1009 ± 284
Water (g)	1574 ± 454	1543 ± 477	1621 ± 476	1514 ± 442	1614 ± 328
Protein (g)	33 ± 11	33 ± 15	33 ± 13	30 ± 13	32 ± 11
Veg. Protein (g)	8 ± 3	9 ± 4	10 ± 5	11 ± 5	11 ± 4
An. Protein (g)	25 ± 9	24 ± 14	23 ± 11	19 ± 10	21 ± 10
Fat (g)	22 ± 8	24 ± 13	22 ± 10	19 ± 10	21 ± 10
Carbohydr. (g)	140 ± 61	142 ± 47	152 ± 50	144 ± 49	170 ± 52
Sucrose (g)	59 ± 40	56 ± 29	57 ± 26	53 ± 27	71 ± 32
Dietary fibre (g)	4.4 ± 3.5	4.7 ± 4.0	5.0 ± 4.0	4.7 ± 2.9	4.9 ± 2.6
PUFA (g)	2.8 ± 1.4	3.3 ± 1.7	3.9 ± 2.0	4.0 ± 2.5	
Vitamin A (µg)	513 ± 194	553 ± 395	472 ± 281	365 ± 220	398 ± 201
Retinol (µg)	508 ± 193	503 ± 332	435 ± 241	332 ± 206	371 ± 205
Carotene (mg)	0.10 ± 0.06	0.38 ± 1.29	0.28 ± 0.95	0.24 ± 0.43	0.23 ± 0.24
Vit. E* (mg)	2.4 ± 1.3	2.9 ± 1.7	3.3 ± 1.8	3.5 ± 2.2	3.7 ± 1.8
Vitamin B1 (mg)	0.50 ± 0.19	0.48 ± 0.19	0.48 ± 0.22	0.42 ± 0.19	0.44 ± 0.17
Vitamin B2 (mg)	0.92 ± 0.41	0.87 ± 0.55	0.74 ± 0.49	0.51 ± 0.31	0.63 ± 0.34
Vitamin B6 (mg)	0.68 ± 0.25	0.68 ± 0.28	0.67 ± 0.29	0.62 ± 0.29	0.63 ± 0.26
Folic ac. eq. (µg)	35 ± 17	35 ± 20	32 ± 16	25 ± 13	27 ± 13
Vitamin C (mg)	15 ± 13	22 ± 24	19 ± 34	15 ± 15	12 ± 8
Potassium (mg)	1084 ± 440	1084v 570	960 ± 510	753 ± 368	845 ± 339
Calcium (mg)	590 ± 270	583 ± 395	484 ± 325	325 ± 189	405 ± 191
Magnesium (mg)	119 ± 42	120 ± 49	115 ± 47	99 ± 39	105 ± 35
Phosphor (mg)	604 ± 210	620 ± 357	559 ± 283	440 ± 209	491 ± 171
Iron (mg)	4.2 ± 1.7	4.5 ± 1.8	4.9 ± 1.9	4.8 ± 1.8	5 ± 1.5
Zinc (mg)	4.2 ± 1.4	4.3 ± 1.6	4.3 ± 1.5	3.8 ± 1.3	4.1 ± 1.2

*** α-tocopherol**
**** number of questionnaires.**

Energy consumption increased slightly with age, and in the fourth year if the findings on average energy consumption of the permanent survey team is used for comparison. The total amount of protein intake was nearly constant throughout the different ages, whereas the kind of consumed protein changed. The vegetable protein consumption increased slightly and the animal protein consumption decreased slightly in the diet with increasing age of the children. For fat intake no change was visible across the age groups, only a modification of the consumed fat. Increased intake of PUFA and vitamin E show that more vegetable oil and possibly also more fish was consumed in the diet. These two items are probably the main sources of PUFA and vitamin E in Maldivian diet. This indicates that the consumption of family food rose with age, e.g., more curry, short eats or roshi were part of the diet where oil is used for preparation. The carbohydrate intake also increased slightly from the first to the fourth year. This trend is applicable to the fourth year only when the average found by the permanent survey team is taken into consideration.
For retinol, riboflavin and calcium the calculated intake decreased with increasing age. The changes between the first and second year were smaller for these nutrients than the jump between the second and third year and between the third and the fourth year. This was probably due to decreased consumption of milk powder, especially from the third year onwards. Potassium, magnesium and folic acid did not change from the first to the second year, but decreased again in the diet of the 3 and 4 year old children. Surprisingly, vitamin C and carotene intake were highest for the 2 year old children followed by the three year old children. A further decrease was observed among the 4 year old children. Children aged one year had the lowest carotene intake and were on the same level as the four year old children for vitamin C intake. This leads to the assumption that the one year old children probably received more milk powder, but less vegetables and fruit. Three and four year old children probably received decreasing amounts of milk powder, fruit and vegetables compared to the two year old children. Therefore, the younger children probably had a better supply of several micro nutrients than the older children despite the fact that demand increases with age. Iron intake increased slightly with age because of increased proportions of family food. For zinc intake there were no obvious changes.
All these observed changes were small and therefore only tested for significance between the 2 and 3 year old children. The differences were not significant except for vegetable protein which was higher for the 3 year old children.

4.9.2 Differences in the average nutrient intake per atoll (children age 1 to 3)

A closer look at the atoll level shows big differences among the selected atolls (Table 39). Great variation was especially observed with respect to energy intake. Haa Dhaal had by far the lowest energy intake (640 kcal), followed by Laam atoll (871 kcal). Gnaviyani, Kaaf and Meem atoll were relatively similar (1038 kcal, 1081 kcal, 1008 kcal). Therefore, most other nutrients were also lower in Haa Dhaal than in Laam and increasingly higher in the other three atolls compared to Haa Dhaal. A similar trend has already been seen in the interviews of the mothers.
In Meem atoll the highest consumption of sucrose (77 g) was reported. In Kaaf atoll retinol (510 mg), riboflavin (1,01 mg) and calcium (665 mg) was obviously higher than in the other atolls. These nutrients corresponded with the reported higher use of milk powder in the diet of

the children. The carotene intake was also highest in Kaaf atoll (0.21 mg). The highest amounts of carbohydrates (173 g), dietary fibre (6.6 g) as well as vitamin C (23 mg), and potassium (1191 mg) were reported in Gnaviyani atoll.

Table 39: Average nutrient intake of 1-3 year old children per atoll.

Atoll Nutrients	Haa Dhaal Mean ± SD	Laam Mean ± SD	Gnaviyani Mean ± SD	Kaaf Mean ± SD	Meem Mean ± SD
Number **	49	44	63	31	39
Energy (kcal)	640 ± 653	871 ± 885	1038 ± 1059	1081 ± 1097	1008 ± 1025
Water (g)	1136 ± 1163	1574 ± 1574	1738 ± 1803	1819 ± 1767	1644 ± 1682
Protein (g)	24 ± 25	29 ± 30	34 ± 35	38 ± 41	36 ± 38
Veg. Protein (g)	7 ± 7	8 ± 8	11 ± 12	12 ± 12	10 ± 10
An. Protein (g)	15 ± 17	21 ± 22	23 ± 23	26 ± 29	27 ± 28
Fat (g)	14 ± 14	21 ± 22	25 ± 26	25 ± 29	21 ± 23
Carbohydr. (g)	103 ± 105	140 ± 140	173 ± 169	160 ± 165	165 ± 164
Sucrose (g)	36 ± 39	62 ± 59	54 ± 60	52 ± 53	77 ± 74
Dietary fibre (g)	2.3 ± 2.7	2.9 ± 3.3	6.6 ± 8.2	4.7 ± 5.0	3.3 ± 3.8
Vitamin A (µg)	276 ± 308	417 ± 459	511 ± 555	535 ± 628	529 ± 597
Retinol (µg)	276 ± 296	384 ± 443	485 ± 503	510 ± 589	473 ± 519
Carotene (mg)	0.06 ± 0.10	0.11 ± 0.16	0.13 ± 0.38	0.21 ± 0.33	0.12 ± 0.51
Vitamin E* (mg)	2.0 ± 2.2	2.5 ± 2.8	3.2 ± 3.4	3.1 ± 3.8	3.2 ± 3.6
Vitamin B1 (mg)	0.32 ± 0.33	0.36 ± 0.41	0.55 ± 0.60	0.49 ± 0.55	0.51 ± 0.51
Vitamin B2 (mg)	0.37 ± 0.48	0.69 ± 0.73	0.88 ± 0.96	1.01 ± 1.04	0.65 ± 0.78
Vitamin B6 (mg)	0.47 ± 0.48	0.51 ± 0.58	0.76 ± 0.81	0.69 ± 0.74	0.74 ± 0.76
Folic ac. eq. (µg)	21 ± 21	28 ± 30	36 ± 41	37 ± 40	30 ± 32
Vitamin C (mg)	5 ± 6	8 ± 19	23 ± 32	17 ± 28	9 ± 12
Potassium (mg)	574 ± 619	846 ± 923	1191 ± 1291	1152 ± 1227	856 ± 956
Calcium (mg)	240 ± 299	434 ± 513	595 ± 635	665 ± 720	405 ± 475
Magnesium (mg)	81 ± 81	101 ± 109	136 ± 139	133 ± 138	118 ± 119
Phosphor. (mg)	325 ± 363	461 ± 561	668 ± 689	633 ± 768	521 ± 552
Iron (mg)	3.6 ± 3.5	4.0 ± 4.0	5.7 ± 5.6	5.1 ± 5.4	5.2 ± 4.9
Zinc (mg)	2.8 ± 2.9	3.9 ± 4.0	4.9 ± 5.0	5.0 ± 5.3	4.4 ± 4.3

*** α-tocopherol**
**** number of questionnaires.**

The permanent survey team measured slightly increasing energy content with each subsequently visited atoll (Annex 31). In Haa Dhaal, Laam and Meem atoll the other local survey teams recorded lower energy intake and therefore lower nutrient intake than the permanent survey team, whereas in Gnaviyani and Kaaf atoll this was reversed. These discrepancies influenced the results for the single atolls, and mean that lower energy intake is not necessarily caused by a lower nutrient intake.

Therefore, the nutrient density for 930 kcal, the average caloric intake, was calculated (Table 40). This was about the average energy intake of all atolls.
The averages of the macro nutrients were quite similar. In Kaaf and Meem atoll the amount of protein in the diet was a little higher compared to the other atolls, whereas the proportion of carbohydrate was lowest in Kaaf atoll. In Gnaviyani the dietary fibre intake showed the highest level as did the nutrients thiamine, vitamin B6, folic acid, vitamin C, potassium and magnesium. The nutrient density of Kaaf atoll was high in calcium, riboflavin, and retinol, which is an indicator of the highest use of milk powder in their dietary intake. Meem atoll had

by far the highest level of carotene, surprisingly, because vitamin C was low compared to the other atolls. The nutrient density of Haa Dhaal was lower in some nutrients compared to the other atolls, e.g., for retinol, riboflavin and vitamin C, but the differences were not substantial when Haa Dhaal, Laam and the final 3 visited atolls are compared.

Table 40: Nutrient density for 930 kcal (recommendation) per atolls

Atolls Nutrients	Haa Dhaal Mean ± SD	Laam Mean ± SD	Gnaviyani Mean ± SD	Kaaf Mean ± SD	Meem Mean ± SD
Number***	49	44	63	31	39
Protein (g)	34 ± 9	31 ± 6	31 ± 5	35 ± 4	34 ± 8
Veg. Prot. (g)	11 ± 4	9 ± 3	11 ± 3	10 ± 4	9 ± 3
An. prot. (g)	23 ± 11	22 ± 8	21 ± 6	25 ± 6	26 ± 9
Fat (g)	20 ± 7	22 ± 7	22 ± 5	24 ± 7	20 ± 6
Carboh. (g)	152 ± 21	149 ± 20	149 ± 14	141 ± 16	150 ± 17
Sucrose (g)	56 ± 21	63 ± 21	53 ± 20	45 ± 18	67 ± 22
Diet. Fibre (g)	3.9 ± 1.9	3.3 ± 1.6	7.0 ± 3.7	4.3 ± 2.1	3.6 ± 1.8
Vit. A (µg)	406 ± 226	467 ± 204	486 ± 243	526 ± 184	567 ± 475
Retinol (µg)	389 ± 225	453 ± 205	442 ± 152	488 ± 197	468 ± 183
Carot. (mg)	0.14 ± 0.21	0.15 ± 0.14	0.33 ± 1.27	0.31 ± 0.42	0.64 ± 2.62
Vit. E ** (mg)	2.9 ± 2.0	2.8 ± 1.3	2.8 ± 1.4	3.1 ± 1.8	3.3 ± 2.3
Vit. B1 (mg)	0.47 ± 0.12	0.43 ± 0.09	0.53 ± 0.14	0.47 ± 0.09	0.47 ± 0.12
Vit. B2 (mg)	0.65 ± 0.42	0.76 ± 0.41	0.84 ± 0.36	0.87 ± 0.37	0.69 ± 0.34
Vit. B6 (mg)	0.67 ± 0.19	0.60 ± 0.13	0.72 ± 0.16	0.63 ± 0.11	0.69 ± 0.22
Fol. ac. (µg) *	30 ± 14	31 ± 10	36 ± 11	34 ± 10	29 ± 8
Vit. C (mg)	8 ± 8	18 ± 18	27 ± 41	23 ± 17	11 ± 10
Potas. (mg)	867 ± 382	950 ± 343	1127 ± 295	1028 ± 296	859 ± 274
Calcium (mg)	412 ± 265	532 ± 302	556 ± 226	599 ± 272	417 ± 233
Magn. (mg)	116 ± 28	114 ± 22	122 ± 26	118 ± 22	108 ± 21
Phosph. (mg)	501 ± 172	575 ± 206	604 ± 130	634 ± 197	495 ± 145
Iron (mg)	5.2 ± 1.4	4.3 ± 1.3	4.9 ± 1.1	4.7 ± 1.2	4.5 ± 1.2
Zinc (mg)	4.3 ± 0.7	4.3 ± 0.5	4.5 ± 0.7	4.5 ± 0.6	3.9 ± 0.5

*** folic acid equivalent**
**** α-tocopherol**
***** number of questionnaires per atoll.**

5 Discussion

5.1 Assessment of the nutritional status

5.1.1 Anthropometric assessment

Anthropometric measurements are widely used and adopted internationally as a standard practice [GIBSON, 1990]. To assess the nutritional status common methods like measurement of weight and height were used as growth indicators for the interviewed mothers and their weaned child. It is an easy and quick low cost method and has already been used in Maldives in previous surveys.

Possible measurement errors in weighing are common if the person on the weighing scale is moving or wearing too heavy clothing. Generally, the mothers and children were weighed as they appeared for measurement. Therefore, to estimate this margin of error, some clothing was measured. Children's clothing weighed between 100 g and 230 g, and the mothers' between 300 g and 400 g. Possible errors in measuring height can be incorrect positioning of the measured person or not firmly placing the board against the head, or that a child stands in a slanting position against the board. To avoid inter-personal variations in measuring, all heights were always taken by the same two persons who were members of the permanent survey team and visited all islands. [Gibson, 1990]

It is always difficult to select appropriate reference data to use for comparing a sample population with an apparently healthy population. Categories for risk and cut off points also have to be decided upon. Previous studies have used the United States National Center for Health Statistics (NCHS), which is also recommended by the WHO. Therefore, this study used this as well and set the cut off point of minus 2 SD as an indicator for malnutrition.

5.1.2 Methodology of the dietary intake measurements

To assess nutritional status anthropometric assessment is used as a general indicator for acute and chronic imbalance between nutrient intake and the needs of the body, e.g., protein-energy malnutrition as well as micro nutrient deficiency. Nutritional growth failure or weight loss per se can not identify which particular nutrient is lacking. This was done by recording dietary intake.
Different methods are used for nutritional evaluations to estimate food composition and dietary patterns of population groups. Commonly used methods are estimated food record, weighed food record, 24-h recall, dietary history and food frequency questionnaire. The first two are prospective types of recording food habits during meals, whereas retrospective methods (such as the 24 h-recall, dietary history and food frequency questionnaires) review past dietary patterns. Each method has its own advantages and limitations. A general dilemma in nutritional surveys involves the fact that subjects who are asked to recall their recent intake are limited by memory, subjects who are asked to record their intake as they consume it are

likely to change their intake, and that subjects who are asked to report their usual intake are often unable to generalise with any accuracy. Furthermore, all three methods are potentially affected by various social influences dictating the type of diet that ”should” be reported, and this can produce biased dietary information [LISSNER ET AL., 1998]. The gap between knowledge and controversial behaviour is a well known problem, e.g., in Germany where most people are informed through mass media and education about which foods and diets are best. That this could have some impact in this survey can be seen in the answers of the mothers to the question what the best perceived food of the young child is (e.g. fruit) compared to the actual intake in the nutritional protocols (e.g. fruit intake very low).
The techniques chosen and found to be best for this survey shall be briefly introduced. [GIBSON, 1990; GIBSON, 1993; THOMPSON AND BYERS, 1994]

The **weighed food record** provides quantitatively accurate information. Food and beverages are recorded when food is eaten by weighing them on a scale over a defined period of time. A modified method is the estimated food record where eaten foods and beverages are estimated in household measurements rather than weighed precisely. Disadvantages of both methods are that they are quite time consuming and that they are based on the assumption that the respondent does not change his dietary behaviour during the recording period. The weighed food record was not of major importance in this survey. It was, however, applied to compare portion sizes of meals with those of the 24-h recall and to obtain a realistic basis for defining portion sizes in gram.

The **24-h recall** was decided to be the best method for the questionnaire. In the interviews the participant has to remember the actual foods and beverages consumed the previous day and provide remembered information about portion sizes. It is a useful method to assess the average intake of a population group, but it is an inappropriate method to use to describe dietary habits of individuals because a one day sample is not sufficiently representative. The intention of the survey was to determine nutritional intake patterns of the average Maldivian traditional dishes. The number of different traditional staple foods and the number of dishes are limited in Maldives. Therefore, a relatively small number of questionnaires would be needed to cover most dietary habits and to obtain information about average dietary intake.
Compared to other methods, the particular advantage is that it is a standardized, easy, quick and inexpensive method which minimally burdens the respondents and therefore, has high compliance rates. Additionally, in order to compare possible differences in food intake among the atolls the survey was supposed to cover different parts of the country. Another advantage of the 24-h recall is that literacy of the respondent or a special interest in nutrition is not required. Literacy was only required for the trained enumerators. In most cases, the mothers were willing and motivated to answer the questions in the interview. In situations where additional adult persons from the household or neighbourhood were watching or answering in the interview, the quality of answers might be reduced. In a few cases, when the husband was at home, he often responded instead of, or in addition to the mothers. In general, the enumerators were also highly motivated. During the field work there were school holidays in Maldives and therefore many of the young people had a lot of spare time. It was somewhat of a problem that different enumerators were recruited for each atoll and the necessary training was sometimes inadequate because of lack of time. One effect of this is reflected in the

different results they recorded compared to those findings of the permanent survey team who visited all atolls. Some of the enumerator groups from the islands reported lower energy intake than the permanent survey team, and some groups reported higher energy intake, which is a systematic error because of inter-personal variation. Another source of error arose in the course of the permanent team's survey. The permanent team's findings on energy intake for mothers and children constantly increased as they moved from island to island during the survey (intra-personal variation). One possible explanation for this is that questions were asked more precisely as gaining more experience.

For the respondent, in this survey the mother, the 24-h recall is an element of surprise, so that she is less likely to modify her eating patterns. One problem is that the respondents sometimes palliate real food intake. The probability of correct answers depends on the interview situation. Often people forget or omit little food items that they do not consider important enough to mention, like fruit, snacks, or sweets. By systematically asking about all meals and in-between meals common in Maldives we tried to limit this error. For example, it was surprising that bananas rarely appeared in the questionnaire. Although 79 % of households reported growing bananas, the average reported intake of mothers and children was about 4 g/day, which on average would be one fresh banana every twelfth day. Bananas are not expensive and are available throughout the year. Candies were never mentioned in the 24-h recall although several times it was observed that children were eating them even during the interviews. Such sweets only have an impact on the calorie intake and proneness for caries, but not on the micro nutrient intake which was of most interest in this survey. In general, the small variety of foods available and consumed in Maldives helped the respondent to remember the consumed foods better. Further, respondents with lower observed intake in general tend to over report their intake while those with higher observed intake tend to underreport their past intake [THOMPSON AND BYERS, 1994]. This tendency is reflected in the average nutrient intake of mothers with higher and lower BMI. The mothers with a higher BMI reported a lower nutrient intake. BINGHAM (1987) states that the 24 h-recall method, on average, underestimates food intake due, for instance, to limited memory, selective omissions, insufficient interviewer probing. This is especially the case for children [GIBSON, 1990] perhaps because the mother is not always present when the child eats or that the child receives additional foods from other persons which the mother does not know about. On the other hand, it was observed, that the mothers were quite good in remembering meals and portion sizes of the previous day. One reason was that most of them were involved in the preparation process of meals. They were also not seldom the person who looked after the children during meals. The interviews were often a combination of reported accurate food intake from the day before and general dietary habits, especially information about portion sizes which seem to be quite similar every day, e.g., portion sizes for roshi and rice or the amount of sugar and milk powder in tea. When the mother stated that one of the meals of the previous day was atypical for her or her child, the usual meal pattern was recorded instead. It was, nevertheless, difficult to ask and define the reported portion sizes in gram, especially for rice and tuna fish. One spoon of rice can have different amounts of rice and the different estimates of fish in inches was also difficult to interpret.

Another weakness of the survey was that it was only conducted for a two month period and therefore did not consider seasonal effects. To avoid such limitations interviews should be

performed during different seasons. Some agricultural products might not appear in the results because it was not the season for certain types of food products. Fridays which are the weekly holiday when special nutritious meals like chicken curry might be cooked more often were included because food intakes of Fridays were reported in the interviews on Saturday.
Briefly reviewed, the 24-h recall was a suitable method for Maldives. Sources of error in the 24-h recall have to be kept in mind when interpreting the results. Omitting foods, adding foods, estimating portion sizes and day to day variations can be limiting factors [GIBSON, 1993].

5.1.3 Computer calculation of the 24-h recall

The Ebis computer programme, which was primarily designed for use in Germany, had to be modified for the Maldivian situation. This was mainly done by defining portion sizes of commonly used household measurements like teaspoons, tablespoons, glasses, cups and other kinds of spoons in gram. Special spoons often used for rice were called a rice spoon and for curry a bowl spoon. These were also translated into the Maldivian language Dhivehi. The collected recipes were entered into the Ebis programme. Often, cooking losses were not considered because recipes were mainly entered as a raw ingredient when information about the nutrients in cooked form was unavailable. Fat content from fried products was calculated according to similar fried foods consumed in Germany which have been measured as cooked meals. Therefore, these recipes are only a rough approximation to real contents. There was no other option because Maldivian food items have not yet been analysed. The fact that a Maldivian food table is unavailable is another possible source of error because some nutrients in certain agricultural products, e.g., minerals like selenium strongly depend on the soil in which they are grown. Some foods were taken from an Indian food composition table [GOPALAN ET AL., 1991] and others from the German nutrient databases BLS instead. In the Ebis programme the Indian products were marked separately (in bracket ind.) or if the label of commercial products was used, the brand name was written in bracket. Another limiting factor is that for fish generally tuna fish was taken, although a small proportion of mothers mentioned reef fish during the interviews. But for reef fish no nutritional values were available.

A further potential error is the source of the food composition table. Up to now, several analytical methods have been used for nutrients in different food composition tables. Some of them are unsatisfactory or out of data [GIBSON, 1990]. Losses in micro nutrients due to handling and storage procedures, stage of ripeness and method of food preparation and cooking procedures are not considered.

It also has to be kept in mind that all food composition values represent the total amount of the constituent in food and not the absorbed and utilised amount. But bioavailability of nutrients from different diets are different. This is not considered while applying food composition tables [GIBSON, 1990].

5.1.4 Validity of recommendations

The daily dietary intake is defined as the individual's average intake persisting over moderate periods of time without necessarily being present in those amounts every day [WHO, 1996]. Until now, it has not been possible to measure and define an individual's daily intake so precisely that all specific requirements are met. The necessary amount of nutrients often can only be calculated to prevent visible deficiencies, but, in general, higher amounts are necessary for optimal metabolism. Additionally, individuals differ in their requirements even though they may have the same general characteristics like age, sex, physical activity, and body size. Therefore, the recommendations mainly cover average requirements of a group of individuals, e.g., young, adult women, etc. Such RDA are often based on experienced values and, therefore, may differ among countries and continents. Several important factors influence these requirements. Firstly, the average intake of the healthy population including a safe range is calculated for many nutrients in a specific region or country. Secondly, the recommendations also depend on the availability of nutrients according to the traditional available food items. Thirdly, to keep them realistic and obtainable for the majority of the population the recommendations are kept lower in certain regions or countries even though some scientists would prefer higher intake. Generally, recommendations represent mean intake for a population and not for an individual. The intake of the individuals is often normally distributed around the mean value. An individual food intake of 2 SD above or below the mean value is still within an acceptable range. [BIESALSKI, 1996a]

For the Maldives there have as yet been no special recommendations for the country. Therefore, the recommendations of the neighbouring country, India, were chosen as reference to compare the results of the 24 h-recalls. In India and Maldives some of the nutritional habits are similar like the consumption of rice with curry or certain short eats. Some foods regularly consumed in Maldives are imported from India. But in general the Indians seem to consume a lot more vegetables and fruit [GOPALAN ET AL., 1991]. Therefore, the recommendations for India have to be looked at critically when being applied to Maldivian conditions. For example, the recommendations for dietary fibre are rather unrealistic for Maldivian dietary habits, because unrefined cereals, which have the highest fibre contents, are not consumed in Maldives. However, the value of carotene can be reached through the consumption of locally grown vegetables and fruit. If the Indian recommendations were not available, the WHO recommendations were applied instead. These recommendations are specially designed for countries with generally low nutrient intake. For nutrients not included in the WHO recommendations the USA-RDA were used.

5.2 Nutritional status

5.2.1 Anthropometry

5.2.1.1 Mothers

The BMI of non-pregnant mothers in a previous survey [DPH, WHO MALE, UNICEF MALE, 1994] was reported on average to be 21.3 ± 3.8 which is very close to the result in this survey of 21.8 ± 4.0.

5.2.1.2 Children

In the reference curves (Figure 11, 17 and 18), only 2.3 % of the children are below –2 SD for the three indicators WFA, HFA and WFH. In Maldives the percentage of children found below –2 SD was much higher which is a sign of possible risk of nutrient deficiency. The percentage of children below –2 SD for WFH, indicating acute malnutrition, is looked at as particular good indicator to use for comparing groups [EARLY WARNING AND PLANNING SERVICES, 1990]. The classification is shown in Table 41.

Table 41: Classification of the percentage of children below –2 SD for WFH.

Percent < –2 SD for WFH	Indicator
< 5	Good
6-10	Satisfactory
11-20	Poor
> 20	Serious

If more than 10 % of the children are below –2 SD for WFH, relief assistance is indicated. More than 20 % point to a serious situation. The situation of all atolls together was poor (14 %). The children in Laam (10 %), Gnaviyani (10 %) and Kaaf (11 %) atolls were in the border between satisfactory and poor and in Haa Dhaal atoll (20 %) between poor and serious, whereas the children's acute nutritional status in Meem atoll (22 %) was found to be serious.

The NATIONAL NUTRITIONAL SURVEY, conducted in 1994, reports that the prevalence of -2 SD of WFA, HFA and WFH has decreased significantly since 1981. The comparison between the last 2 surveys (without the capital) and our survey is shown in Table 42.

Table 42: Comparison of the last 3 surveys.

	National Nutritional Survey, 1994	Mald. Multiple Indicator Survey, 1996	This survey, 1997 and 1998
< - 2 SD of WFA (**undernutrition**)	39 %	49 %	51 %
< - 2 SD of HFA (**stunting**)	30 %	32 %	41 %
< - 2 SD of WFH (**wasting**)	16 %	19 %	14 %

The proportion of underweight children is nearly the same between the survey in 1996 (49 %) and this survey (51 %), whereas the reported percentage in 1994 was lower at 39 %. However, the prevalence of stunting increased considerably. For the two previous surveys the percentages were about the same with 30 % and 32 %. In contrast, this survey found 41 % of its sample population were stunted whereas for wasting, which indicates the acute situation, the two previous surveys reported 16 % and 19 % compared to 14 % measured in this survey. The fact that the distribution of the age groups was quite different in this survey could be one possible reason for the different percentages, especially in stunting. In the NATIONAL NUTRITIONAL SURVEY 65 % of the children were 2 years and below including children from 0 to 12 month, whereas only 5 % of the children in this survey were between one and two years of age and the rest were even older. The MALDIVES MULTIPLE INDICATOR SURVEY also included children from 0 to 60 months. Because the prevalence of stunting and underweight increases with age, which has been stated in all three surveys, this would explain the higher percentage of children with risk for chronic malnutrition in this survey. Another possible explanation is that this survey does not represent all children in this age group, but preferably those who were not breast fed at the time of the survey. It could be that the nutritional status of children who still receive breast milk is slightly better.

In Male, in 1996 the reported percentage of children below –2 SD for WFA, HFA and WFH was lower compared to the rest of the country (23 %, 10%, 9 %). [UNICEF MALE, 1996]

Compared to India where the reported percentage of underweight, stunting and wasting are 53 %, 52 % and 18 % [UNICEF, 1998] the percentages are lower in Maldives although it is above the percentages of the low income countries (36 %, 43 % and 9 %) [DE ONIS ET AL., 1993].

5.2.2 Plasma analysis

Plasma level of nutrients are nutritional biomarkers which reflect relationships between diet, nutritional status, susceptibility to diseases and disease processes [NELSON, 1998]. For some vitamins clinical signs of deficiency are not very specific and visual signs often appear when there is already a severe state of deficiency. Therefore, plasma vitamin levels are useful to detect subclinical or marginal deficiency states. Some measurements are already in international use with internationally recognized standards, however, there are still some factors which impair the interpretation of the results. Such factors are homeostatic regulation of nutrients, variations over time, diseases, especially infections, and current nutritional habits. Furthermore, plasma levels of nutrients depend on characteristics of the individual like age, sex, ethnic group, hormonal status, and physical activity. [GIBSON, 1990]. Because only 15 blood samples from one atoll could be taken, the results have to be interpreted with caution and generalisations for the whole country can not be drawn from these results. They do, however, supply useful additional information for interpreting the results of the 24 h-recalls and the anthropometry.

5.2.2.1 Vitamin C

Plasma ascorbic acid concentrations are the most frequently used and practical index of vitamin C status in humans. Plasma levels are influenced by the recent intake of vitamin C, especially, when intake is high. Therefore, the collection of fasting blood was essential. With increasing dietary intake the plasma levels increase until 1.4 mg/d [Gibson, 1990]. According to NELSON (1998) vitamin C in blood is considered rather a poor marker at low levels of intake, increasing in sensitivity as a marker of intake across the middle range of intake, and is poor once again at high levels of intake where excess vitamin is excreted in the urine. Plasma levels of ascorbic acid are lowered by several non-nutritional factors, like acute stress, different infectious diseases, heavy smoking or contraceptive agents. Plasma levels below the cut off point of 0.2 mg/dl are associated with clinical signs of scurvy. This level also indicates intake of vitamin C below 20 mg/day. In other publications marginal vitamin C deficiency is defined from 0.2 to 0.29 mg/dl [SAUBERLICH, 1981] or from 0.2 to 0.39 mg/dl [GIBSON, 1990]. According to the findings of long term laboratory research in Stuttgart/Hohenheim where the plasma levels were measured, a plasma level between 0.2 and 0.5 mg/dl defined marginal deficiency. Then 4 mothers suffered from a marginal deficiency, whereas according to the other cited definitions no mother (0.2–0.3 mg/dl) or one mother (0.2–0.4 mg/dl) would fall into this category. Laboratory research has shown that plasma levels between 0.5 and 0.75 mg/dl correlate with a low vitamin C supply according to the German recommendations (75 mg/day for adult women [DGE, 1995]). 9 of the 15 mothers would fall into this category. This level is still acceptable, but not optimal for vitamin C to fulfil all its functions. The results of the average vitamin C intake of the 15 mothers (24 ± 35 mg/d) also indicate a rather low plasma level which is close to the total average intake of all atolls (21 ± 29 mg/d).

5.2.2.2 Retinol

Vitamin A is stored in the liver. The liver regulates the blood level homeostatically. Even though there is a marginal deficiency the liver continues to keep the plasma level in a normal range as long as possible. Therefore, plasma levels as used in this survey are not a suitable indicator of marginal deficiency. But other methods are either too time consuming like the relative dose response test or are not practicable in a survey like ours, e.g., a liver biopsy. Therefore, the plasma retinol level is still often used. Despite these difficulties of assessing vitamin A status through plasma levels, different levels are given to state a normal, marginal (< 0.70 µmol/l) and deficit (< 0.35 µmol/l) vitamin A level [GIBSON, 1997]. Then 2 mothers had a marginal deficiency of vitamin A. According to BIESALSKI (1997) plasma levels of vitamin A below 1.05 µmol/l are already indicative of a marginal deficit. In this case 6 mothers were affected, or 40 % of the tested mothers. This indicates that there are probably certain women at risk. One mother was above the upper level of 1.75 µmol/l, but levels up to 2.45 µmol/l are still reported as normal [BIESALSKI, 1997].

5.2.2.3 α-Tocopherol

The concentrations of α- and χ-tocopherol in plasma are the most frequently used biochemical indices of vitamin E status. It is still questionable if they are a good index of tissue stores [GIBSON, 1990]. But the plasma tocopherol level seems to show a more or less linear relationship between blood and dietary levels across a broad range of intake [NELSON, 1998]. In the plasma tocopherol is mainly transported in the lipoproteins together with fat and other fat soluble substances. In adults, the tocopherol plasma level is closely correlated with cholesterol and total lipid concentrations. The supply also has to be seen in correlation to the PUFA intake. [GIBSON, 1990]

In 1994, a German study with 1951 volunteers reported an average α-tocopherol plasma level for males and females of 30.6 ± 0.2 µmol/l [HESEKER ET AL., 1994]. The plasma level of the Maldivian women was only half of this. But fat and caloric intake is much higher in Germany so that the plasma α-tocopherol level is expected to be higher than in Maldives. Therefore, the plasma α-tocopherol level might be in an acceptable range in terms of the Maldivian diet. Three mothers were found below the cut off point 11.6 µmol/l, which is associated with a low vitamin E status. Keeping the small sample size in mind, this indicates that there might be groups in the population who are not receiving sufficient vitamin E.

5.2.2.4 ß-Carotene

ß-Carotene in plasma is a good indicator for vegetable and fruit intake. In Maldives due to the availability of fruit and vegetables which are rich in carotene the level would be expected to be high. But the resulting plasma levels show that ß-carotene was rarely consumed. 13 mothers (87 % of the tested mothers) were below the cut off point of 0.3 µmol/l and, therefore, had an insufficient supply. For 6 mothers ß-carotene was not detectable. A plasma level of 0.2–0.3 µmol/l corresponds with ß-carotene intake per day of 0.5 mg or even less. This corresponds with the findings of the mothers' nutritional interviews (0.36 ± 1.35 mg). Only one mother reached a plasma ß-carotene level of 0.5 µmol/l which would mean an intake of 2-5 mg per day. [BIESALSKI, 1995] Studies propose that the level 0.5 µmol/l probably has preventive effects, e.g., against diseases like cancer [BIESALSKI, 1997].

5.2.2.5 Cholesterol

Cholesterol plasma levels are not constant. For example, they can be influenced by stress situations. Non nutritional factors like age and sex also influence plasma concentration. The level is regulated by cholesterol intake and the body's own synthesis. If cholesterol intake is high, then the synthesis is reduced. For Germany, a dietary intake of 500 mg to 750 mg is regarded as normal [BIESALSKI, 1995]. For the Maldivian mother's the cholesterol intake was calculated at 56 ± 52 mg/day. Still if the standard deviation is considered, the intake is far from the required acceptable intake in Germany. The main cholesterol sources in the diet are fish (which is possibly quite low, especially tuna fish because of its low fat content) milk powder, poultry and eggs. Besides this, other nutritional factors influence the plasma cholesterol level. A high fat intake increases the plasma cholesterol concentration, especially the saturated fatty acids, whereas the unsaturated fatty acids seem instead to have a positive effect [KASPER, 1996]. In general, the fat intake observed in this survey was too low. This corresponds to the plasma cholesterol levels which were in a good range (148 mg/dl) compared to the German recommendation of 200 mg/dl plus age. Therefore, cholesterol does not seem to be a risk factor for these mothers for diseases like arteriosclerosis and coronary heart disease which are common health problems in Germany.

5.2.2.6 Folic acid

Homocysteine is an amino acid which is built up as an intermediary metabolite in the metabolism from methionine to cystine. This reaction takes place in every cell of the body. Folic acid, pyridoxine and vitamin B12 are cofactors in this reaction. A deficiency in one or more of these vitamins leads to an intracellular and extracellular accumulation of homocysteine. An increase in the concentration of homocysteine is discussed as a risk factor for cardiovascular diseases. Negative influences on memory and intelligence performance are also possible effects [NAURATH, 1996]. An increasing homocysteine level is a sensitive indicator of a deficit in one of the three vitamins folic acid, vitamin B6 and B12. This can even be the case, if the plasma levels are still in a normal range [Till, 1996]. Because among the three vitamins folic acid has the highest probability of being deficient, homocysteine is used as an indicator for folic acid deficiency. The cut off point is, however, still a matter of discussion. Studies with emphasis on cardiovascular diseases show that blood levels between 11 and 15 µmol/l indicate a risk, which is correlated to a low intake of one of the three vitamins [Pietrzik, 1996]. If the homocysteine level has no genetic cause, it can be lowered by supplementing folic acid, pyridoxine and vitamin B12.

In this study the higher homocysteine levels were probably influenced by low folic acid and vitamin B6 intake. The recorded intake in the nutritional interviews of the 15 mothers, but also of all mothers together, was low for both vitamins (15 mothers: vitamin B6: 1.2 ± 0.4 mg/d and folic acid: 36 ± 15 µg/d, which makes 60 % and 36 % of the Indian RDA; all mothers: vitamin B6: 1.0 ± 0.5 mg/d and folic acid 34 ± 24 µg/d). The plasma level of 10 mothers was above 11 µmol/l and of 5 mothers above 15 µmol/l. Altogether with the rather low dietary intake, this indicates probable risks of folic acid and vitamin B6 deficits.

5.2.2.7 Iron

Three stages describe the development of iron deficiency [Cook and Finish 1979]. The first stage is characterised by a progressive reduction in the amount of stored iron in the liver. The iron haem is normal while ferritin concentrations are already decreased. In the second stage, the iron stores are completely diminished. The haemoglobin level still remains within a normal range, the erythropoitic cells produce erythrocyte protoporphyrin, a precursor of haem, because of an insufficient supply of iron in these cells. 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. To measure iron deficiency several parameters can be used like haematocrit, ferritin, erythrocyte protoporphyrin, and others which indicate a special stage of iron deficiency. Measurement of the concentration of haemoglobin in whole blood is probably the most widely used screening test for iron-deficiency anaemia, although the method is relatively insensitive and has several limitations like age, sex, and race dependence. Low haemoglobin values are also found in people with diseases like chronic infections and inflammations, haemorrhage, protein-energy malnutrition, vitamin B12 and folic acid deficiency, etc. [Gibson, 1990] None of the measured mothers was found with a level below the WHO cut off point of 12 g/dl, indicating that none of the 15 mothers was at risk for stage three of iron deficiency [ACC/SCN, 1991].

5.2.3 Nutrients

The term ”protein-energy malnutrition” is very commonly used. Children and adults who suffer from an inadequate intake of protein and energy often have parallel deficiencies in minerals like iron, zinc, potassium, magnesium and calcium as well as in vitamins like vitamin A, C, E or D. Furthermore, the intake of essential amino acids and essential fatty acids can be affected. Therefore, some scientists plead for a new term called ”multi-nutrient deficiency” [SCHERBAUM AND FÜRST, 1999]. A long time before clinical signs of severe malnutrition such as kwashiorkor and marasmus develop, there is a marginal deficiency, and often a mild chronic deficiency of macro and micro nutrients. Except delays in growth, loss of weight and proneness to infections and diseases there are no clinical syndromes to indicate malnutrition. GOLDEN (1996) differentiates between nutrients of type I deficiencies and nutrients of type II deficiencies. Micro nutrients with characteristic clinical signs and symptoms which have a specific pathway in the body like iron or retinol belong to type I deficiency. According to this classification selenium, iodine, copper, calcium, manganese, thiamine, riboflavin, ascorbic acid, tocopherol, calciferol, folic acid, cobalamin and pyridoxine belong to the type I nutrients. Type II unites these nutrients which build the blocks of the tissues. They are used ubiquitously in the body, fluctuate according to daily input because they are not stored in the body and have no characteristic signs of deficiency except immediate growth retardation. Nitrogen, sulphur, essential amino acids, potassium, sodium, magnesium, zinc, phosphorus, and water belong to this category of nutrients. According to GOLDEN they control each other’s balance. Therefore, a deficiency of one of these nutrients results in catabolism of tissues and loss of all its components. Resynthesis can only take place when all nutrients are in balance. The response to a mild chronic deficiency of any of these nutrients would be stunting. The extent would be determined by the degree and duration of the deficiency. Acute deficiency would lead to tissue loss and wasting in both adults and children. Stunting as well as wasting is found in Maldivian children. It has to be emphasized, that also a deficit of the so called type I nutrients, e.g., iron or iodine leads to growth failure.

In the following the different nutrients calculated from the interviews are discussed in comparison to the recommendations, plasma analyses and nutritional status. To interpret the nutritional intake of the mothers and children, the fulfillment of the dietary intake according to the different recommendations were divided into following groups:

> 125 %	high supply
75 – 125 %	sufficient supply
< 75 %	insufficient supply

The cut off point of 75 % for an insufficient supply was also used by HOUSHIAR-RAD ET AL. (1998).

The limitations in interpreting the results of the nutritional interviews have already been discussed in chapter 0 and 0. Further, it was not considered in the interpretations if the mothers reported giving their children vitamin supplements or not. 71 % of the mothers reported giving no vitamin supplements whereas 29 % reported using them for the index child. The given supplements were mainly vitamin A, D including sometimes vitamin C. Iron supplements were also given.

5.2.3.1 Energy:

According to the WHO definition the energy requirement of an individual is defined as ” the energy intake which will balance energy expenditure when the individual has a body size and composition and level of physical activity consistent with long-term good health; and that will allow for the maintenance of economically necessary and socially desirable physical activity. In children and pregnant or lactating women, the energy requirement includes the energy needs associated with the deposition of the tissues or the secretion of milk at rates consistent with good health” (FAO/WHO/ UNU 1985). As mentioned in the quotation, the energy need depends on different factors and varies with age, sex and body proportion (weight and height). These factors were considered in the calculation of the energy requirement of the mothers (1685 kcal) using the Ebis programme. Further factors like body composition are important because of different metabolic rates in different tissues. The climate is also of interest because temperatures above 30 °C increase the energy needed for sweating. Genetic differences may play a role between different ethnic groups. Important factors for increased energy need are diseases, especially infections with fever. The energy intake is not only increased during the illness, but also in the recovery phase after illness. Last but not least, activity influences the energy need. For children, the energy for growth has to be considered in the calculation.

For the Maldivian mothers the energy requirements are based on sedentary physical activity, although the work in and around the house can not be called sedentary work. The genetic effects can not be considered, but it is assumed that the mothers are probably adapted to lower caloric intake from childhood on. The numbers of children with wasting, stunting and underweight and the average small height of the mothers (149 cm) provide some indication of this. Compared to the calculated energy requirements, the actual calculated energy consumption was at the lowest level (75 %) of the above given definition for a sufficient supply. But this can also be influenced by underestimating or not reporting food during the interviews. The average of the last three visited atolls (Gnaviyani, Kaaf, Meem) of 1490 kcal is 89 % of the recommendations, which is probably more realistic also for the first two atolls Haa Dhaal and Laam (1016 kcal and 1032 kcal). The BMI of the mothers per island does not show any correlation with the reported energy consumption. The average BMI (22) was in an acceptable range, which leads to the assumption that the mothers seemed to have a rather balanced energy intake and energy expenditure. A further interesting finding was that the BMI did not increase or decrease with age, except for the mothers below 20 years. In several low-income countries the BMI decreases with age of the mothers due to a high number of pregnancies and low energy and nutrient intake. Often, just the opposite occurs, i.e., BMI increases with the age and the number of children. In this survey the BMI was stable and increased slightly with the number of children.

Obesity seems to be a minor problem. Only 8 % of the mothers had a BMI over 27.5 and 3 % a BMI of 30 and above. Obesity is reported to be an increasing problem with increasing affluence, changing lifestyles and occupational patterns in South East Asian countries. These changes have a certain impact on dietary patterns, for example, that more animal foods and fat, and more processed foods are consumed. For the region South East Asia it is expected that this problem will increase in the coming years and will lead to increasing degenerative diseases like coronary heart disease and diabetes, especially in urban areas [GOPALAN,1994].

In Male, the capital and centre for imports and distribution of food products, the variety of commercial food products is the highest in Maldives. This leads to quicker changes in traditional nutritional habits than in other parts of the country. Due to lack of space almost no agricultural cultivation is possible. This influences working patterns which, in turn, have an impact on nutritional habits making fast food and short eats more preferred meals during the day. In the future, it might be useful to conduct a survey in Male with special emphasis on changes in dietary habits due to changes in lifestyle and occupational patterns comparing caloric intake and risk factors to diet related diseases.

On the interviewed islands a noticeable number of mothers suffer from underweight (22 % BMI < 18.5). This is not only a risk factor for mothers themselves during illness, pregnancy and lactation, but that their children are at risk of having low birth weight. As mentioned above, an energy deficit is often combined with micro nutrient deficits which is also important for the development of an embryo and infant. The highest percent of underweight women were not older than 20 years (33 %). Many of these women are still growing themselves and have a higher energy need than older women. Together with the reported low height of women, the three most important risk factors for a low-birth weight baby (< 2.5 kg) are described in the introduction. The percentage of infants with low birth weight in Maldives is 20 % which is a little higher than the average of 17 % for low income countries [UNICEF, 1998]. But within this age group (≤ 20 years) there was also a high percent of obese women (13 %). This might be an indication that the pattern of food consumption has already changed to imported, energy rich foods which are often poor in micro nutrients. Additionally, the small number of mothers in the younger and older age groups could have influenced the results.

According to the HOUSEHOLD INCOME AND EXPENDITURE SURVEY in 1981, the average energy intake for men ranged from 1935 kcal, 1980 kcal to 2053 kcal calculated for different income groups whose RDA was estimated to be 2500 kcal. The average height was 1.6 m and weight was 57 kg. This would make an average BMI of 22. This complies well with the BMI and energy intake of the mothers in this survey. Men have a higher energy intake than women and normally eat first in Maldivian families. If the men's energy intake remains low, this supports the assumption that the Maldivian diet in general is low in energy and fat.

The energy intake of the one to three year old children was just barely sufficient and was insufficient for the 4 year old children. This finding is confirmed by the percentages of wasted (14 %), stunted (41 %) and underweight (51 %) children, although the low energy intake might additionally be influenced by the cited problem of underreporting children's energy and food intake. The results of the interviews show slightly increasing caloric intake with age, but the reported energy intake for the 4 year old children was the worst compared to the requirement. The highest prevalence for wasting, indicating acute malnutrition, was in the 3 years old children. The fact that a 4 year old child is less dependent on the care of the mother than the younger children might partly explain this finding. At this age children might start to take foods themselves or might receive food from neighbours during the time they are playing outside of the house, and this is not observed by their mothers and was therefore not reported. Altogether, the nutritional protocols as well as the anthropometry of the children lead to the conclusion that the energy intake was probably too low.

5.2.3.2 Macro nutrients:

The total energy intake can be broken down according to the macro nutrients protein, fat and carbohydrates. These nutrients are in an acceptable range for adults if they are distributed as seen in Table 43 [GOPALAN ET AL., 1991; GARROW AND JAMES, 1993]. For women of reproductive age the FAO (1993) recommends consumption of fat for at least 20 % of energy requirement.

Table 43: Source of energy in percentage of total energy intake as recommended for adults and as result of the dietary survey from mothers.

Recommendation for adults	Results of non-pregnant mothers
10 – 15 % protein	14 %
20 – 30 % fat	17 %
55 – 70 % carbohydrate.	69 %
< 10 % sucrose	15 %

Looking at the results of the nutritional interviews compared to the recommendations the mothers were within the percentage range for protein with a value of 14 %. Fat was lower (17 %) and the carbohydrates at the upper level of the recommendation (69 %). This confirms the results of previous reports which found that the Maldivian diet is rich in carbohydrates [SPECKHARDT, 1992]. According to the FAO (1993) the fat energy ratio in Maldives was 14 % for 1988-90, which is lower than the findings of this survey. But the total fat intake (39 g compared to 24 g in the mothers' diet in this survey) and the average energy intake per capita and day (2400 kcal) was higher compared to our results for the mothers and the HOUSEHOLD INCOME AND EXPENDITURE SURVEY, 1981.

The DIETARY GUIDELINES FOR AMERICANS (1995) recommend that children's fat intake should be gradually decreased beginning at 2 years of age to reach no more than 30 % of energy by the time children are 5 years old. The German DGE requirement (1995) for fat is 35-40 % of energy for the 1-3 year old children and 30-35 % for the 4-6 year old children. Compared to this the interviewed Maldivian children were far below this recommendation with an average fat intake of 21 % plus low energy intake. The fat intake of the 4 year old children even decreased below 20 %. SKINNER ET AL. (1997) conducted a survey to determine the nutrient and food intake of healthy, white infants from families of middle and upper socio-economic status in the USA and compared it with the current recommendations. Comparing the energy intake the diet of the 1 and 2 year old children in this survey was about 300 kcal lower than the energy intake of the 12 months old US children who about reached the Indian RDA (1240 kcal for 1-3 year old children). A further big difference was the higher proportional fat intake between the Maldivian children (22 % and 23 % in the 1 and 2 year old children) and the US children (32 % and 30 % at the age of 12 and 24 months) as seen in Table 44. As consequence the proportional carbohydrate intake was higher in the diet of the Maldivian children. The proportional protein intake was about the same.
Although the percentage of fat intake was much higher for the American than for the Maldivian children SKINNER ET AL. interpret their results as a proportional low fat intake which has been indicated as a potential problem for these children. This leads to the assumption that Maldivian children are even more at risk for low fat intake.

Table 44: Comparison of macro nutrient intake between the 1 and 2 year old children in this survey and the 12 and 24 months old children in the survey of SKINNER ET AL., 1997.

Age Nutrients	1 year	2 years	12 months	24 months
Energy (kcal)	894 ± 337	921 ± 321	1173 ± 350	1292 ± 414
% protein intake of energy	15	15	14	14
% fat intake of energy	22	23	31	30
% carbohydr. intake of energy	63	62	55	56

Carbohydrates have to be differentiated in order to interpret the results adequately. For the mothers the calculated sucrose made up 15 % of the energy intake or 46 g/d. This is twice as high as the WHO recommendation of 1990 for non-starch polysaccharides (16–24 g/d). In Germany it is recommended that the sucrose intake should not be higher than 10 % of the energy intake [DGE, 1995]. The mothers were comparatively higher at 15 %. In the children's diet the sucrose intake even went up to 25 % of the energy intake. Sugar is a high risk factor for caries. If drinks with high amounts of sugar are given before meals the children don't feel hungry during the meal and might eat less. The third disadvantage is that sucrose only contributes to the energy intake, but not to the micro nutrient intake. Additionally, other carbohydrate rich foods which are mainly consumed in Maldives such as parboiled rice and refined wheat flour are also low in micro nutrients. This lack of micro nutrients has to be compensated for by other foods rich in micro nutrients to prevent deficiencies and contributes to low intake in **dietary fibre**. This again can lead to well known problems like constipation which was reported as a problem in Maldives during some conversations with the investigator. There are different types of fibre in foods and their function differs with their chemical structure. Dietary fibre increases the faecal weight and lowers the colonic transit time. Furthermore, the water soluble fibres are fermented and used as an energy source in the cells of the colon. Dietary fibre also influences cholesterol, glucose and fat metabolism. Low intake of dietary fibre is proposed to have a negative effect contributing to the so called "diseases of civilisation" e.g. constipation, gastro intestinal diseases, gallstones and coronary heart diseases [ENGLYST AND KINGMAN, 1993]. Dietary fibre, on the other hand, decreases the absorption of minerals like calcium, magnesium, iron, zinc and protein, especially if eaten in high amounts, which is not desired. Therefore, some scientists [GOPALAN, 1994] recommend foods rather low in dietary fibre if the nutrient intake is low. But usually high fibre foods are also higher in mineral contents, so that this effect is usually counterbalanced. Great Britain, where intake of dietary fibre is rather low, has an average intake of 12.4 g/d. In Japan, where rice and fish belong to the staple food like in Maldives, the intake of dietary fibre is 10.9 g/d [ENGLYST AND KINGMAN, 1993]. The results of this survey show that Maldives was lower in comparison to these two countries (8 g/d, and without Gnaviyani 6 g/d). So the proclaimed 40 g/d of India [GOPALAN ET AL., 1991] might be realistic applied to India, but not to Maldives. An international recommendation [KING AND BURGESS, 1992] gives a general guideline that adults should eat about 30 g/d. The results in Gnaviyani show that through locally grown carbohydrate rich foods like yam (which is a staple food in Gnaviyani) it is possible to significantly increase the content of fibre in the diet (15 g/d) although the level is still half of the recommendation. A regular intake of sweet potato and breadfruit also increase dietary fibre as do other vegetables and to some extent green leafy vegetables (GLV). This

would also increase the micro nutrient intake. In contrast, it has been reported that grains like maize, millet and sorghum are declining in the Maldivian diet [CHAKRAVARTY, 1995]. For South East Asian countries it has also been reported that millet, once the staple food of poor rural groups, is steadily being replaced by wheat and rice, especially by the highly milled varieties [GOPALAN, 1994].
The children's dietary fibre intake was also low at nearly 5 g/d for both age groups compared to the DGE recommendation (1995) for the 4-6 year old children at 22.5 g. Here again the intake was significantly higher in Gnaviyani (8 g/d) compared to the second highest atoll (Kaaf with 6 g/d).

To assess the total amount of **protein** intake, the source of protein and the amount of foods high in fibre have to be considered. Fibre decreases the digestibility of protein. Furthermore, animal protein is better digestible than vegetable protein. Therefore, an international recommendation [KING AND BURGESS, 1992] differentiates between a diet high in fibre and low in animal protein with 48 g/d for the mother and 23 g/d or 26 g/d for the 1-3 and 4-6 year old children respectively. For a diet low in dietary fibre and high in animal protein the recommendation is 41 g/d for the women and 14 g/d or 18 g/d for the children aged 1-3 or 4-6 years respectively. The second recommendation applies more closely to the Maldivian nutritional situation because of a diet low in dietary fibre and high intake of animal protein through fish and milk powder. Fish protein is easy digestible and has a high amino acid score. If this recommendation is seen in comparison to the calculated average protein intake per day, the supply of the mothers with protein was sufficient. The protein need of the children in both age groups was also easily covered quite well, especially for the younger children because of the higher amounts of milk powder in their diet. Therefore, if enough fish and small amounts of milk powder in tea is consumed, the diet should provide enough protein.

The Indian RDA for **fat** (with 20 g/d) is rather too low for the mothers, considering that fat only makes 17 % of the reported energy intake. An international recommendation [KING AND BURGESS, 1992] proposes 59 g fat for mothers of child bearing age. Comparatively, the interviewed mothers only reached 41 % of this. Increasing the availability and consumption of dietary fat is often considered a priority for overcoming the problems of protein-energy malnutrition [FAO, 1993]. Generally, the fat content of the Maldivian diet is low, especially when tuna fish , which is not high in fat, is consumed as garudiya fish (boiled fish) or curry with rice or roshi rather than as fried fish or fried snacks. In Maldivian diet fat sources are mainly, on the one hand, vegetable oil and fish which contain a high percentage of polyunsaturated fatty acids, and on the other hand, coconut and milk powder which are rich in saturated fatty acids. Misgivings that coconut fat is a risk factor for high cholesterol plasma levels because of saturated fatty acids is unfounded. This would be more of a problem in countries with high animal fat intake, rich in saturated fatty acids and cholesterol. The cholesterol level of the 15 tested mothers in the plasma underscore this very well. All mothers were far below the German recommendation (200 mg/dl plus age) which should be not exceeded. Therefore, if people reduce the coconut consumption, an important energy source in the diet is reduced, too. It is more preferable to increase the use of coconut in the traditional diet instead of vegetable oil which is used for frying foods. Coconut, used as grated coconut or

coconut milk, is processed fresh, whereas the vegetable oil is often exposed to the sun in transparent plastic bottles and stored in the tropical heat until the bottle is empty. These two factors decrease the vitamin E level and affect the polyunsaturated fatty acids. Further, coconut is available for all families in Maldives and is therefore not expensive. Coconut eaten as whole fruit also contains fibre, vitamins and minerals which could additionally increase the intake of some micro nutrients.
If the international recommendations are used [KING AND BURGESS, 1992] with 35 g/d and 42 g/d for the 1-3 or 4-6 year old children respectively, all children, included in the survey, failed to reach this recommendation (63 % for the 1-3 year old children and 45 % for the 4 year old children). Considering that breast milk provides between 50-60 % energy as fat, care needs to be taken to prevent dietary fat intake from falling too rapidly or below the required levels during the weaning period [FAO, 1993]. The younger children in our survey seemed to be slightly better supplied because of a higher intake of milk powder which strongly increases the fat intake. The average milk powder intake of all interviewed children was 32 g (about 3 tablespoons) per day. This contributes 17 % of the children's energy intake, 41 % of their fat and 25 % of their protein intake. COLETTA AND BAARTHOLMEY (1994) clearly state that babies need fat not only for concentrated food energy as source for growth but also for normal development of the brain and nervous system. Instances of failure to thrive have been reported among infants fed low-fat diets that resulted in inadequate energy intake, although their parents believed such diets would prevent chronic disease in later life (PUGLIESE ET AL., 1987). SKINNER ET AL. (1997) propose that mothers need to be advised that low fat diets is not desirable for young children. This indicates that low fat intake probably is an important influencing factor for the high prevalence of malnutrition in Maldivian children. In conclusion, the consumed milk powder and the family food should provide the necessary fat amounts. Through greater consumption of coconut this could partly be made possible without a remarkable increase in food expenses.

In the National Plan of Action for Nutrition in the Republic of Maldives, CHAKRAVARTY (1995) mentions estimates for the daily consumption of rice, flour and sugar calculated from the imports and an estimate for fish consumption per day for the total population in 1991. The calculated rice consumption was recorded at 160 g/capita and day, wheat flour and sugar consumption at 100 g/capita and day. In this survey a rough calculation of these three staple foods (including the recipes) came up to 140 g/mother and day for rice, 55 g/mother and day for refined wheat flour and 46 g/mother and day for sugar. The reported average sugar intake in the survey was probably rather too low, considering that one cup or one glass of tea on average contains two teaspoons of sugar. This would already make about 48 g for 3 cups or glasses of tea per day. In CHAKRAVARTY'S report the results of the survey undertaken in Seenu atoll in 1982 are also cited. For rice an intake of 174 g was found, for wheat flour 92 g and for sugar 83 g/d. The daily amount of rice and wheat flour depend on the interviewed population group (men, women, children) and if other carbohydrate-rich staple food (like yam in Gnaviyani atoll) is additionally consumed. If the higher amounts of rice, flour and sugar found in 1991 and 1982 were closer to the actual intake, this would only make a difference for energy and carbohydrate intake, but no distinct difference for most micro nutrient intake.

Furthermore, CHAKRAVARTY reports that the fish consumption in 1991 was 80 kg per year and person. This would make about 220 g per day, whereas the survey undertaken in Seenu atoll (1982) found a fish consumption of 94 g/d. The results of the survey in Seenu atoll would compare well with the results of daily fish consumption in our survey (80 g/d).

5.2.3.3 Fat soluble vitamins:

Vitamin A intake depends on 2 different vitamin A sources consisting of retinol or retinyl ester and the group of carotenes which are provitamins of vitamin A. Most important as provitamin and also measured in the plasma is ß-carotene. The food sources of retinol and carotenes are totally different. Retinol and its derivates are found in animal products. Foods rich in retinol which are consumed in Maldives are poultry, milk, eggs, fish (especially fatty fish or small fish eaten whole together with the liver). Liver is an especially rich source. For small children breast milk is an important source. Carotenes are part of the chloroplasts in plants. Therefore, foods rich in carotenes are yellow or orange fruit and vegetables and GLV. Locally grown foods in Maldives are mangoes, papaya and sweet potatoes, and the leaves of vegetables like drumsticks, pumpkin or sweet potatoes. Many other vegetables and fruit contain lower amounts of carotenes. These two sources of vitamin A are united and measured in vitamin A equivalents or in short term as vitamin A (1 µg retinol = 1 µg vitamin A equivalent; 6 µg ß-carotene and 12 µg other provitamin carotenes = 1µg vitamin A equivalent [BIESLASKI, 1997]). The amount of carotene needed is higher and also depends on the type of carotene to obtain 1 µg vitamin A equivalent. Altogether this shows that there are different possibilities in Maldivian diet to achieve the recommended vitamin A intake.

Retinol and retinoic acid play fundamental roles in the economy of the body. They have important functions in cellular differentiation, especially in the respiratory, gastrointestinal and genitourinary tracts. Further, retinol plays an important role for proper functioning of the eyes. Other processes in which vitamin A is known to be involved in are foetal development, the immune response, haematopoiesis, appetite, hearing and physical growth [MCLAREN ET AL., 1996]. In the last period of pregnancy a woman must have an adequate supply of vitamin A to assure proper functioning of the lungs after birth. One influencing factor for high maternal mortality and high infant mortality and morbidity is a maternal insufficient level of vitamin A. Then the alveoles of the lung can not work properly after birth which can even lead to the infant’s death. Night blindness and bitot spots are late clinical signs of vitamin A deficiency. The above mentioned functional disorders are already affected much earlier in the so called marginal deficiency state. Resistance against pathogenic agents declines. Therefore, in many low-income countries diarrhoea and acute respiratory infections are also proposed as a cause of a marginal vitamin A deficiency. In Maldives, acute respiratory infection is reported to be the top ranking disease for under five year old children [UNICEF MALE, 1996]. GOPALAN (1994) reminds that children almost never suffer from vitamin A deficiency alone. It is invariable associated with protein-energy malnutrition and frequently with anaemia and vitamin B complex deficiency.
The nutritional interviews for the children indicate a sufficient supply of retinol and vitamin A, especially for the 1 to 3 year old children, compared to both the Indian RDA and the WHO safe level (115 % and 125 %; 4 year old children: 83 % and 91 %). This was due to the reported consumption of milk powder which is enriched with vitamin A. Reported amounts of

milk powder supplied on average more than half (53 %) of the Indian RDA for retinol on average for all children under 5. The vitamin A content of the Maldivian tuna has not been measured in the laboratory of the University of Hohenheim yet. Therefore, the assumed vitamin A intake from the computer programme has to be looked at critically, because as yet the exact retinol content of Maldivian tuna is not known. For mothers retinol intake through the reported milk powder was only 12 % of the Indian RDA recommendation. With the assumed vitamin A content in tuna and the reported portion sizes of consumed fish, the mothers were below the Indian RDA (67 %) for retinol and in the range of the WHO recommendation (92 %) for vitamin A . The plasma analyses confirm that clinical vitamin A deficiency might not be a general problem in Maldives, for the NATIONAL NUTRITIONAL SURVEY in 1994 found only one child with bitot spots, but some groups of the population might be at risk of marginal vitamin A deficiency. Especially pregnant and lactating women and children with low or no intake of milk powder and low intake of fish could be affected. It would be interesting to know how high the intake of Maldivian tuna fish has to be to guarantee a sufficient vitamin A intake to make recommendations for families who do not use milk powder and, therefore, have to cover their retinol intake mainly through fish. Poultry, which is cooked and eaten with the liver and eggs, could also increase the retinol intake if eaten in higher amounts.

Currently, **carotene** as provitamin A played only a secondary role, because of low carotene intake in mothers and children. When the supply of fresh fish is low and efforts are being made to use fish sparingly, it is often cooked together with vegetables. In this case carotene intake might become more important for the vitamin A status. Carotenes do not only play a role as provitamin A. Other functions of carotenes are inactivating reactive oxygen species, activating the immune system, anti-tumour promoting properties and protecting against sun-induced skin damages, etc. Clinical deficiency signs are not known yet, but there is some evidence that certain diseases e.g. cancer are correlated with a carotene deficiency [BIESALSKI, 1997]. WEST ET AL. (in press) showed in their survey in Nepal that through weekly supplementation of vitamin A and ß-carotene a reduction in pregnancy-related mortality of 40 % could be achieved. In mothers whose blood samples were taken the average calculated intake was a little lower (0.28 ± 0.39 mg) than the total average of all atolls (0.36 ± 1.35 mg), although two of the 15 women reported a higher carotene intake above 1 mg/day. The plasma level of most mothers showed clear deficits in carotene intake. This compares with the calculated average intake through the 24 h-recalls, so that the plasma results and the results of the nutritional interviews indicate a low carotene intake in the Maldivian diet. In the preliminary report of this survey for vegetable oil palm oil was the oil most commonly used for calculations. Measurements in the laboratory (Stuttgart/Hohenheim) found no carotene in the commonly used vegetable oil. Therefore, this was corrected in this report. The Indian RDA recommends 2.4 mg carotene for adults and 1.6 mg for children, whereas the mothers and children reached about 15 % of this. Higher consumption of locally grown foods could meet the recommended level. Drying carotene rich fruit such as mangoes or papaya could provide a year round supply irrespective of the season.

In contrast, the MALDIVES MULTIPLE INDICATOR SURVEY REPORT (1996) which applied the ”Helen Keller International methodology” found that for children in rural areas the vitamin A supply through plant sources was adequate, while animal sources seemed to be insufficient.

Vitamin E was another fat soluble vitamin which was measured in the plasma. Because vitamin E is a highly effective antioxidant its major biological role lies in protecting polyunsaturated fatty acids and other components of the cell membranes from oxidation by free radicals. Therefore, vitamin E intake depends on the intake of fat, especially of polyunsaturated fatty acids. This has to be considered in the vitamin E intake when using the USA-RDA as comparison for the Maldivian mother's and child's intake. Compared to this RDA, the mothers and children reached between 50 and 60 % of the recommendations. Losses through reheating of the fat is not considered in this calculation. The plasma levels of the 15 mothers indicated adequate intake with the exception of three mothers who were below the cut off point.

5.2.3.4 Water soluble vitamins:

Like carotenes **vitamin C** is mainly found in fruit and vegetables. It is easily absorbed, but it is rapidly destroyed by processing and cooking. Vitamin C is necessary for the synthesis of hormones and collagen, which is a component in skin, bones, teeth, gum and, therefore, important for the regeneration of wounds, burns, and bone fractures. It is further involved in the immune system to stimulate white blood cells to counteract infections. Together with vitamin E and ß-carotene it acts as an antioxidant. Vitamin C is also among the protective factors against cancer and increases the absorption of iron from plant foods. 10 mg of vitamin C per day is necessary to prevent scurvy but 200 mg is necessary to reach the steady state plasma concentration [HANCK AND WEBER, 1997]. The Indian RDA recommends 40 mg/d for women and children. Compared to this the calculated average intake was insufficient for both the mothers and the children (53 % for mothers; 50 % and 38% for 1-3 and 4 year old children). In Germany, the recommendation is 75 mg for adults, and for children aged 1 to 3 and 4 to 6 years the recommended intake is 55 mg/d and 60 mg/d respectively. If the Maldivians ate locally grown fruit, vegetables and GLV regularly and in greater amounts, they could easily meet recommended standards for vitamin C. The results of the plasma concentration show plasma levels (average 0.60 mg/dl) which are rather low. Again, a significant difference in vitamin C intake for mothers can be seen in Gnaviyani atoll (41 ± 38 mg/d) compared to the other atolls (between 8 and 28 mg/d). A higher supply of vitamin C would be desirable for several reasons. Firstly, the iron absorption from plant sources could be increased. Secondly, if vitamin C rich food is consumed regularly before an infection occurs, it might serve as protection against infections [BIESALSKI, 1996].

Folic acid and iron deficiencies contribute to nutritional anaemia in countries of the South East Asian Region (SEAR) as elsewhere [GOPALAN, 1994]. Folic acid has been discovered to be a preventive measure against anaemia, especially during pregnancy. Folic acid is part of many important metabolic processes in the body, e.g. the division and differentiation of cells and protein metabolism. Therefore, it is important for all growth and development processes in the body and also has functions in the nervous system. Foods rich in folic acid are liver, kidney, fish and GLV. Eggs, coconut, yam, onions, sweet potato, pumpkin or fruit like mango, guava, passionfruit and banana contribute to folic acid intake. A large proportion of folic acid is destroyed when foods are stored or cooked for a long time. These losses were not considered in assessing the 24 h-recalls, therefore, the actual intake might be lower than the

calculated intake. On the other hand, the amount of folic acid in tuna fish might be higher than the amount used in the computer programme. Another German food table (SOURCI ET AL., 1994) mentioned a slightly higher folic acid value in tuna (15 µg/100 g, instead of 9 µg/100 g). But these values refer to raw and fresh tuna fish and not to cooked tuna.
The calculated intake of the younger children was sufficient according to the Indian RDA (110 %), but not according to the WHO safe levels (66 %), whereas for the older children (63% and 50 %) and the mothers (34 % and 20 %) the calculated intake was insufficient according to both recommendations. For the younger children (1-3 years), the reported amount of milk powder was the main source for the higher intake of folic acid. But again, the intake could be easily improved by a higher intake of fresh, raw or shortly cooked vegetables and fruit. Evaluating the plasma levels of the 15 mothers, homocysteine of a high percentage of mothers (67 %) indicated a probable deficit. Therefore, folic acid seems to belong to the critical micro nutrients in the Maldivian diet. [HALSTED, 1993; KING AND BURGESS, 1992]
During pregnancy the folic acid requirements increase substantially due to the increasing demands of the growing foetus. Given the above findings, a large group of Maldivian mothers could be at risk of premature birth or bearing low birth babies. But usually pregnant women receive folic acid supplements from the health centres.

The three B vitamins **thiamine (B1)**, **riboflavin (B2)** and **pyridoxine (B6)** are cofactors of enzymes in the carbohydrate, fat or protein metabolism. Therefore, a deficit in any one of these vitamins can affect the entire metabolism. Rich sources of thiamine are poultry and fish, especially liver, legumes, milk and eggs. The sources are similar for riboflavin: milk, eggs, fish and liver and to a lesser degree green leaves and legumes. For pyridoxine, rich sources are again poultry, fish, eggs, liver and kidney. Unpolished rice, which is not consumed in Maldives, would also be a good source of these vitamins. Smaller amounts can be found in many fruit and vegetables. The survey findings show that the mothers and children have a rather insufficient supply of these vitamins (mothers: B1 80 %, B2 48 %, B6 51 %; 4 year old children: B1 47 %, B2 51 %, B6 69 %), except the 1 to 3 year old children (B1 80 %, B2 113 %, B6 76 %) compared to the Indian RDA. The homocysteine plasma levels could also be indicative of an insufficient intake of vitamin B6 besides folic acid. [KING AND BURGESS, 1992]

5.2.3.5 Minerals:

Some of the so called type II nutrients, potassium, magnesium, and zinc, which were mentioned at the beginning shall be roughly reviewed in this part.
When one looks at minerals and trace elements, it is important to remember that adequate consumption alone does not guarantee a sufficient supply for the body. Digestion, additives which increase or decrease absorption, interactions among minerals play a role as do processes which modify the systemic utilisation of the elements after their absorption. The previous intake, if low or high, also affect the supply. Some authors advised that appreciation of factors which are likely to influence availability should warn the reader against the inflexible application of tabulated data on trace-element requirements when endeavouring to interpret dietary analyses in a diagnostic context. [WHO, 1996]

Potassium is necessary for the water and acid-base balance in the body. It is the most important intracellular cation. Potassium, e.g., fulfils functions in the muscular, nervous and digestive system. Diarrhoea and vomiting are connected with high losses of potassium. In general, plant foods are rich in potassium, especially dried fruit, but animal products also contribute to the potassium intake [BRÄTTER ET AL, 1992]. Bananas, kurumba, pumpkin and legumes are rich in potassium [KING AND BURGESS, 1992], potatoes, sweet potatoes, yam, milk or milk powder are also good sources. Rice is a very poor source. The 1 to 3 year old children with higher reported amounts of milk powder seemed to be better supplied with potassium than the 4 year old children and mothers. The potassium intake of the younger children was sufficient (101 %), whereas for the older children (4 years old) and mothers the intake was insufficient (54 % and 52 % respectively) according to the Indian RDA. [DGE, 1995]

Magnesium is one of the components of bones and teeth. Like potassium, it has important intracellular functions and acts as a cofactor for many enzymes. A deficit influences heart function, muscles and the nervous system. Nuts, unrefined cereals and legumes are rich sources of magnesium. Good sources are milk powder, bananas, some fruit and vegetables, whereas rice, roshi (refined flour), fish and poultry are low magnesium sources. Without considering the influencing factors on intestinal absorption, the magnesium supply seemed to be sufficient for the children (1-3 years old: 146 % and 4 years old: 83 %) but not for the mothers (43 %) according to the USA-RDA. Positive influencing factors for a high absorption are protein, a long transit time, unsaturated fatty acids, vitamin D and lactose (in milk), whereas dietary fibre, especially the phytic acid in cereals, a surplus of phosphate and calcium, and duration of diarrhoea have a negative influence on the intestinal absorption. [SMITH, 1993]

The important role of **zinc** in normal growth has been known for some decades. Biochemically zinc is a constituent of metallo enzymes found in many important metabolic pathways and in stabilising the structure of organic components in membranes as well as RNA, DNA and ribosome. Zinc is also essential for the immune defence system. Skin ulceration, reduced resistance to infections, growth failure and poor appetite are indications of zinc deficiency. A reduced growth rate and impaired resistance to infections are frequently the only manifestation of mild deficiency in humans. But people seldom lack zinc alone. Usually lack of zinc is due to a generally poor diet with inadequate energy intake and other nutrients. So it is often difficult to find out how much of these signs are due to a lack of zinc itself. Cereals are a good source. But the supply of zinc from cereals depends on the degree of refinement of the grain. Refined wheat flour and polished rice contain less zinc because it is mainly located in the outer layers of the grain. Through parboiling a part of the zinc is retained in the inner layers, so that the content is higher than in usual white rice. Lentils are also rich in zinc. Lean beef contains more zinc than fish. But also milk powder, sweet potatoes, potatoes or yam contribute in smaller amounts to the zinc intake. The absorption is reduced through phytic acid and pharmacological dose of calcium and iron, whereas protein, vitamin C and citrate increase the absorption. Therefore, if a meal contains animal foods, absorption is increased. According to the WHO recommendations the supply would be sufficient (92 %) for the mothers aged ≥ 19 years, in case parboiled rice, the main food source (60 % of the zinc intake), actually contains these amounts of zinc as used in the computer programme. The supply of the 4 year old children (58 %) was rather insufficient, whereas for the 1 to 3 year old children the calculation was at the lower end of the defined sufficient intake (78 %). Therefore, zinc could play a role in growth failure of Maldivian children considering that percentage of recommendation are based on the already low WHO-RDA level. [HALLBERG ET AL., 1993; KING AND BURGESS, 1992; WHO, 1996]. A food consumption survey for a fish-based diet typical of the Amazonas area of Brazil has been reported as a diet lower in zinc intake with 7 mg/d [SHRIMPTON, 1984]. Compared to this, the diet of the interviewed Maldivian mothers was on average one mg lower.

Iron deficiency**,** the most common micro nutrient deficiency world wide, is also a reported problem in Maldives. The NATIONAL NUTRITIONAL SURVEY (1994) reports approximately 82 % of children below the WHO recommended cut off point of 11 g/dl. 68 % of the pregnant women and 62 % of non-pregnant women had haemoglobin levels below the WHO recommended levels of 11 g/dl and 12 g/dl respectively. The percentages of severe anaemia were not mentioned. In low income countries on average 50 % of the children, 60 % of pregnant and 45 % of non-pregnant women are below the same cut off points [DE MAEYER, 1989]. This is lower than in the Maldives. The main part of iron in the body is present in the red cells as haemoglobin where it has important functions in transporting oxygen and carbon dioxide. It fulfils the same functions in the myoglobin of the muscles. Haem groups are also part of several enzymes like cytochroms. Iron is a part of signal-controlling substances of some neurotransmitter systems in the brain, or the synthesis of steroid hormones and the detoxification of various foreign substances in the liver. Iron deficiency not only leads to anaemia, but also has an impact on several brain functions and the immunological defence against infections. It further leads to tiredness and reduced intellectual performance and work capacity. Further, anaemic women are more likely to bear low birth weight babies than non anaemic women. The perinatal mortality probably increases. Low birth weight is closely correlated to higher proneness to infections and infant death rates. Deficits of iron in infants and young children leads to growth failure and compromises learning ability. [GOPALAN, 1994; HALLBERG ET AL., 1993]

Dietary recommendations must be based not only on the amount of iron, but also on the kind of iron. The haem iron absorption from meat and meat products is much higher (about 15-35 %) and minimally influenced by the iron status in contrast to non-haem absorption from milk (with about 10 %) and from plant foods and eggs (with about 5 % or less) [KING AND BURGESS, 1992]. Calcium is the only dietary factor which influences the absorption of haem iron. There are several other dietary factors that either increase or decrease the absorption of non-haem iron. Phytates in cereals, phenolic components in tea, coffee, cocoa, some vegetables like spinach (oxalate), herbs or spices, e.g., oregano inhibit the absorption. Furthermore, other minerals like calcium in milk decrease the absorption. On the other hand, other dietary factors like vitamin C, organic acids (citric acid) or animal protein in meat, fish and milk enhance the absorption. For example, the Maldivian practice of eating rice together with fish, lemon and GLV, even though the leaf portion is quite low, is a good habit. The fish contains iron and increases the absorption of the non-haem iron in GLV and rice through its protein together with the vitamin C and citric acid in lemon and GLV. Parboiled rice should contain more iron than the polished rice. The same effects can be considered for zinc. According to the WHO recommendations the intake of the mothers on average only reached 70 % of the requirements, although the food table of the Ebis programme calculated the parboiled rice with quite a high iron content. Of the 15 mothers where haemoglobin was measured the average intake in iron was calculated about 1 mg higher than the average of all mothers together, although the difference was not significant because of the small sample size. Surprisingly, non of the mothers was below the WHO cut off point for haemoglobin. The iron intake of the children seemed to be better. They seemed to reach sufficient levels according to the WHO recommendations (1-3 year old children: 94 % and 4 year old children: 87 %). In contrast, neither the children nor mothers reached the Indian Recommended Dietary Allowance, (1-3 year old children: 39 % and 4 year old children: 27 %; mothers: 29 %) which are probably higher due to a diet low in absorbed iron. An international recommendation [KING AND BURGESS, 1992] differentiates between a diet with high iron availability (about 15 % absorbed), medium iron availability (about 10 % absorbed) and low iron availability (about 5 % absorbed). The recommendations are given in Table 45.

Table 45: Recommended iron intake according to iron availability for children and mothers [KING AND BURGESS, 1992].

Iron availability	High	Medium	Low
1-3 years old children	5	7	13
3-5 years old children	5	7	14
Mothers	16	24	48

According to this international recommendation the 1-3 year old children reached 67 %, the 4 year old children 69 % and the mothers 36 % of the diet of medium iron availability which probably comes closest to the Maldivian diet. This would partly explain the high prevalence for anaemia in Maldives.
Additionally, non nutritional factors like infectious diseases and parasites have an impact on the iron status which taken as a whole could explain the high percentages of anaemic mothers and children.

Calcium is not only the most important mineral constituent of the skeleton and teeth, but is vital for a large number of functions within the body, including the muscular, neurological and endocrine systems. The calcium homeostasis is regulated through three hormones, the parathyroid hormone, calcitonin and vitamin D. Especially for women a sufficient intake is important to build up a high peak bone mass for the time, after menstruation has stopped and peak bone mass begins to decrease. Good calcium sources are milk (powder) and milk products, small fish, which are eaten with the bones, GLV and spices. The most important source in Maldivian diets is milk powder which seems to be on average enough to reach a sufficient range of the Indian RDA for mothers and children (mothers: 79 %; 1-3 year old children: 131 % and 4 year old children: 81 %). [SMITH, 1993]

5.3 Reported weaning food and perceived best food for young children

In general, the duration of breast feeding seems to be quite long in Maldives. The average calculated breast feeding time was about 23 months which definitely has a positive impact on the health and nutritional status of the children. The mothers who never breast fed their children had special reasons for this, e.g., medical reasons with advice from a doctor. In contrast weaning food seems to be introduced too early. Exclusively breast feeding is recommended for the first 6 months [LABBOK, 1997]. In this survey only a small number of mothers reported that she exclusively breast fed her child up to the age of 6 months, whereas the majority started complementary feeding at the age of 4 months or even earlier (68 %). A previous survey even reported that only 8 % of the mothers exclusively breast fed their children up to 4 months [UNICEF MALE, 1996]. The mothers reported introducing supplementary drinks from the first month onwards. Most commonly cited supplementary drinks were fruit juice, water and honey plus infant formula. At this age these are not adequate alternative substitutes to breast milk for infants. Correct weaning practise is closely correlated to adequate growth and development in infants. According to the WHO (1994) growth faltering started with 5 to 6 months for infants who were predominantly (though not truly exclusively) breast fed in the first 4 to 6 months, and according to COHEN ET AL. (1995) with 9 months for those who were exclusively breast fed for 6 month, or exclusively breast fed for 4 months and given hygienically prepared complementary foods. In Maldives, growth faltering is reported to start between 4 to 8 months (DPH, WHO MALE, UNICEF MALE, 1994), which compare with the results of the WHO (1994). Therefore, one reason for growth faltering could be too early stopping of exclusively breast feeding in combination with inadequate complementary foods. Improvements in the nutritional status could probably be achieved by propagating only breast feeding for the first 6 months. This would also reduce expenses for supplementary food as a cost factor. For mothers with an outdoor job (7 % of the mothers in this survey) this recommendation could cause problems because they usually start to work a few weeks after delivery.

In addition to the duration of breast feeding the type and amount of weaning food, frequency of feeding and hygienic food preparation are other influencing factors for adequate growth and development of the infants. The WHO (1998) prefer the term complementary food rather than weaning food to avoid the idea that complementary food is meant to displace breast milk or initiate the withdrawal of breast feeding. They also differentiate between special transitional food and family food. Transitional food such as milk powder, cereals, banana, other fruit and vegetables, less spicy and hot foods fortified with the necessary amounts of fat, etc., are specially designed to meet the particular nutritional or physiological needs of the young child. The contribution of breast feeding, transitional food and family food to total energy intake at different ages is shown in Figure 12. The graph illustrates that the time of exclusively breast feeding is followed by breast feeding with increasing amounts of special transitional food. Then, gradually, the intake of breast milk is reduced while special transitional food and increasing amounts of family food are offered.

Figure 12: Contribution of different food sources to young children's energy intake in relation to age. [Complementary feeding of young children in developing countries, 1998]

In Maldives, commercial products (cereals and milk powder) which was mentioned by 57 % of the mothers seem to be favourite weaning food. The NATIONAL NUTRITIONAL SURVEY (1994), which focused particularly on weaning practice asked what type of food was offered during first introduction of weaning food. 53 % of the mothers reported giving milk or commercial weaning food, 20 % home-made weaning food (which was not further classified), 5 % family food and 20 % other food (like biscuits, bread, etc.). Again the predominance was given to commercial food which indicates that complementary food is highly valued. If used in the declared amounts on the labels such types of food might provide enough nutrients and energy. Although, according to the 47^{TH} WORLD HEALTH ASSEMBLY (1994) preparation of locally produced complementary feedings are given preference over commercial complementary foods. White rice, refined flour with sugar, biscuits and desserts, which contain a lot of carbohydrates but less micro nutrients, were mentioned as complementary food by 28 % of the mothers. Nutritious foods, like eggs, garudiya fish, fruit and vegetables were also mentioned as complementary food by 13 %, bananas were specially mentioned by 19 % of the mothers. Sometimes a combination of rice and garudiya or rihaakuru was mentioned. Garudiya, the fish soup, might contain low amounts of micro nutrients from the fish, but it can almost be regarded as water with salt. Rihaakuru, the typical Maldivian fish paste, is cooked for many hours. Therefore, the vitamin content will probably be negligible. The content of some minerals and protein might be quite high because of the concentrated residue. But if it is not consumed with fish, eggs, coconut, fruit or vegetables, this does not provide adequate energy, fat and micro nutrient intake for the infants and young children. Rihaakuru and especially garudiya should be viewed as enhancing taste rather than highly nutritious foods.

For liquids offered to young children bottled juice was more often mentioned than fresh juice or kurumba. In contrast to freshly produced juice from one's own fruit, which would be a good contribution to the children's diet the commercial syrup (which is mixed with water) does not contribute to the micro nutrient intake. Freshly prepared fruit juice is predominantly consumed during the Islamic fasting month Ramazan. Consumption of milk in tea is preferable from a nutritional point of view as compared to tea without milk. One positive

observation of the 24h-recall was that the younger children received higher amounts milk powder than the older children.
Mothers' replies to the question, "which is the perceived best food for the index child", were quite different from the actual complementary food offered to their child. This is probably due to the older age of the children (1 to 4 years). 12 % of the mothers still believed that commercial food was the best for their child. The carbohydrate rich food group like rice, roshi, noodles or yam was most important in the eyes of the mothers (44 %). Protein rich food (fish, fish products, eggs), bananas and other fruit and vegetables were all mentioned by 18 %, 17 % and 16 % of the mothers. These nutritious foods seemed to be more important in the minds of the mothers than in reality because they did not appear in great frequency in the 24 h-recalls. Again garudiya and rihaakuru were mentioned quite often (22 %). Bottled juice was more often mentioned than fresh juice from own fruit and kurumba. This might be due to convenience and the perception that imported products are in general good and healthy. It would be desirable if the importance of their own products (eggs, vegetables, fruit, GLV) would increase in value in the eyes of the population and if the available sources would be used for the diet not only as a small side dish, e.g., GLV, but in higher proportions.

5.4 Group differences

5.4.1 Differences in the diet of mothers and children

Although it is difficult to work out differences because of many sources of errors in the evaluation of the nutritional data, some differences are obvious. Growth faltering in Maldivian children is reported to start between 4-8 month [DPH, WHO MALE, UNICEF MALE, 1994]. The prevalence of growth faltering continues with increasing age of the child. In this survey the highest prevalence for stunting was found in the 4 year old children, whereas the prevalence for underweight was highest in the 3 year old children. This indicates that the 3 and 4 year old children seem to be most affected by insufficient nutrition. This corresponds to the nutritional changes obvious from the nutritional interviews. The reported milk powder consumption decreased with the age of the children as is reflected in the decreasing calcium and riboflavin intake. These are good indicators for the milk powder intake because milk powder is the richest food source for these micro nutrients. Further, milk powder contributes highly to the energy, fat and protein intake as well as the micro nutrient intake like retinol, folic acid and magnesium, but also thiamine and pyridoxine. With increasing age milk powder was less frequently offered, and family food like rice, roshi, fish and fish products (e.g. curry, short eats, seen in the increase of vitamin E) more frequently. But especially staple food like rice, wheat flour and sugar have a lower energy, fat and micro nutrient density so that the energy and micro nutrients only increased slightly or even decreased slightly although the portion sizes probably increased. These changes (less milk powder, more family food) do not mean that there is necessarily an increased intake of vegetables and fruit. This is reflected in a continued low intake of dietary fibre. Therefore, the body’s need was probably better reached by the younger children rather than by the older. As a whole this would explain much about why the prevalence of malnutrition increases with age. Surprisingly, according to the 24 h recall, the 2 year old children had the highest intake of carotene and vitamin C. Although the diet of the 1 and 2 year old children seems to be sufficient for many nutrients except for carotene and vitamin C the fat and energy intake was probably insufficient. This probably has an important impact. However, the high prevalence for stunting (26 %), wasting (12 %) and underweight (37 %) in this age group can not be explained alone by nutritional influencing factors.

In comparison to the recommendations the pregnant and non-pregnant mothers average nutrient intake seemed to be worse than the average intake of the 1-3 year old children, but as inadequate as the 4 year old children. This indicates risk factors for the nutritional status especially of pregnant mothers.

Dietary fibre, carotene and vitamin C were low in all diets, indicating that mothers as well as children had a low vegetable and fruit intake.

5.4.2 Differences per atoll

Generally, there was no correlation between the nutritional status of the mothers and the children. Therefore, the BMI distribution of the mothers among the atolls was different from WFA, HFA and WFH of the children in the different atolls. The data also indicated

differences in dietary intake, in growing agricultural products, raising chicken, period of exclusively breast feeding, and sanitary facilities on atoll level.
On the island **Dhiffushi** the mean BMI (20.6) was lowest and the percentage of mothers below the cut off point of 18.5 was the highest (32 %) of all selected atolls, whereas the children had the lowest prevalence of malnutrition (-2 SD below the reference median). On this island the inhabitants grew the lowest number of different agricultural products (index score 42) together with Nolhivaram (index score 37) and had the highest percentage of households not raising chicken or ducks (93 %). The dietary habits on Dhiffushi probably had an important influence on the nutritional status of the children. The average food intake of the mothers calculated from the nutritional protocols showed a combination of high fish and milk powder intake. This might be due to the high percentage of fishermen, so that fish was probably often available in sufficient amounts for the whole family and the close distance to the capital which might influence the availability of other food products on the island consequently increasing the food diversity in comparison to other islands which are farer away from the capital. A further positive food habit was that they usually ate garudiya fish in combination with onions and lemon. These differences (e.g. in Vitamin A but also other micro nutrients) could have an effect on the nutritional status and the growth development of the children.
Furthermore, hygiene influences nutritional status. The high percentage of toilets used on Dhiffushi (90 %) can be regarded as an indicator of prosperity and development on the island. The risk of infectious diseases and the spread of parasites is diminished. TV-programmes televised from Male with lectures in health and nutrition could have another positive influence. Such programmes can only be received in the area around Male but not in the North and South of the country.

In **Laam** atoll the reported energy intake of the mothers was 1032 kcal or lower as compared to the atolls Gnaviyani, Kaaf and Meem (1439 kcal, 1567 kcal and 1466 kcal respectively). The lowest percentage for a BMI < 18.5 and highest percentage for a BMI > 27.5 were found in this atoll. The nutritional status of the children was above the total average for WFA, HFA and WFH. Laam atoll had the second highest score for growing vegetables and fruit around the houses (55) and the second highest percentage of households were raising chicken or ducks. The nearby airport might have an influence on the variety of products and other articles that can be bought on the island.
With 59 % Laam atoll had about the same percent of toilets than Meem atoll. One positive influencing factor on the nutritional status might be the longer reported time before the mothers started with complementary feeding (on average at the age of six months) compared to the other atolls Gnaviyani, Kaaf and Meem atoll (on average at the age of four months). In Haa Dhaal the mothers also reported starting at the age of six months.

Comparing to the sanitary facilities and the nutritional situation one would expect nutritional similarity between **Meem** and Laam atolls or even better in Meem atoll due to higher reported energy and nutrient intake. In fact, the mean BMI of the mothers (21) was lower than in Laam atoll (23) and the percentage of mothers below the cut off point of 18.5 much higher (30 %). A similar situation was observed in children. The prevalence of stunting (29 %) compared to 36 % in Laam atoll was lower, whereas the prevalence of underweight (57 %) compared to

41 % in Laam atoll was higher. Meem atoll was also the atoll with the highest prevalence of wasting (22 %) although the Regional Hospital is situated on one of the visited islands (Muli) and the other selected island is not far from the hospital (Mulah). Comparable to Kaaf atoll the fish intake was quite high, but the milk powder intake was lower than in Kaaf atoll. The percentage of households raising chicken was above the total average and the percentage of different agricultural products ranked in the middle of all islands (index score 48).

In **Foammulah** the percentage of mothers below (16 %) and above (4 %) the BMI cut off points was lower than the total percentage of all atolls (22 % and 8 %). The milk powder intake for the mothers (21 g) seemed to be comparable to Dhiffushi (19 g), but milk powder intake of the children and fish intake were reported lower than in Dhiffushi. Therefore, fish was probably more often consumed as vegetable curry. Curry is comprised of a solid part (fish and vegetables) and a liquid part. Men commonly get the first servings and, therefore, probably receive a greater share of the solid part. This was not considered in the nutritional interview, but this does here an important impact on the actual intake of nutrients. The high yam consumption instead of rice was a distinct difference in Foammulah compared to the other island. The island also had the highest index score in growing fruit and vegetables (69). Vegetables, prepared with rice, e.g., except of vegetable curry and fruit were consumed rarely like on the other islands, with the exception of more green leaves. Because of a higher calculated intake in micro nutrients, especially through yam, it would be expected that the growth development of children would be similar to Dhiffushi. This was not the case. Diffushi was better off except for the prevalence of wasting which was quite similar on both islands (Foammulah: 10 %, Dhiffushi: 11 %). Surprisingly, the prevalence of underweight and stunting (significant) was higher than in Laam atoll, although Laam atoll was worse in many of the listed points.
Non nutritional factors could be responsible for the different nutritional status. The percentage of households with toilets was the second highest (72 %).

The average BMI of the mothers (21) in **Nolhivaram** was in the same range as the mothers in Gnaviyani and Meem atoll and the percentage of mothers below the cut off point of BMI < 18.5 was lower (23 %) than in Kaaf and Meem atoll, whereas the prevalence for stunting (68 %) and underweight (67 %) of the children in Nolhivaram was the highest of all atolls. The energy and nutrient intake of mothers and children was the lowest of all islands although this may be an error due to underreporting like in Laam atoll. Food diversity in terms of different agricultural products was lowest in this atoll (index score 37), but the highest percentage of households raised chickens or ducks (96 %).
Further, the highest percentage of mothers reported going to the forest for defecation (83 %) and the smallest number of households had toilets (10 %). This is probably an important risk factor for the spreading of infections and parasites. Another difference compared to the other visited atolls (except the small island Gaadhoo/Laam atoll) was that Nolhivaram did not have electricity for 24 hours only between 6–11 p.m. indicating probable economic disadvantages compared to the other islands in many other points. These different aspects might be underlying causes for the nutritional situation of these children.

5.5 Non nutritional factors influencing the nutritional status

According to UNICEF MALE (1996) positive changes in water supply and sanitation as well as a success in the immunization programmes and treatment of illness like diarrhoea have been achieved in the past years. In this survey a positive correlation between the two variables nutritional status of children and sanitary facilities was found. WFA and HFA were significantly ($p < 0.05$) lower for children who lived in households where gifilis were used than for children in a household where the mothers reported having a toilet. WFA, HFA and WFH of children was significantly ($p < 0.05$) lower in households where the families used the forest or the beach for defecation than in households with toilets. There was no significant differences in the nutritional status in households which had a gifili and households which were using the forest or beach. For the BMI of the mothers there was no correlation with the sanitary facilities. Gifilis are seen as a risk factor because they are dug within the household premise which are often close to private wells and therefore there is constant risk of contamination [UNICEF MALE, 1996]. This correlation leads to the assumption that the kind of sanitary facility used could belong to non-nutritional risk factor for the nutritional status of the children through greater spreading of parasites. In the same survey [UNICEF MALE, 1996] the reported percentages of toilets (55 %), gifilis (18 %) and households (24 %) using the beach/forest for defecation in rural areas were similar to the findings in this survey (toilet 55 %, gifili 13 % and beach/forest 32 %). The MALDIVES MULTIPLE INDICATOR SURVEY REPORT (1996) further reports that about 70 % of the children under 5 years (including Male) had suffered from an acute respiratory infection (ARI) in the past two weeks, whereas 10 % of the children in rural areas had diarrhoea in the last two weeks. Intestinal parasites were also a reported problem. A survey in Laanui and Vaavu atoll found a prevalence of worm manifestations of around 68 % in under-3 year old children, mostly due to Trichuris and Ascaris [CHAKRAVARTY, 1995]. This might not only be a problem of hygiene but also due to high temperatures and humidity, which encourage the growth of parasites year round. Intestinal diseases such as diarrhoea, worm infections, etc., decrease the absorption of nutrients thus leading to a viscous cycle as illustrated in the first chapter.

Another influencing factor for the nutritional status might be the maternal and childcare practice. Some authors [UNICEF MALE, 1996] suggest that because many women marry several times social problems associated with the upbringing of children from different partners could arise. Further, the high prevalence of poor nutritional status might be associated with certain childcare practices, childhood illnesses and feeding practices rather than with factors like food security or income on household level.

5.6 Availability and consumption of own agricultural products and animal

The relatively high number of households in the survey who grew agricultural products might be due to activities and training programmes of the Ministry of Agriculture and Fisheries to encourage and train the population in farming. CHAKRAVARTY (1995) reports that plantations of bananas and papayas have increased substantially during the last years. As Maldives is still described as a country with a low level of local food production [UNICEF MALE, 1997] these are desirable developments. The success of such programmes depends strongly on the size of the island, the population density and the kind of soil. On the island Foammulah, for example, the agricultural production is higher because of the bigger size of the island and more fertile soil due to a higher elevation above sea level. The high numbers of households in this survey with chicken (about 70 %) suggest a regular consumption of eggs and, occasionally, chicken meat. Looking at vegetable and fruit production (8 % of the households not doing any gardening) and the raising of chickens, on the one hand, and the results of the mothers' 24-h recalls on the other hand, vegetable (about 53 g/day mainly yam, onions and potatoes), fruit (about 14 g/day) and GLV (about 2 g/day) intake as well as the consumption of eggs (about 2 g/day) seems to be surprisingly low. Seasonal fluctuations in availability of vegetables and fruit may partly be responsible but the main point is probably the fact that people prefer to sell their products rather than eat them (CHAKRAVARTY, 1995). Lack of knowledge about the nutritional value of these foods (vegetables, eggs, etc.) could be one reason and problems of storage in a hot climate over a longer period of time an other reason. Methods of food preservations like drying fruit etc., does not seem well know and practised so far on the islands.

If the households included in the survey growing agricultural products (91.6 %) are compared to the small number of families (4.4 %) where the fathers current occupation is farming, it becomes evident that only a small proportion of families depends on agricultural products as a main source of income. Therefore, it would be desirable if programmes were supported which increase the consumption of home grown agricultural products for improving the health condition of all family members. New methods of preservation of food should be tested. This would be especially important on remote islands where the supply of imported foods might not always be secured. Home grown vegetables and fruit are always better than imported ones because they do not loose micro nutrients due to long transport and storage time. Processing of foods immediately after harvesting guaranties the highest micro nutrient content. Further, the imported carbohydrate rich foods, e.g., parboiled rice and refined wheat flour have less nutritional value yam, breadfruit, or sweet potatoes. Other commercially available foods like biscuits and soft drinks have even less nutritional value. Eggs, which appeared rarely in the nutritional protocols, could help reduce malnutrition, especially among children if consumed on regular basis. In a previous report [DPH, WHO MALE, UNICEF MALE, 1993] the authors have already recommended promoting home and community horticulture to make products available to vulnerable groups.

6 Recommendations

6.1 Recommendations for the traditional dietary habits

Milk powder / eggs

Milk powder in tea (after the tea has been prepared, or better added just before drinking) is a good nutritional habit and an important fat, calorie and micro nutrient source for small children, pregnant and lactating women.

Egg consumption could be increased from the reported 1 egg every 3 weeks to 1-3 eggs per week.

Fat

Because of a generally low fat content of the diet (about 20 %) greater use of coconut in the traditional diet to increase fat, calorie, but also micro nutrient intake is recommended. For increasing dietary fibre grated coconut is preferable to coconut milk.

Vegetables

It would be preferable for the families to use more available agricultural products for their family's diet rather than to sell them. Methods of preservations like drying fruit, etc., could be developed in further studies and be introduced on the islands.

These are some recommendations on how to increase vegetable intake.

- Rice and roshi could be replaced by breadfruit, yam or sweet potatoes depending on the seasonal and local availability.
- Rice could also be mixed with breadfruit, yam, sweet potatoes, potatoes, other vegetables or GLV for garudiya fish, rihaakuru, fried fish or curry.
- Curry could more regularly be prepared as vegetable curry using the locally grown vegetables in season like breadfruit, drumstick, brinjal, thoraa, chichanda, pumpkin, sweet potatoes, etc.
  To increase the nutritional value it would be desirable to use proper proportions of liquid and solid parts (vegetables and fish) with a higher proportion of the solid part.
- Short eats prepared from fish, coconut and flour could be nutritionally enriched by adding vegetables and fruit.

Green leafy vegetables (GLV)

Several GLV are good sources for carotene, but they contain other nutrients as well, which can contribute, in some measure, to a better nutrition of macro nutrients like vitamin C, folic acid, calcium and iron. e.g.:

Drumstick leaves: *carotene* 6.780 mg; folic acid not measured; *vitamin C* 220 mg; iron 0.85 mg; *calcium* 440 mg.

Copy leaves: carotene 0.1 mg, *folic acid* 66 µg, *vitamin C* 124 mg, ion 0.8 mg, calcium 39 mg. [GOPALAN, 1994] The micro nutrients in italics stand for a rich source.

These could be used more and in higher amounts in the Maldivian diet (e.g., half to one middle size leaf per person). For example copy leaves grow quite well and quickly. To increase the acceptability and palatability new ways of preparation could be studied.

The existing positive dietary habit of complementing rice and fish or rihaakuru with:

Coconut rasps
Lemon
Bilimagu
Onions
Leaves (copy leaves, drumstick leaves, etc.)
Leave salad

could be regularly practised.

Rice or roshi only with garudiya or rehaakuru is low in calories and micro nutrients and, therefore, should be supplemented.

Snacks

- Locally grown fruit like banana, mango, papaya, stone apple, bilimagu, jamburol, etc., whenever available should be consumed every day.
- Salty short eats, made mainly from coconut, flour, fish, onions, garlic and oil are richer in micro nutrients and, therefore, preferable to sweet ones made from sugar, refined flour and scraped coconut.
- The consumption of sweets by children should be kept low.

Drinks

- The habit of drinking water after each meal is a desirable habit and should be continued.
- Fresh juice from fruit is preferable to bottled juice. Bottled juice contains nearly no micro nutrients except single ones which are enriched.
- It is desirable to use little or no sugar in tea.

Meals

For children's caloric intake to reach required energy levels it is important to spread their food intake over the whole day. In addition to the 3 regular warm meals it is desirable to have something in between the meals, or even before breakfast or before going to bed.

The above mentioned recommendations are not complete and leave room for more ideas and suggestions. Some foods like nuts which would be also desirable were not mentioned because they did not appear in the nutritional protocols.

6.2 Example for dietary intake of 3 year old children

The following 6 nutritional protocols were designed with the aim of showing how increases in calorie, fat and micro nutrient intake of 3 year old children could be made possible by modifying available traditional food and agricultural products which grow on the islands (Annex 35). The ideas were not tested for acceptability in the population or with respect to how realistic they are, e.g., in portion sizes. A nutritional project survey in Vietnam was available [ENGLISH ET AL., 1997] to demonstrate health outcome based on increased household food production with specific emphasis on nutritional education. BROWN ET AL., 1992 have also reported improved child growth of Bangladesh children by teaching families to feed simple, cheap, energy-enriched complementary foods.
In Table 46 the resulting nutritional intake of the six dietary plans is listed.

Table 46: Analysis of the six dietary plans.

Nutrient	Analysed Value	Recommended value/day	Percentage fulfillment
Energy (kcal)	1287	1240	104
Water (g)	2408	-	-
Protein (14 %) (g)	44	22	200
Veg. Protein (g)	15	-	-
An. Protein (g)	29	-	-
Fat (32 %) (g)	46		
Carbohydr. (54 %) (g)	171	-	-
Sucrose (g)	50	-	-
Dietary fibre (g)	11	-	-
PUFA (g)	4.9		
Vitamin A (µg)	834	400	209
Retinol (µg)	566	400	142
Carotene (mg)	1.7	1.6	106
Vit. E[?] (mg)	4.7		
Vitamin B1 (mg)	0.6	0.6	100
Vitamin B2 (mg)	1.1	0.7	157
Vitamin B6 (mg)	1.1	0.9	122
Folic ac. eq. (µg)	71	30/50	237/142
Vitamin C (mg)	101	40	253
Potassium (mg)	1881	1000	188
Calcium (mg)	706	400	177
Magnesium (mg)	207	80	259
Phosphor. (mg)	885	800	111
Iron (mg)	6.8	5.0	136
Zinc (mg)	6.0	5.5	109

The percentage of fulfillment are all above 100 %. However, these protocols were designed for 3 year old children and the RDA are based on the age group of 1-3 year old children. Additionally, the intake of vitamins will be reduced by storage and cooking losses which are usually not considered in the calculations. Also the Indian or WHO-RDA are sometimes rather low compared to recommendations of industrialized countries, e.g., for vitamin C or iron as discussed above. The distribution among the macro nutrients is 14 % protein, 32 % fat and 54 % carbohydrates. Sucrose makes up 16 % of the total caloric intake. Some of the used vegetables might only be available locally or seasonally. On the other hand, not all available vegetables and fruit were included, so that the annual variety could even be greater.

These protocols shall only give an idea for further studies on how to improve the nutritional intake of children. Additionally, availability, portion sizes as well as acceptability and palatability by the population have to be tested.

7 Summary

The purpose of this study was to assess the dietary intake of mothers and children as well as to determine how dietary intake influences the nutritional status. Further information was gathered about family background, mothers' knowledge about nutrition, weaning practice, availability of own agricultural products, raising animals, and sanitary facilities. The target groups were mothers (age 18 to 50) and one of her child (12 to 49 months) who was no longer being breast fed at the time of the survey. For data collection the Department of Public Health (DPH) selected 5 out of 19 atolls in the North, Middle and South of the country (Haa Dhaal, Laam, Gnaviyani, Kaaf and Meem atoll). In each atoll one island was randomly selected. Altogether the survey was conducted on 7 islands gathering 333 questionnaires. For dietary intake an adapted 24 h-recall was used to assess the macro and micro nutrient intake and for the anthropometric assessment weight and height of mothers and children were measured. In Meem atoll blood samples of 15 mothers were collected to determine the vitamin A, ß-carotene, α-tocopherol, vitamin C, folic acid, cholesterol and iron status.

The data indicate distinct differences between the selected atolls in dietary intake, nutritional status of mothers and children, mean exclusively breast feeding time, growing agricultural products, raising chicken, sanitary facilities, and working patterns of the parents.
On average the BMI of the mothers was in a sufficient range (BMI 21.8). 22 % of the mothers were below the cut off point of 18.5 indicating a certain level of maternal malnutrition. In the group of the ≤ 20 year old mothers the highest percentage of mothers (33 %) were affected. Together with early marriage and pregnancies this group of mothers is more likely to have miscarriages or to deliver low birth weight babies. 51 % of the children were found below –2 SD of the NCHS reference median for WFA (underundernutrition). 41 % of the children were below –2 SD for HFA (stunting) and 14 % were wasted (WFH < -2 SD).
The attempt to identify dietary factors which are important for mothers' well being as well as for the prevention of childhood malnutrition lead to some interesting findings. The results indicate that the diet of mothers and children was rich in carbohydrates through high intake of rice, flour and sucrose, but rather low in dietary fibre because of the consumption of refined carbohydrate. Protein intake was found to be adequate for mothers and children because they consumed fish (especially tuna fish) and milk powder. Other protein sources like eggs and poultry were rarely consumed. In contrast to this, the data strongly suggest that the energy intake was inadequate especially because of low fat intake (mothers 17 % and children 20 % of the total energy intake) which was definitely too low for the under five year old children to guarantee proper growth and normal development especially for the brain and nervous system. For the mothers an increasing fat consumption could result in increasing weight because they are probably adapted to a low-fat diet. Most important fat source of the children was milk powder whereas family food was generally low in fat content. Vegetables and fruit featured rarely in the diets. Due to the intake of refined carbohydrates which are rather low in micro nutrients, the diet of the mothers and children was likely to lack certain micro nutrients like vitamin C, ß-carotene, folic acid and iron. In the mothers' diet further micro nutrients like potassium, riboflavin, pyridoxine and retinol were calculated below 75 % of the Indian or WHO RDA. A similar situation was found for the 4 year old children. Zinc, potassium,

thiamine, riboflavin and pyridoxine were calculated each below 75 % of the used RDA. Through higher milk powder consumption (which is often additionally enriched with vitamins) the average dietary intake of the 1-3 year old children seemed to meet (75 to 125 % of the recommendations) the recommendations for most calculated micro nutrients, especially retinol, riboflavin, potassium, calcium, and magnesium.

The average duration of breast feeding was calculated at 23 months. Exclusive breast feeding up to 6 months was not a common practice. About 70 % of the mothers reported having started with complementary feeding at the age of 4 months. Commercial products or milk powder were predominantly used as complementary foods. Vegetables and fruit, except bananas, were rather rarely offered to young children. Bottled juice also seemed to be favoured over freshly prepared juice from available grown fruit.

Besides nutritional factors further aspects like sanitary facilities and the incidence of infectious diseases and parasites have to be considered which together have an important impact on the nutritional status. The nutritional status of the children was significantly better ($p < 0.05$) in households with toilets as compared to households with gifili or where the mothers reported the family would use the beach or forest for defecation.

The results of the blood measurements indicated low consumption of β-carotene, vitamin C, folic acid and pyridoxine. A small number of mothers were at risk for marginal retinol and α-tocopherol deficiency (2 out of 15 for retinol and 3 out of 15 for tocopherol). For cholesterol and heamoglobin no mother was at risk.

This study suggests possible measures which could be undertaken:

Encourage mothers to exclusively breast feed their babies for the first six months and afterwards to fortify the baby’s food with oil/coconut fat, and to give more fruit and vegetables.

In general, for all family members, but especially for the children, pregnant and lactating women fat intake should be increased by more generous use of scraped coconut and vegetable oil, and increasing vegetable, fruit and GLV intake in seasons when they are available.

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10 Appendix

10.1 Household characteristics

10.1.1 Family and household size

Annex 1: Average family size divided by atolls

Atoll	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem	Total
Average family size [%] ± SD	6.9 ± 2.0	6.0 ± 2.3	5.6 ± 2.4	5.2 ± 2.1	5.6 ± 2.1	5.9 ± 2.3

Annex 2: At least one grandparent living with the family and average number of people living in the same household by atolls.

Atoll	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem	Total
Grandparents [%]	5.4	37.3	22.8	8.8	61.4	36.9
Additional HH-members	1.0	1.6	2.8	4.3	3.0	2.4
Missing data [%]	2.7	0	0	0	0	0.6

10.1.2 Education of parents

Annex 3: Education of parents.

Parents Education	Father Percent [%]	Mother Percent [%]
Literacy	39.6	30.5
Grade 3	43.5	38.4
Grade 5	6.7	15.4
Grade 7	7.0	12.4
O-level	3.2	3.3
Missing data	6.0	0.6

Annex 4: Education of fathers by atolls

Father Education	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]
Literacy	65.3	59.7	25.0	25.6	7.0
Grade 3	25.0	24.7	60.3	56.4	63.2
Grade 5	6.9	1.3	4.4	10.3	14.0
Grade 7	2.8	10.4	7.4	2.6	10.5
O-level	0	3.9	2.9	5.1	5.3
Missing data	1.4	7.2	11.9	4.9	0

Annex 5: Education of mothers by atolls

Mother Education	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]
Literacy	55.6	41.0	20.5	19.5	5.3
Grade 3	23.6	25.3	51.3	58.5	43.9
Grade 5	16.7	12.0	15.4	14.6	19.3
Grade 7	4.2	20.5	6.4	7.3	22.8
O-level	0	1.2	6.4	0	8.8
Missing data	1.4	0	1.3	0	0

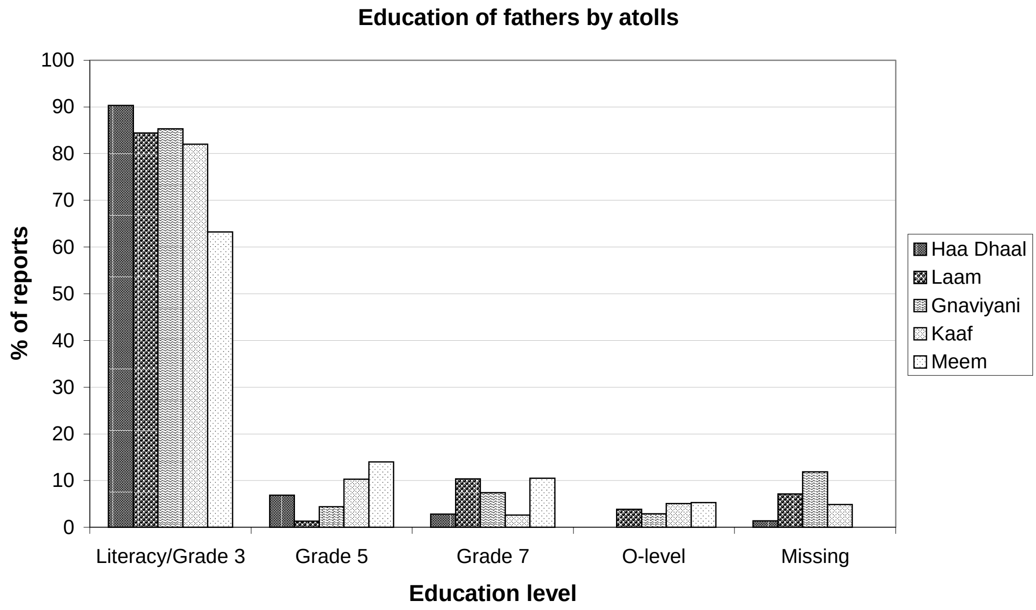

Figure 13: Education of fathers by atolls.

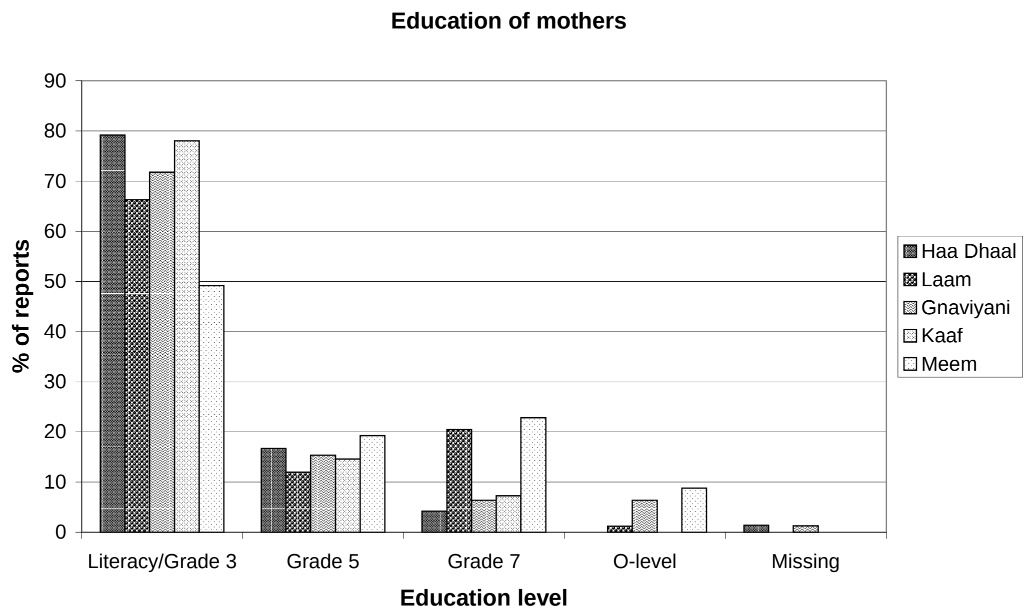

Figure 14: Education of mothers by atolls.

10.1.3 Occupation of parents

Annex 6: Occupation of the parents.

Parents Occupation	Father Percent [%]	Mother Percent [%]
Fisher	22.2	0
Worker in tourism	9.2	0
Trader	6.6	0.3
Farmer	4.4	0.9
Government worker	21.2	6.6
Labourer	5.7	1.2
Sailor	7.6	0
Transport	4.4	0
Seamstress	0	9.6
Housewife	0	80.7
Other *	9.5	0
Others, not specified	7.0	0.6
No occupation	2.2	0
Missing data	5.1	0.3

*** Mason, carpenter, welder, black smith, engineer, contractual worker.**

Annex 7: Occupation of fathers by atolls

Father Occupation	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]
Fisher	13.9	6	3.8	76.9	38.6
Worker in tourism	11.1	0	22.8	5.1	1.8
Trader	6.9	4.8	6.3	2.6	10.5
Farmer	12.5	4.8	1.3	5.1	0
Government worker	8.3	47	10.1	0	21.1
Labourer	9.7	1.2	6.3	0	8.8
Sailor	18.1	1.2	10.1	0	3.5
Transport	11.1	4.8	2.5	0	0
Others *	2.8	9.6	15.2	5.1	10.5
Others, not specified	4.2	9.6	7.6	5.1	5.3
No occupation	1.4	4.8	2.5	0	0
Missing data	1.4	6	11.4	4.9	0

*** Mason, carpenter, welder, black smith, engineer, contractual worker.**

Annex 8: Occupation of mothers by atolls

Mother Occupation	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]
Trader	0	0	1.3	0	0
Farmer	1.4	0	0	2.4	1.8
Government worker	2.8	10.8	5.1	0	12.3
Labourer	1.4	0	3.8	0	0
Seamstress	2.8	0	22.8	2.4	8.8
Housewife	90.3	81.9	65.8	95.1	77.2
Other, not specified	1.4	0	1.3	0	0
Missing data	1.4	0	0	0	0

Figure 15: **Occupation of the father by atolls**
*** Mason, carpenter, welder, black smith, engineer, contractual worker.**

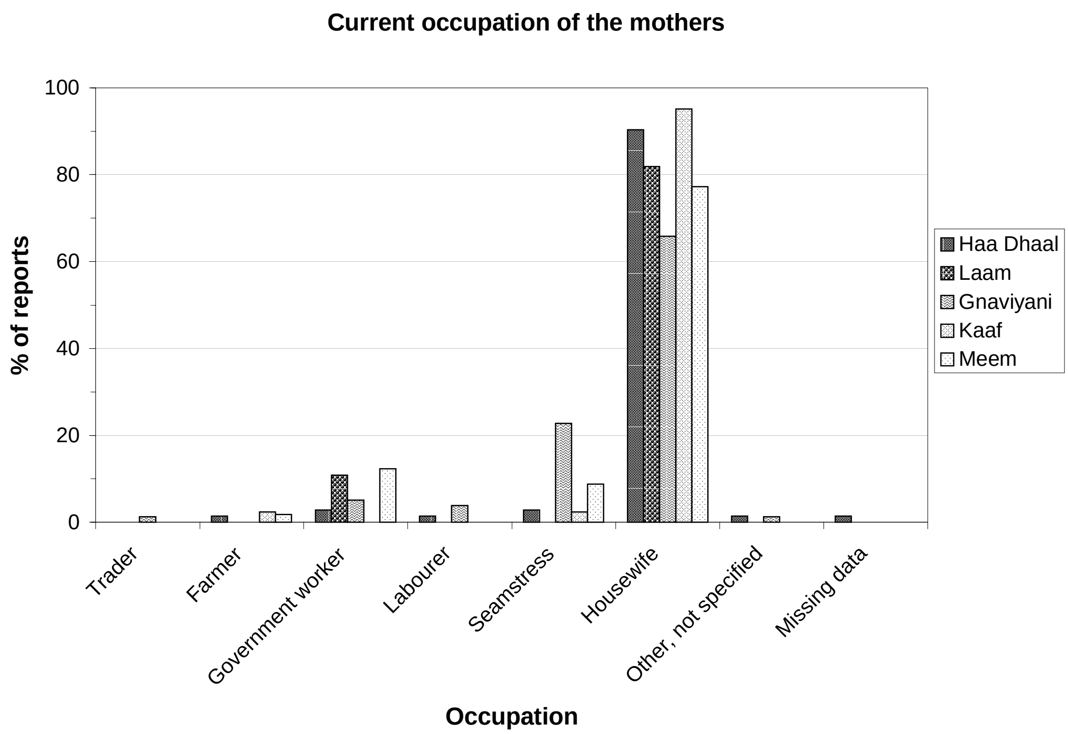

Figure 16: **Occupation of the mothers by atoll.**

10.2 Economic characteristics

10.2.1 Agricultural products:

Annex 9: Frequency of agricultural products in percentage in each atoll.

Atoll	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem	Total
Agricultural products	Percent [%]	Percent [%]	Percent [%]	Percent [%]	Percent [%]	Percent [%]
Banana	72.6	88.0	98.7	56.1	71.9	79.0
Coconut	53.4	16.9	94.9	46.3	80.7	74.5
Papaya	26.0	67.5	70.9	36.6	45.6	51.7
Guava	23.3	78.3	57	41.5	35.1	49.2
Green leaves	20.5	51.8	63.3	51.2	40.4	45.6
Breadfruit	28.8	50.6	29.1	22	47.4	36.6
Passionfruit	15.1	53.0	53.2	19.5	14	33.9
Drumsticks	27.4	41.0	34.2	31.7	19.3	31.5
Mango	4.1	26.5	60.8	7.3	12.3	24.9
Brinjal	13.7	16.9	19.0	29.3	38.6	21.9
Yam	0	6.0	72.2	9.8	1.8	20.1
Lemon	26.0	8.4	11.4	9.8	10.5	13.5
Betel leaves	17.8	0	0	7.3	7	6.0
Other prod. 1 (*)	27.4	30.1	16.5	31.7	36.9	27.6
Other prod. 2 (**)	11.4	16.9	10.1	14.7	21.1	14.7
No prod. (***)	16.4	1.2	0	29.3	5.3	8.4

Agricultural products grown in 5 to 10 % of the households: chilli, sweet potatoes, Jamburol/ Jambu, pumpkin, pomegranate.

**** Agricultural products grown in 2 to 5 % of the households: atha, stone apple, chichanda/ thoraa, bilimagu, litchi.**

***** All products below two % are not included in the list.**

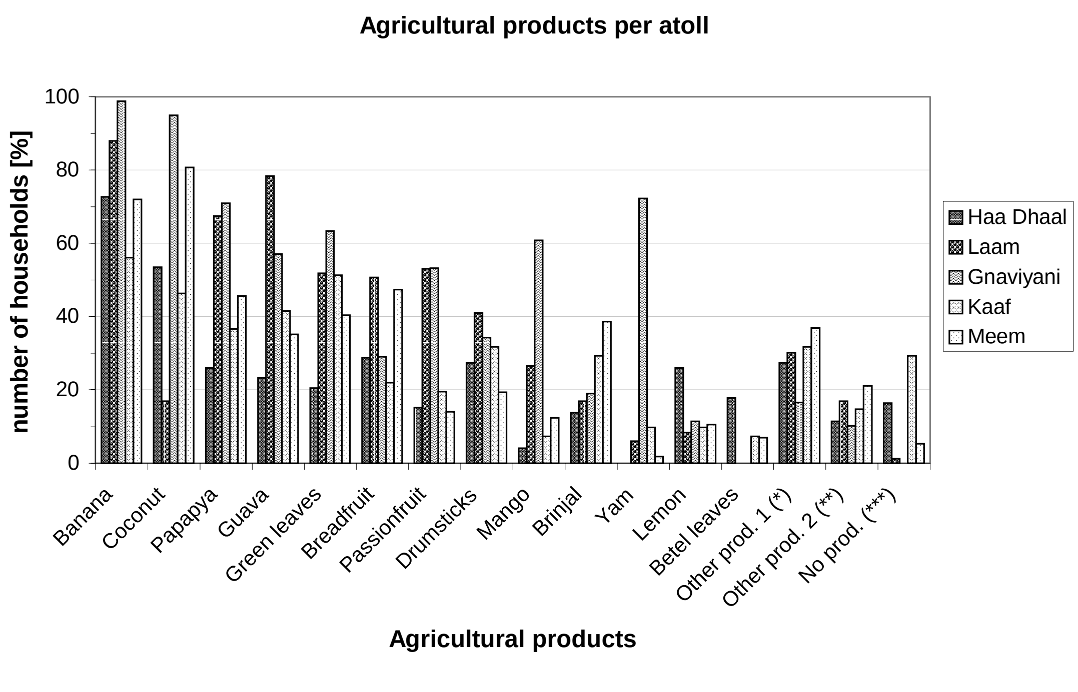

Figure 17: Agricultural products grown around the house per atoll; Explanation of *, **, * see Annex 9.**

10.2.2 Animals

Annex 10: Animals in the households per islands.

Atoll Animals	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]	Total Percent [%]
No animals	4.1	13.4	15.2	92.5	59.6	29.3
Chicken	89.0	51.2	77.2	5.0	28.1	56.2
Ducks and chicken	6.8	32.9	7.6	2.5	8.8	13.0
Ducks	0	2.4	0	0	3.5	1.5
Missing data	0	1.2	0	2.4	0	0.6

10.2.3 Sanitary facilities

Annex 11: Facilities used for defecation.

Atoll Sanitary facility	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]	Total Percent [%]
Toilet	9.7	58.5	72.2	90.2	59.6	55.3
Gifili	6.9	13.4	24.1	9.8	5.3	12.7
Beach / forest	83.3	28	3.8	0	35.1	32
Missing	1.4	1.2	0	0	0	0.6

10.3 Mother's characteristics

10.3.1 Age of the mother

Annex 12: Age of the mothers per atolls.

Atoll Age [years]	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]	Total Percent [%]
≥ 20	5.6	2.4	5.1	10.3	1.8	77.6
21-25	40.3	38.6	29.1	35.9	15.8	18.1
26-30	27.8	19.3	35.4	25.6	40.4	2.8
31-35	18.1	18.1	15.2	12.8	17.5	0.3
36-40	6.9	16.9	7.6	10.3	15.8	0.9
41-50	1.4	4.8	7.6	5.1	8.8	0.3
Missing	1.4	0	0	4.9	0	2.1
Mean ± SD	30.1 ± 5.0	30 ± 7.3	28.4 ± 6.5	27.4 ± 6.8	28.5 ± 6.2	29.0 ± 6.4

10.3.2 Age of the mother at her first birth

Annex 13: Mother's ages, when oldest child was born per atolls.

Atoll Age mother at first birth	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]	Total Percent [%]
≥ 20	78.6	85	72.2	82.9	69.6	77.6
21-25	18.6	10	25.3	9.8	25	18.1
26-30	1.4	2.5	1.3	4.9	5.4	2.8
31-35	0	0	1.3	0	0	0.3
36-40	1.4	2.5	0	0	0	0.9
41-50	0	0	0	2.4	0	0.3
Missing	4.1	3.6	0	0	1.8	2.1
Mean ± SD	18.2 ± 4.1	18.0 ± 4.5	18.7 ± 3.4	19.0 4.7	18.9 ± 3.4	18.5 ± 4.0

10.3.3 BMI, weight and height for non-pregnant mothers

Annex 14: Weight, height and BMI per atolls.

Atoll	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem	Total
Number of mothers	57	78	62	41	53	291
Height [cm] ± SD	150.0 ± 5.7	150.2 ± 5.3	147.5 ± 5.3	150.2 ± 6.0	148.9 ± 5.2	149.4 ± 5.5
Weight [kg] ± SD	48.2 ± 9.2	52.4 ± 9.8	47 ± 8.1	46.6 ± 9.1	46.9 ± 9.2	48.6 ± 9.4
Mean BMI ± SD	21.4 ± 3.8	23.2 ± 2.0	21.6 ± 3.7	20.6 ± 3.5	21.2 ± 4.3	21.8 ± 4.0

Annex 15: BMI per atolls

BMI	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem
Number	66	88	73	41	57
< 18.5	22.7	10.0	16.4	31.7	29.8
18.5 to 27.5	69.7	76.3	79.5	65.9	61.4
> 27.5	7.6	13.8	4.1	2.4	8.8

Annex 16: Average BMI by age of the mothers

BMI	≥ 20	21-25	26-30	31-35	36-40	41-50
Number of mothers	13	94	81	48	37	15
Mean BMI	19.6 ± 3.9	22.2 ± 3.9	21.2 ± 3.9	22.3 ± 4.1	22.1 ± 4.7	22.1 ± 2.8

Annex 17: BMI by age of the mothers.

BMI	< 20 years	21 – 25	26 - 30	31 - 35	36 - 40	41 - 50
Number	15	102	92	52	37	16
< 18.5	33.3	20.6	22.8	15.4	18.9	6.3
18.5 to 27.5	53.3	69.6	72.8	73.1	73.0	93.8
> 27.5	13.3	9.8	4.3	11.5	8.1	0

Annex 18: BMI by energy intake and number of children.

BMI	Energy intake	Number of children
< 18.5	1337 ± 481	3.5 ± 2.3
18.5 – 22.9	1309 ± 487	3.8 ± 2.1
23.0 – 27.5	1226 ± 430	4.5 ± 2.2
> 27.5	1207 ± 406	5.1 ± 2.0

10.4 Child characteristics

10.4.1 Age of the index child:

Annex 19: Children's age per atoll.

Atoll Age	Haa Dhaal Percent [%]	Laam Percent [%]	Gnaviyani Percent [%]	Kaaf Percent [%]	Meem Percent [%]	Total Percent [%]
1	6.8	0	12.7	4.9	1.8	5.4
2	19.2	15.7	26.6	22	19.3	20.4
3	41.1	37.3	40.5	48.8	47.4	42.1
4	32.9	47	20.3	24.4	31.6	32.1
Mean ± SD	3 ± 0.9	3.3 ± 0.7	2.7 ± 0.9	2.9 ± 0.8	3.1 ± 0.8	3.0 ± 0.9

10.4.2 Duration of breast feeding

Annex 20: Mean time of breast feeding.

Time [month]	Percent [%]
0	97.6
1	97.3
3	95.8
6	93
9	89.4
12	79.7
15	77.6
18	66.1
21	62.4
24	34.5
27	32.7
30	24.5
33	23
36	3.3
39	2.4
45	1.8
48	0
Missing data	0.9

Annex 21: Average breast feeding time per atoll.

Mean breast f. time	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem	Total
Mean ± SD	24 ± 10	27 ± 10	21 ± 8	18 ± 11	25 ± 11	23 ± 10
Missing data [%]	0	1.2	2.5	0	0	0.9

10.4.3 Age of introducing of weaning food

Annex 22: Mean age of introducing weaning food.

Age [month]	Percent [%]
0	3
1	6.4
2	10
3	20.7
4	68.4
5	74.5
6	87.8
7	89.4
8	90.9
9	92.7
10	93
12	98.5
15	98.8
18	99.1
24	100
Missing data	1.2

Annex 23: Time of introducing weaning food.

Mean time intr. w.f.	Haa Dhaal	Laam	Gnaviyani	Kaaf	Meem	Total
Mean ± SD	6 ± 4	6 ± 4	4 ± 2	4 ± 3	4 ± 2	5 ± 3
Missing data [%]	1.4	1.2	1.3	2.4	0	1.2

10.4.4 Anthropometry

Figure 18: Z-Score distribution for: HFA

```
-5.0:   #
 -4.5:  #****
 -4.0:  #****
 -3.5:  #**********
 -3.0:  #************
 -2.5:  *#******************************
 -2.0:  ****#*********************
 -1.5:  ************#***********************
 -1.0:  ***********************#********
 -0.5:  ****************                  #
 0.0:   **********                             #
 0.5:   ********                          #
 1.0:   ******                 #
 1.5:   **          #
 2.0:       #
 2.5:    #
 3.0:   #
 3.5:   #
 4.0:   #
 4.5:   #
 5.0:   #
```

Figure 19: Z-Score distribution for: WFH

```
-5.0:   #
 -4.5:  #
 -4.0:  #
 -3.5:  #**
 -3.0:  #****
 -2.5:  *#******
 -2.0:  ****#***************************
 -1.5:  ************#***************************************
 -1.0:  ***********************#********************
 -0.5:  **********************************#*
 0.0:   ************                           #
 0.5:   ********                          #
 1.0:                          #
 1.5:               #
 2.0:       #
 2.5:    #
 3.0:   #
 3.5:   #
 4.0:   #
 4.5:   #
 5.0:   #
```

10.5 Blood samples

10.6 Nutrient intake of mothers

Annex 24: Mothers' nutrient intake of all groups compared to the permanent group.

Groups Nutrients	All Mean ± SD	Permanent Mean ± SD
Number ***	307	81
Calc. Ener. (kcal) **	1678 ± 209	1643 ± 194
Energy (kcal)	1272 ± 469	1399 ± 415♦
Water (g)	2062 ± 650	2285 ± 513
Protein (g)	44 ± 19	49 ± 19♦
Veg. Protein (g)	19 ± 7	20 ± 5
An. Protein (g)	25 ± 14	29 ± 16
Fat (g)	24 ± 12	27 ± 12
Carbohydr. (g)	216 ± 79	236 ± 67♦
Sucrose (g)	47 ± 31	55 ± 38
Dietary fibre (g)	8.1 ± 5.8	8.8 ± 6.0
PUFA (g)	5.9 ± 3.2	7.0 ± 2.8♦
Vitamin A (µg)	458 ± 395	525 ± 447
Retinol (µg)	399 ± 307	483 ± 441
Carotene (mg)	0.36 ± 1.35	0.27 ± 0.40
Vit. E* (mg)	4.8 ± 2.7	5.8 ± 2.4♦
Vitamin B1 (mg)	0.72 ± 0.31	0.78 ± 0.26
Vitamin B2 (mg)	0.53 ± 0.36	0.58 ± 0.38
Vitamin B6 (mg)	1.01 ± 0.45	1.13 ± 0.45♦
Folic ac. eq. (µg)	34 ± 24	38 ± 24
Vitamin C (mg)	21 ± 29	19 ± 22
Potassium (mg)	1040 ± 619	1130 ± 599
Calcium (mg)	317 ± 213	336 ± 205
Magnesium (mg)	150 ± 60	160 ± 52
Phosphor. (mg)	592 ± 272	640 ± 255
Iron (mg)	8.7 ± 3.3	9.4 ± 2.4
Zinc (mg)	6.0 ± 2.1	6.5 ± 1.5♦

$^*\alpha$-tocopherol
**** Calculated average energy requirement based on individual need according to weight, height, age and sedentary work**
***** number of questionnaires.**
♦ Significant difference ($p < 0.05$).

10.7 Comparison between different groups of mothers

Annex 25: Nutrient intake of mothers per age.

Age Nutrients	18 - 29 Mean ± SD	30 - 48 Mean ± SD
Number ***	183	121
Calc. Ener. (kcal) **	1678 ± 199	1685 ± 217
Energy (kcal)	1294 ± 488	1225 ± 439
Water (g)	2103 ± 657	2003 ± 635
Protein (g)	45 ± 19	42 ± 18
Veg. Protein (g)	19 ± 7	18 ± 7
An. Protein (g)	25 ± 15	23 ± 13
Fat (g)	25 ± 12	23 ± 13
Carbohydr. (g)	219 ± 82	209 ± 73
Sucrose (g)	48 ± 31	44 ± 29
Dietary fibre (g)	8.6 ± 6.1	8.0 ± 7.4
PUFA (g)	6.0 ± 3.2	5.6 ± 3.2
Vitamin A (µg)	482 ± 382	427 ± 414
Retinol (µg)	431 ± 348	357 ± 225♦
Carotene (mg)	0.32 ± 0.80	0.43 ± 1.91
Vit. E* (mg)	4.9 ± 2.7	4.7 ± 2.9
Vitamin B1 (mg)	0.74 ± 0.33	0.71 ± 0.28
Vitamin B2 (mg)	0.57 ± 0.38	0.47 ± 0.32♦
Vitamin B6 (mg)	1.04 ± 0.48	0.97 ± 0.41
Folic ac. eq. (µg)	36 ± 23	32 ± 25
Vitamin C (mg)	22 ± 27	20 ± 33
Potassium (mg)	1083 ± 609	984 ± 633
Calcium (mg)	340 ± 224	285 ± 190♦
Magnesium (mg)	154 ± 62	144 ± 57
Phosphor. (mg)	614 ± 283	562 ± 251
Iron (mg)	8.8 ± 3.4	8.6 ± 3.1
Zinc (mg)	6.2 ± 2.2	5.8 ± 1.9

***α-tocopherol**
**** Calculated average energy requirement based on individual need according to weight, height, age and sedentary work**
***** number of questionnaires.**
♦ Significant difference ($p < 0.05$).

Annex 26: Nutrient intake of mothers per BMI

BMI Nutrients	14.5 - 22.9 Mean ± SD	23 - 40 Mean ± SD
Number ***	188	103
Calc. Ener. (kcal) **	1581 ± 159	1857 ± 172♦
Energy (kcal)	1314 ± 493	1205 ± 418♦
Water (g)	2133 ± 645	1944 ± 644♦
Protein (g)	46 ± 19	40 ± 17♦
Veg. Protein (g)	19 ± 7	19 ± 6
An. Protein (g)	26 ± 15	21 ± 13♦
Fat (g)	25 ± 13	23 ± 11♦
Carbohydr. (g)	222 ± 83	207 ± 70
Sucrose (g)	49 ± 32	44 ± 28
Dietary fibre (g)	8.4 ± 6.1	7.8 ± 5.4
PUFA (g)	5.9 ± 3.1	5.8 ± 3.3
Vitamin A (µg)	519 ± 457	359 ± 246♦
Retinol (µg)	443 ± 344	328 ± 224♦
Carotene (mg)	0.46 ± 1.69	0.20 ± 0.38♦
Vit. E* (mg)	4.9 ± 2.7	4.8 ± 2.8
Vitamin B1 (mg)	0.76 ± 0.32	0.67 ± 0.26♦
Vitamin B2 (mg)	0.59 ± 0.38	0.42 ± 0.29♦
Vitamin B6 (mg)	1.06 ± 0.47	0.92 ± 0.39♦
Folic ac. eq. (µg)	37 ± 24	29 ± 18♦
Vitamin C (mg)	22 ± 28	19 ± 32♦
Potassium (mg)	1104 ± 618	895 ± 492♦
Calcium (mg)	350 ± 224	257 ± 182♦
Magnesium (mg)	158 ± 63	136 ± 52♦
Phosphor. (mg)	629 ± 284	528 ± 236♦
Iron (mg)	9.1 ± 3.5	8.3 ± 2.8♦
Zinc (mg)	6.3 ± 2.2	5.6 ± 1.8♦

*** α-tocopherol**
**** Calculated average energy requirement based on individual need according to weight, height, age and sedentary work**
***** number of questionnaires.**
♦ Significant difference ($p < 0.05$)

Annex 27: Nutrient intake of pregnant and non-pregnant mothers.

Pregnant Nutrients	No Mean ± SD	Yes Mean ± SD	Requirement for pregn.
Number ***	294	26	
BMI			
Calc. ener. (kcal) **	1678 ± 209		
Energy (kcal)	1272 ± 469	1383 ± 405	+ 300
Water (g)	2062 ± 650	2238 ± 615	
Protein (g)	44 ± 19	47 ± 16	+ 15
Veg. Protein (g)	19 ± 7	20 ± 5	
An. protein (g)	25 ± 14	27 ± 12	
Fat (g)	24 ± 12	26 ± 13	+ 10
Carbohydr. (g)	216 ± 79	236 ± 68	
Sucrose (g)	47 ± 31	56 ± 31	
Dietary fibre (g)	8.1 ± 5.8	9.2 ± 6.3	
PUFA (g)	5.9 ± 3.2	5.5 ± 4.1	
Vitamin A (µg)	461 ± 401	490 ± 285	+ 100*
Retinol (µg)	402 ± 311	428 ± 238	Same
Carotene (mg)	0.37 ± 1.38	0.40 ± 0.55	Same
Vit. E* (mg)	4.9 ± 2.7	4.2 ± 2.8	+ 2**
Vitamin B1 (mg)	0.72 ± 0.31	0.80 ± 0.25	+ 0.2
Vitamin B2 (mg)	0.53 ± 0.36	0.60 ± 0.32	+ 0.2
Vitamin B6 (mg)	1.01 ± 0.45	1.09 ± 0.38	+ 0.5
Folic ac. eq. (µg)	34 ± 22	38 ± 23	+ 300 / + 250*
Vitamin C (mg)	21 ± 29	24 ± 27	Same
Potassium (mg)	1027 ± 582	1167 ± 552	No increment ***
Calcium (mg)	316 ± 214	406 ± 252	+ 600
Magnesium (mg)	150 ± 60	161 ± 49	+ 40**
Phosphor. (mg)	592 ± 271	672 ± 277	1200
Iron (mg)	8.8 ± 3.2	9.8 ± 2.3	+ 8
Zinc (mg)	6.0 ± 2.1	6.6 ± 1.9	+ 0.8 – 6.8°°

***α-tocopherol**
**** Calculated average energy requirement based on individual need according to weight, height, age and sedentary work**
***** number of questionnaires**
*** WHO (1988) safe level**
**** USA-RDA**
***** USA minimum requirement**
° WHO (1974) RNI
°° WHO (1992) normative requirement on diet of moderate zinc availability

Annex 28: Average nutrient intake of mothers per atoll with of all interviewing groups compared to the permanent group

Atoll	Haa Dhaal		Laam		Gnaviyani		Kaaf		Meem	
Nutrients	**All**	**Perm.**	**All**	**Perm.**	**All**	**Perm.**	**All**	**Perm.**	**All**	**Perm.**
Number ***?	63	18	81	23	68	15	41	11	53	15
Calc. en. (kcal)**	1706	1684	1755	1706	1634	1579	1650	1590	1636	1600
Energy (kcal)	1016	1143	1032	1143	1439	1587	1567	1666	1466	1736
Water (g)	1662	2012	1774	2195	2483	2529	2219	2193	2303	2596
Protein (g)	35	40	33	38	46	49	60	68	54	66
Veg. Protein (g)	16	18	16	18	22	23	24	24	20	23
An. Protein (g)	19	22	17	20	24	26	36	45	34	43
Fat (g)	16	19	19	20	32	33	31	34	28	35
Carbohydr. (g)	179	199	180	199	238	268	258	267	247	284
Sucrose (g)	30	39	39	42	49	75	47	48	73	84
Dietary fibre (g)	5.1	6.2	5.8	6.3	15.0	17.0	9.1	8.4	7.0	8.0
Cal. en. (kcal) **	3.7	5.0	5.0	6.2	6.7	7.7	7.5	7.8	7.3	9.6
Vitamin A (µg)	290	331	328	451	530	524	640	766	621	706
Retinol (µg)	270	294	302	429	434	447	584	721	514	666
Carotene (mg)	0.13	0.23	0.16	0.14	0.57	0.49	0.37	0.31	0.66	0.27
Vitamin E* (mg)	3.0	4.3	4.2	5.4	5.5	6.5	6.0	5.8	6.0	7.8
Vitamin B1 (mg)	0.65	0.67	0.53	0.62	0.82	0.83	0.96	1.05	0.79	0.92
Vitamin B2 (mg)	0.34	0.36	0.34	0.40	0.72	0.72	0.77	0.87	0.60	0.81
Vitamin B6 (mg)	0.82	0.90	0.75	0.85	1.16	1.29	1.35	1.52	1.17	1.40
Folic ac. eq. (µg)	21	23	23	26	56	65	42	44	35	43
Vitamin C (mg)	8	16	12	9	41	37	28	26	18	16
Potassium (mg)	703	769	711	751	1597	1755	1284	1462	1040	1287
Calcium (mg)	201	211	224	247	474	432	421	467	315	436
Magnesium (mg)	116	130	117	126	185	188	187	201	166	194
Phosphor. (mg)	454	475	434	489	739	745	807	893	641	790
Iron (mg)	8.1	8.6	7.1	8.1	9.3	9.5	11.1	11.6	9.5	10.7
Zinc (mg)	5.2	5.7	5.0	5.7	6.7	6.8	7.5	7.9	6.5	7.6

*** α-tocopherol**
**** Calculated average energy requirement based on individual need according to weight, height, age and sedentary work**
***** number of questionnaires per atoll**

10.8 Nutrient intake of children

Annex 29: Average nutrient intake of all interviewing groups compared to the permanent group for the 1-3 year old children.

Groups Nutrients	All groups Mean value ± SD	Permanent group Mean value ± SD
Number**	226	70
Energy (kcal)	936 ± 318	933 ± 250
Water (g)	1594 ± 474	1536 ± 382
Protein (g)	33 ± 13	33 ± 11
Veg. Protein (g)	10 ± 5	10 ± 4
An. Protein (g)	23 ± 12	23 ± 10
Fat (g)	22 ± 11	21 ± 8
Carbohydr. (g)	148 ± 50	151 ± 43
Sucrose (g)	57 ± 28	61 ± 27
Dietary fibre (g)	4.9 ± 4.0	4.4 ± 2.4
Vitamin A (µg)	500 ± 315	451 ± 225
Retinol (µg)	461 ± 270	434 ± 227
Carotene (mg)	0.29 ± 1.03	0.16 ± 0.19
Vit. E* (mg)	3.1 ± 1.7	3.2 ± 1.6
Vitamin B1 (mg)	0.48 ± 0.21	0.47 ± 0.17
Vitamin B2 (mg)	0.79 ± 0.51	0.74 ± 0.44
Vitamin B6 (mg)	0.68 ± 0.28	0.66 ± 0.23
Folic ac. eq. (µg)	33 ± 17	31 ± 13
Vitamin C (mg)	20 ± 30	13 ± 10
Potassium (mg)	1007 ± 525	942 ± 395
Calcium (mg)	522 ± 346	478 ± 281
Magnesium (mg)	117 ± 47	112 ± 36
Phosphor. (mg)	581 ± 303	534 ± 220
Iron (mg)	4.7 ± 1.9	4.6 ± 1.6
Zinc (mg)	4.3 ± 1.5	4.1 ± 1.2

*** α-tocopherol**
**** number of questionnaires.**

Annex 30: Average nutrient intake of all interviewing groups compared to the permanent group for the 4 year old children.

Groups Nutrients	All Mean value ± SD	Permanent Mean value ± SD
Number **	107	20
Energy (kcal)	872 ± 308	1009 ± 284
Water (g)	1514 ± 442	1614 ± 328
Protein (g)	30 ± 13	32 ± 11
Veg. Protein (g)	11 ± 5	11 ± 4
An. Protein (g)	19 ± 10	21 ± 10
Fat (g)	19 ± 10	21 ± 10
Carbohydr. (g)	144 ± 49	170 ± 52♦
Sucrose (g)	53 ± 27	71 ± 32♦
Dietary fibre (g)	4.7 ± 2.9	4.9 ± 2.6
Vitamin A (µg)	365 ± 220	398 ± 201
Retinol (µg)	332 ± 206	371 ± 205
Carotene (mg)	0.24 ± 0.43	0.23 ± 0.24
Vit. E* (mg)	3.5 ± 2.2	3.7 ± 1.8
Vitamin B1 (mg)	0.42 ± 0.19	0.44 ± 0.17
Vitamin B2 (mg)	0.51 ± 0.31	0.63 ± 0.34
Vitamin B6 (mg)	0.62 ± 0.29	0.63 ± 0.26
Folic ac. eq. (µg)	25 ± 13	27 ± 13
Vitamin C (mg)	15 ± 15	12 ± 8
Potassium (mg)	753 ± 368	845 ± 339
Calcium (mg)	325 ± 189	405 ± 191
Magnesium (mg)	99 ± 39	105 ± 35
Phosphor. (mg)	440 ± 209	491 ± 171
Iron (mg)	4.8 ± 1.8	5 ± 1.5
Zinc (mg)	3.8 ± 1.3	4.1 ± 1.2

* **α-tocopherol**
** **number of questionnaires.**
♦ **Significant difference ($p < 0.05$).**

10.9 Comparison between different groups of children

Annex 31: Average nutrient intake of the 1-3 year old children per atoll with of all interviewing groups compared to the permanent group.

Atoll	Haa Dhaal		Laam		Gnaviyani		Kaaf		Meem	
Nutrients	**All**	**Perm.**	**All**	**Perm.**	**All**	**Perm.**	**All**	**Perm.**	**All**	**Perm.**
Number **	49	18	44	15	63	16	31	9	39	12
Energy (kcal)	640	757	871	914	1038	941	1081	1026	1008	1141
Water (g)	1136	1299	1574	1620	1738	1484	1819	1518	1644	1872
Protein (g)	24	27	29	30	34	30	38	38	36	42
Veg. Protein (g)	7	8	8	9	11	10	12	10	10	11
An. Protein (g)	15	20	21	21	23	20	26	28	27	31
Fat (g)	14	16	21	21	25	21	25	27	21	26
Carbohydr. (g)	103	123	140	150	173	157	160	154	165	182
Sucrose (g)	36	53	62	61	54	63	52	51	77	81
Dietary fibre (g)	2.3	2.8	2.9	3.9	6.6	6.8	4.7	4.0	3.3	4
Vitamin A (µg)	276	347	417	413	511	427	535	561	529	603
Retinol (µg)	276	329	384	400	485	416	510	536	473	579
Carotene (mg)	0.06	0.15	0.11	0.13	0.13	0.12	0.21	0.23	0.12	0.22
Vitamin E* (mg)	2.0	2.4	2.5	3.2	3.2	3.2	3.1	3.3	3.2	4.0
Vitamin B1 (mg)	0.32	0.37	0.36	0.45	0.55	0.50	0.49	0.53	0.51	0.56
Vitamin B2 (mg)	0.37	0.54	0.69	0.71	0.88	0.76	1.01	0.89	0.65	0.97
Vitamin B6 (mg)	0.47	0.54	0.51	0.62	0.76	0.71	0.69	0.71	0.74	0.81
Folic ac. eq. (µg)	21	24	28	29	36	35	37	32	30	37
Vitamin C (mg)	5	7	8	12	23	19	17	17	9	13
Potassium (mg)	574	703	846	893	1191	1051	1152	1064	856	1124
Calcium (mg)	240	334	434	470	595	481	665	601	405	606
Magnesium (mg)	81	91	101	111	136	110	133	122	118	140
Phosphor. (mg)	325	389	461	534	668	557	633	648	521	633
Iron (mg)	3.6	3.8	4.0	4.5	5.7	4.7	5.1	5.0	5.2	5.3
Zinc (mg)	2.8	3.2	3.9	4.1	4.9	4.1	5.0	4.8	4.4	4.9

*** α-tocopherol**
**** number of questionnaires per atoll**

10.10 Map, time table, questionnaire, example for dietary intake

Annex 33: Time table of the field work.

Observation of the nutritional habits and pretesting and Translation of the questionnaire:
21.11. – 03.12.1997 Hinnavaru / Lhaviyani

Conducting the survey with the questionnaire:
07.12 – 10.12.1997 Nolivaram / Haa Dhaal
13.12. – 18. 12. 1997 Fonadhoo and Gadhoo /
21.12. – 25.12.1997 Foammulah / Gnaviyani
04.02. – 18.02.1998 Dhiffushi / Kaaf
15.02 – 18.02.1998 Muli and Mulah / Meem

Observations:
Februar to April 1998 Male

Annex 34: Questionnaire.

HH - No..........................
Interviewer: ....

Date: ....
Island: ....
Atoll: ....

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Direction: *This questionnaire is for interviewing the mother of the family.*
The family should have at least one child between 1 and 5 years without breastfeeding.
If there is more than one child, the interviewer has to select one child randomly.

A. Demographic Questionnaire

Number of Household- members:
Number of Family- members *(including grandparents)*:
Do grandparents live with the family ? 1 Yes
2 No

List for Family- members (only mother, father, children) :

S.N	***First Name***	***Family Status***	***Age***	***Sex*** **A**	***Education*** **B**	***Occupation*** **C**

A Sex:
1 Male
2 Female

B Education:
1 Never attended school
2 Can read and write without schoolings
3 Macuthabu
4 School up to grade 5
5 School up to grade 7
6 School from grade 8-10
7 Secondary (grade 11-12)
8 University
9 Other ....

C Occupation:
1 Fishing
2 Tourism
3 Trade
4 Farming
5 Clerical work
6 Labourer
7 Sailor
8 Tailor
9 Housewife
10 No occupation
11 Other ....

HH- No: ....
Interviewer: ....

Date: ....
Island: ....
Atoll: ....

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B. Socioeconomic Questionnaire:

1.Own agriculture products including green leaves:
- 1 No *(if no go to Q 2)*
- 2 Yes *(if yes specify)*
  - a Coconut
  - b Banana
  - c Papaya
  - d Guava
  - e Mango
  - f Lemon
  - g Brinjal
  - h Drumsticks
  - i Breadfruit
  - k Passionfruit
  - l Pumpkins
  - m Sweet Potatoes
  - n **Green Leaves**
  - o Others ....

2. Own Animals
- 1 No
- 2 Yes *(if yes specify)*
  - a Chicken
  - b Duck
  - c Others ....

3. How much fresh fish did you have yesterday ?
- 1 Less than normal
- 2 Normal
- 3 More than normal

4. Where do you store your food ? e.g. rice, sugar
- 1 Kitchen
- 2 Living room
- 3 Special place

5. How many meals do you cook every day?
- a One meal
- b Two meals
- c Three meals or more

6. How many snacks do you have every day ?
- a No snack
- b One snack
- c Two snacks
- d More than two snacks

7. What do you do with your left over food after dinner ?
....

8. Who normally eats first in the family, who last ?
- 1 First ....
- 2 Last ....
  - a Father
  - b Mother
  - c Boys
  - d Girls
  - e Children
  - f Grandparents (old people)
  - g Other ....

HH- No: .... **D**ate: ....
Interviewer: .... **I**sland: ....
Atoll: ....

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9. How many children have to be fed ?
a None *(if none, than go to Q 11)*
b One
c Two
d Three
e More than three

10.What is the name of these children ?
1 ....
2 ....
3 ....

11. Which special food do you consume during pregnancy ? *(if no special food then go to Q 13)*

1…………………..........3……………………........

2…………………..........4……………………........

12. Reasons for eating special food during pregnancy:

1…………………..........3……………………........

2…………………..........4……………………........

13. What special food do you consume during lactation ? *(if no special food then go to Q 15)*

1…………………..........3……………………........

2…………………..........4……………………........

14. Reasons for eating special food during lactation.

1…………………..........3……………………........

2…………………..........4……………………........

15. What kind of toilet facility does your household have?

1 Flush Toilet
2 Gifili
3 Beach
4 Others

HH- No: .... **D**ate: ....
Interviewer: .... **I**sland: ....
Atoll: ....

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C. Child Questionnaire

CHILD *(between 1 and 5 years without breastfeeding)*

1. Name………………………..

2. Date of birth ………………..

3. How long did you breastfeed your child? …… months

4. When did you start with weaning food? ……. months

5. With which weaning food do you start ?

   1 .... 2.................................

   3 .... 4..................................

6. Do you use any vitamin supplements ?
   1 Haliborange
   2 Iron
   3 Cod liveroil (Vit. A and D)
   4 ....

7. What food do you think is best for your young children ?

   1 .... 2..................................

   3 .... 4..................................

8. Which fluids do you think are best for your young children ?

   1 .... 2..................................

   3 .... 4..................................

HH- No: ....
Interviewer: ....

Date: ....
Island: ....
Atoll: ....

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10. Do you give or avoid special food or fluids, when your child is ill ?
    1 No
    2 Yes *(if yes specially)*
    a High fever
    Food / fluids given: ....
    Food / fluids avoided: ....
    Reason: ....

    b Diarrhoea
    Food / fluids given: ....
    Food / fluids avoided: ....
    Reason: ....

    c Cold
    Food / fluids given: ....
    Food / fluids avoided: ....
    Reason: ....

    d Other: ....
    Food / fluids given: ....
    Food / fluids avoided: ....
    Reason: ....

11. Does the child have dental caries ?
    (*Please check , if the child has dental caries)*
    1 Yes
    2 No

12. When does the child brush the teeth ?
    1 Never
    2 Morning
    3 Evening
    4 Other ....

HH- No: .... **D**ate: ....
Address: .... **I**sland: ....
Interviewer: .... **A**toll: ....

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E. Anthropometric Questionnaire

CHILD *(same child as in section D)*

1 Name………………………..

2 Date of birth ………………..

3 Height……………(cm)

4 Weight………….(kg)

5 Does any member of your family have night blindness? 1 Yes
2 No

6 Is blood taken for HemoCue ? 1 Yes Value: ....
2 No

7 Is blood taken for VAD ? 1 Yes
2 No

MOTHER

1. Are you pregnant ? 1 Yes
2 No

2. Age………..(years)

3. Height………..(cm)

4. Weight ……….(kg)

Annex 35: 6 possible dietary protocols for 3 year old children.

Food	Amount in g	Kcal
Plan 01		
BEFORE BREAKFAST		
Tea black (1 glass)	200	1.0
Milk powder (2 tablespoons)	20	101.8
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Banana fresh (1 piece)	50	47.6
BREAKFAST		
Tea black (1 cup)	150	0.7
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Roshi with coconut (R) (2/3 piece)	30	99.3
Bluefin tuna (1 inch piece)	20	27.6
LEMON FRESH (1/8 PIECE)	3	1.7
Drumstick leaves (2 full teaspoons)	4	3.7
BETWEEN BREAKFAST AND LUNCH		
Passionfruit (1 piece)	25	13.5
Drinking water (1 glass)	200	0
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Mas roshi (2/3 to one piece)	30	82.6
LUNCH		
Drinking water (1 ½ glasses)	300	0
Rice and coconut milk (R) (1 ½ rice spoons)	110	125.5
Dhaal curry w. mango (R) (2 bowl spoons)	80	62.0
BETWEEN LUNCH AND DINNER		
Tea black (1 cup)	150	0.7
Milk powder (1 tablespoon)	10	50.9
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Papaya fresh	50	6.5
Faa roshi (1 piece)	20	73.1
DINNER		
Drinking water (1 ½ glasses)	300	0
Rice and breadfruit (R) (1 ½ rice spoons)	110	146.0
Tuna fried (R) (1 inch piece)	20	43.4
Lemon fresh (1/8 piece)	3	1.7
Copy leaves (1/2 middle size piece)	10	2.7
Onions fresh (1/8 piece)	8	2.2
Coconut meat (3 tablespoons)	30	133.1
BEFORE BED		
Tea black (1 glass)	200	1.0
Milk powder (2 tablespoons)	20	101.8
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
		Total 1292 kcal/day

Plan 02

BEFORE BREAKFAST		
Tea black (1 glass)	200	1.0
Milk powder (2 tablespoons)	20	101.8
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Banana fresh (1 piece)	50	47.6
BREAKFAST		
Tea black (1 cup)	150	0.7
Sugar	8	32.4
Drinking water	100	0
Roshi with coconut (R) (2/3 piece)	30	99.3
Mashuni (R) (1 ½ to 2 tablespoons)	20	36.2
Mango green (small piece)	5	3.5
BETWEEN BREAKFAST AND LUNCH		
Water melon juice (R) (1 glass)	200	19.1
Sugar	8	32.4
Drinking water	100	0
Chicken egg fresh backed (1 egg)	35	54.0
Vegetable oils (for frying egg; 1 teaspoon)	5	44.1
LUNCH		
Drinking water(1 ½ glasses)	300	0
Rice and coconut milk (R) (1 ½ rice spoons)	110	125.5
Thoraa / chichandaa kirugarudiya (R) (2 ½ bowl spoons)	100	32.4
Coconut meat (2 tablespoons)	20	88.7
BETWEEN LUNCH AND DINNER		
Tea black (beverage)	150	0.7
Milk powder (1 teaspoon)	10	50.9
Sugar	8	32.4
Drinking water	100	0
Jambu / janbu (2 pieces)	50	31.0
Salty cracker (2 pieces)	30	112.9
DINNER		
Drinking water	300	0
Yam fresh	110	111.5
Fish curry (R) (1 ½ bowl spoon)	60	46.9
BEFORE BED		
Tea black (beverage)	200	1.0
Milk powder	20	101.8
Sugar	8	32.4
Drinking water	100	0
		Total 1273 kcal/day

Plan 03

BEFORE BREAKFAST		
Tea black (1 glass)	200	1.0
Milk powder (2 tablespoons)	20	99.9
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Banana fresh (1 piece)	50	47.6
BREAKFAST		
Tea black (1 cup)	150	0.7
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Roshi (R) (1 piece)	30	83.9
Mashuni (R) (1 ½ to 2 tablespoons)	30	54.3
Drumstick leaves (3 full teaspoons)	6	5.5
BETWEEN LUNCH AND DINNER		
Drinking water	200	0
Lemon fresh (1/2 lemon)	10	5.6
Sugar	8	32.4
Drinking water	100	0
Gulha (R) (1 piece)	15	35.6
LUNCH		
Drinking water (1 ½ glasses)	300	0
Rice and breadfruit (R) (1 ½ bowl spoons)	110	146.0
Copy leaves (1/2 piece)	10	2.7
Coconut meat (3 tablespoons)	30	133.1
Lemon fresh (1/8 lemon)	3	1.7
Rihaakuru (1 teaspoon)	6	14.1
Bluefin tuna (1 inch piece)	20	27.6
AFTERNOON		
Tea black	150	0.7
Milk powder (1 tablespoon)	10	50.0
Sugar	8	32.4
Drinking water	100	0
Banana fresh	50	47.6
Faa roshi (1 piece)	20	73.1
DINNER		
Drinking water	300	0
Rice and coconut milk (R) (1 ½ rice spoons)	110	125.5
Drumstick kirugarudiya (R) (2 ½ bowl spoons)	100	36.6
Coconut meat (1 tablespoon)	10	44.4
BEFORE BED		
Tea black	200	1.0
Milk powder	20	99.9
Sugar	8	32.4
Drinking water	100	0
		Total 1300 kcal/day

Plan 04

BEFORE BREAKFAST		
Tea black (1 glass)	200	1.0
Milk powder (2 tablespoons)	20	111.9
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Banana fresh (1 piece)	50	47.6
BREAKFAST		
Tea black (1 cup)	150	0.7
Sugar	8	32.4
Drinking water	100	0
Roshi with coconut (R) (2/3 piece)	30	99.3
Bluefin tuna (1 inch piece)	20	27.6
Satani with copyfai (R) (2 tablespoons)	20	5.3
Coconut meat (1 ½ tablespoons)	15	66.5
BETWEEN LUNCH AND DINNER		
Drinking water	200	0
Lemon fresh (1/2 piece)	10	5.6
Sugar	8	32.4
Drinking water	100	0
Dhonkeyoo kajuru (R) (1 piece)	30	80.9
LUNCH		
Drinking water	300	0
Yam fresh	50	50.7
Rice and coconut milk (R) (more than ½ rice spoon)	50	57.0
Pumpkin curry (R) (2 ½ bowl spoons)	100	50.3
BETWEEN LUNCH AND DINNER		
Tea black	150	0.7
Milk powder (1 tablespoon)	10	56.0
Sugar	8	32.4
Drinking water	100	0
Dhonkeyoo kajuru (R) (½ piece)	15	40.4
Mango fresh (1/2 mango)	40	24.1
DINNER		
Drinking water	300	0
Rice and coconut milk (R) (1 ½ rice spoons)	110	125.5
Chicken curry (R) (2 ½ bowl spoons)	100	59.6
Coconut meat (2 tablespoons)	20	88.7
BEFORE BED		
Tea black (beverage)	200	1.0
Milk powder	20	111.9
Sugar	8	32.4
Drinking water	100	0
		Total 1275 kcal/day

Plan 05

BEFORE BREAKFAST		
Tea black (1 glass)	200	1.0
Milk powder (2 tablespoons)	20	99.9
Sugar (1 teaspoon)	8	32.4
Drinking water (1/2 glass)	100	0
Banana fresh (1 piece)	50	47.6
BREAKFAST		
Tea black (1 cup)	150	0.7
Sugar	8	32.4
Drinking water (1/2 glass)	100	0
Roshi with coconut (R) (2/3 piece)	30	99.3
Fried fish (R) (1 inch piece)	20	43.4
Copy leaves (1/2 leave)	10	2.7
BETWEEN LUNCH AND DINNER		
Drinking water (1 ½ glasses)	200	0
Papaya (ind.)	50	16.0
Sugar	8	32.4
Drinking water	100	0
Mas roshi (R) (2/3 piece)	30	82.6
LUNCH		
Drinking water	300	0
Noodles (R) (1 ½ rice spoons)	110	145.2
Bluefin tuna (1 inch piece)	20	27.6
Drumstick leaves (3 full teaspoons)	6	5.5
Coconut meat (3 tablespoons)	30	133.1
BETWEEN LUNCH AND DINNER		
Tea black	150	0.7
Milk powder (1 tablespoon)	10	50.0
Sugar	8	32.4
Papaya (ind.)	50	16.0
Faa roshi (1 piece)	20	73.1
DINNER		
Drinking water	300	0
Batate (sweet potato) fresh	50	55.7
Rice and coconut milk (R) (more than ½ rice spoon)	50	57.0
Fish kirugarudiya (R) (2 bowl spoons)	80	46.3
Coconut meat (2 tablespoons)	20	88.7
BEFORE BED		
Tea black	200	1.0
Milk powder	20	99.9
Sugar	8	32.4
Drinking water	100	0
		Total 1355 kcal/day

Plan 06

BEFORE BREAKFAST		
Tea black (1 glass)	200	1.0
Milk powder (2 tablespoons)	20	101.8
Sugar (1/2 teaspoon)	4	16.2
Drinking water (1/2 glass)	100	0
Banana fresh (1 piece)	50	47.6
BREAKFAST		
Tea black (1 cup)	150	0.7
Sugar	4	16.2
Drinking water	100	0
Roshi with coconut (R) (2/3 piece)	30	99.3
Mashuni (R) (1 tablespoon)	20	36.2
Mango green (ind.) (small piece)	5	3.5
Drumstick leaves (3 full tablespoons)	6	5.5
BETWEEN BREAKFAST AND LUNCH		
Drinking water	200	0
Lemon fresh (1/2 lemon)	10	5.6
Sugar	4	16.2
Drinking water	100	0
Chicken egg fresh backed (1 egg)	35	54.0
Vegetable oils (for frying egg; 1 teaspoon)	5	44.1
Salty cracker (2 pieces)	20	75.2
LUNCH		
Drinking water	300	0
Potatoes peeled fresh cooked	50	35.1
Rice and coconut milk (R) (more than ½ rice spoon)	50	57.0
Lemon fresh (1/8 piece)	3	1.7
Bluefin tuna (1 inch piece)	20	27.6
Coconut meat (2 full tablespoons)	20	88.7
Copy leaves (1/2 leave)	10	2.7
Bilimagu (1/2 piece)	5	0.9
BETWEEN LUNCH AND DINNER		
Tea black	150	0.7
Milk powder	10	50.9
Sugar	4	16.2
Drinking water	100	0
Guava	50	25.5
Faa roshi (1 piece)	25	91.4
DINNER		
Drinking water	300	0
Rice and coconut milk (R) (1 ½ rice spoons)	110	125.5
Dhaal curry w. mango (R) (2 bowl spoons)	80	62.0
BETWEEN LUNCH AND DINNER		
Tea black (beverage)	200	1.0
Milk powder	20	101.8
Sugar	4	16.2
Drinking water	100	0
		Total 1228 kcal/day