



**Food Based Dietary Guidelines
Technical background and description**

**Task force for the development and implementation of
the Omani Food Based Dietary Guidelines**

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Preface:

The Ministry of Health in Oman strived since the early seventies to reduce the burden of diseases through the establishment of a primary health care system that is accessible to all people and provision of a comprehensive package of care; in addition to secondary and tertiary care facilities that are distributed all over the country.

Health; however by definition is not merely the absent of disease and the investment in health requires conscious efforts by the government and individuals even before signs of illness are observed. Modern lifestyles are implicated for the epidemic of obesity and chronic diseases in the developed countries; and it is our goal to halt if not to reverse this trend in Oman which can only be achieved through collaborative work on all medical; social and individual levels.

A healthy lifestyle could reduce the risk of disease and prolong an active, high quality living conditions which could be assisted through following a balanced diet and daily physical activity. This report is a documentation of the effort to establish guidelines for diet that takes into consideration the nutritional and health status of the Omanis; the traditions and cultures of the society. The outcome of this report will be disseminated in consumer friendly packages for various population groups; as well as technical documents that will be targeted to professionals and health care providers as reference materials.

We are hopeful that this milestone in promoting adequate diet and physical activity will assist all stakeholders in their efforts to educate the public and standardize nutrition messages at all levels. The guidelines will be reviewed every 10 years; and the Ministry of Health will follow up the implementation of the guidelines and monitor their impact.

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EXECUTIVE SUMMARY

Background

The dietary patterns and nutrient intakes had been recognized as important factors in health and disease and this led to the establishment of Recommended Dietary Intakes (RNI's) for energy, protein, carbohydrate, vitamins and minerals. These RNI's address human nutritional needs throughout the lifecycle and should lead to optimum nutrition and low risk of disease. However, people eat foods and not nutrients. Therefore, the World Health Organization (WHO), together with the Food and Agriculture Organization (FAO) of the United Nations recommend that member countries develop Food-Based Dietary Guidelines (FBDG) to address existent nutrition-related health problems. These FBDG should be based on the prevalent eating patterns of the population, should include traditional and indigenous foods, and should be sensitive to the culture of the population. Moreover, the FBDG should contain foods that are available, accessible and affordable. They should consist of easily understandable messages, expressed in a positive way to motivate people to change dietary habits where necessary.

Methods

The main aims of this document are to firstly describe the evidence used and the process followed to develop FBDG for Oman; secondly, to give and discuss the guidelines; and thirdly, to suggest the follow-up steps necessary for the testing and implementation of the guidelines. Possible policy implications, including legislation, are briefly discussed.

Published literature; and government reports were reviewed to assess the nutrition-related public health problems; and to identify the policies and programs that influence those in Oman. Nutrients of concern for infants, young children, school children and adults were identified. The Food Based Dietary Guidelines are developed for the Omani population aged more than two years; and nutrients and food recommendations are developed for each population category. A national policy for infants and young child nutrition had been developed earlier that includes breastfeeding; complementary feeding and safe preparation of complementary foods. The height data from the Omani Household Income and Expenditure Survey (OHIES) were used to calculate energy requirements for the different lifecycle groups in the population, employing the FAO recommended method. Nutrient requirements were calculated using nutrient density scores based on the energy requirements as per the recommended WHO values. The reported dietary pattern from this survey was further analyzed, translated into servings and volumes, and classified into food groups. The dietary pattern was modified to test for nutrient adequacy for each population category. Based on these results, dietary messages that would lead to adequate diets and optimum nutrition were then developed during a consultative process to ensure that these messages will be relevant, understandable and practical.

Results

The review showed that under nutrition, specific micronutrient deficiencies, overweight, obesity and diabetes are prevalent in Oman. Low intakes of iron, zinc, vitamin A, possibly vitamin D, and dietary fiber, as well as high intakes of saturated fat, sodium chloride and possibly Trans fat were identified. Among the public health problems identified were iron deficiency anemia, diabetes, overweight and obesity, which indicates that the FBDG should

target making food choices that leads to optimum nutritional status and controls non-communicable diseases as well as under nutrition in the Omani population.

The recommendations for quantities consumed of different food groups in volumes can be summarized for various population groups as follows; recommendation for far is use sparingly therefore they were not quantified:

a) Children and adolescents

Group	1-5 years	6-14 years	14-18 years	14-18 years
	M/F	M/F	Males	Females
Whole grains	0.5 c*	1.0 c	1.5 c	1.0 c
Refined grains	2.0 c	3.0 c	4.5 c	4.0 c
Fruits	2.0 c	3.0 c	5.0 c	4.0 c
Vegetables	1.5 c	2.5 c	4.5 c	4.0 c
Meats	60 g	100 g	130 g	100 g
Legumes	0.5 c	1.0 c	1.0 c	1.0 c
Milk; Dairy	0.3 c	0.5 c	1.0 c	0.5 c

* c= cups. 1 cup grains = 1 slice of bread; ½ cup cooked cereal rice or pasta or 1 cup ready to eat cereal flakes.

- Fruits and vegetables: 1 cup = 1 cup raw fruits or vegetables or ½ cup chopped, cooked or canned fruit or vegetable, ¾ cup of fruit or vegetables juice.
- Milk and dairy: 1 cup equivalent=1.5 oz (42.5g) natural cheese (e.g cheddar); or 2 oz (56.7g) processed cheese (e.g. American).

b) Adults and Elderly:

Group	19-70	19-70	>70
	Males	Females	M/F
Grains			
Whole	1.0 c	1.0 c	1.0 c
Refined	3.5 c	2.5 c	2.5 c
Fruits	4.0 c	3.5 c	3.0 c
Vegetables	3.0 c	3.0 c	2.5 c
Meats	100 g	80 g	75 g
Legumes	1.0 g	0.5 c	1.0 c
Milk; Dairy	0.5 c	0.5 c	0.5 c

c= cups. 1 cup grains = 1 slice of bread; ½ cup cooked cereal rice or pasta or 1 cup ready to eat cereal flakes.

- Fruits and vegetables: 1 cup = 1 cup raw fruits or vegetables or ½ cup chopped, cooked or canned fruit or vegetable, ¾ cup of fruit or vegetables juice.
- Milk and dairy: 1 cup equivalent=1.5 oz (42.5g) natural cheese (e.g cheddar); or 2 oz (56.7g) processed cheese (e.g. American).

The proposed FBDG developed are:

1. Enjoy a variety of nutritious foods and drink plenty of water.
2. Maintain a healthy body weight by balancing total food intake with activity.
3. Eat regular meals with healthy light meals in-between, starting the day with breakfast before work or school.
4. Consume foods and beverages low in fat, sugar and salt.
5. Eat at least 5 servings of a variety of fruits and vegetables every day.
6. Include a variety of starchy foods such as cereals, grains, rice, bread, pasta and potatoes in your diet daily in the wholegrain form or potatoes in their skins.

7. Consume milk and dairy products every day, preferably low-fat products.
8. Include meat or poultry or fish or eggs or nuts in your daily diet.
9. Eat lentils, dry beans and peas regularly.
10. Ensure that your food and drinking water is safe and hygienic during production, storage and preparation.

Conclusions and recommendations

It is concluded that the ten (10) FBDG messages can be used as an informative and educational tool to promote a better diet in Oman. These guidelines, if applied correctly, will lead to food and beverage choices for adequate diets regarding all nutrients, at the same time address the growing problem of non-communicable diseases in Oman.

It is recommended that these FBDG are tested for comprehension in relevant groups (such as adult women) and a social marketing campaign is designed and implemented to support the implementation of the guidelines. The food groups developed with and for the guidelines, should be used in this material. The FBDG should be explained and discussed with all relevant health personnel and other stakeholders, in order to have their cooperation for implementation. Both the process of implementation as well as the impact of the guidelines on the nutritional status and disease risk of the Omani population should be evaluated in due course. Baseline data should be generated that includes the nutritional status (anthropometry, biochemical markers, clinical signs of malnutrition and detailed nutrient intakes), dietary patterns and relationships of these with health and disease full-scale implementation of the FBDG.

Abstract:

Food Based Dietary Guidelines are developed to advise the public on the types and quantities of foods to consume in order to satisfy their nutritional requirements and prevent disease. The World Health Organization (WHO) advises countries to develop guidelines based on the population structure and nutritional status as well as the food commodities available and general consumption pattern in each country.

This document was developed based on the most recent available literature, data and experts advise in order to facilitate the development of locally acceptable food guidance for the Omani population. Energy requirements are determined by basal metabolism, metabolic response to food, physical activity, growth, pregnancy and lactation according to documented guidelines of the Food and Agriculture Organization (FAO). Nutrient requirements were calculated based on density score recommended by the WHO. Dietary pattern of the Household Income and Expenditure survey was analyzed and modified to develop the quantitative recommendations and the messages to be used in developing the social marketing materials for the Food-Based Dietary Guidelines for Oman.

Not unlike other countries, the Omani diet was found to be lacking in important nutrients and high in fats, saturated fats and Trans fats. Among the low intake nutrients were iron, vitamin D, zinc, fiber and calcium whereas high sodium intake was observed. The recommendations of nutrient profiles were developed to satisfy the Recommended Nutrient Intakes (RNI) for these profiles and these were translated into servings and volumes. The modeled diets were still lacking in vitamins E, D and zinc which drew attention to the importance of fortification for these nutrients.

The Food Groups were classified into Starchy foods; vegetables; fruits; Meats and alternatives; legumes; milk and dairy; and fats and oils. The fruits were sub grouped into vitamin A; Vitamin C; Potassium rich groups and others; whereas the vegetables were sub grouped into vitamin A; vitamin C; iron/folic acid rich groups and others. This classification was done to emphasize variety and nutrients adequacy within each food group.

Quantitative recommendations food servings and volumes per food group for each population category were developed to simplify the recommendations and facilitate consumer friendly education tools and materials. Accompanied with the messages; these recommendations will be further developed into visual presentations and education materials within a national communication campaign that will be used to target all population categories.

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1. INTRODUCTION:

Dietary guidelines are defined as a set of guidelines or qualitative statements for making food choices that will help a person or a population lead a healthy life, maintain optimum weight and reduce the risk of chronic disease. They are based on nutritional targets such as recommended energy and nutrients intakes, optimum weight and health targets such as prevention of chronic disease, control of obesity and under nutrition.

The Omani guidelines are composed of the food groups and servings guidelines, aided by a visual presentation, and the messages that will facilitate achieving optimum dietary intake. The guidelines are intended for the general population in Oman, and should be routed through public health professionals, nutritionists, and education experts. All channels of public education should disseminate the messages according to the educational level of the target group intended. This document will not discuss methods of dissemination of the dietary guidelines, although it will suggest and recommend a basic plan of action that could be appropriate.

Each healthy individual can benefit from following the guidelines in the Omani Food Based Dietary Guidelines. These are based on the energy and nutrients requirements of the Omani population, and are applicable to anyone above the age of 2 years. Dietary guidelines can be used as a basis for individualized diet planning but must be performed by professionals in the area of dietetics. It involves assessing the nutritional status, determining diet and clinical history, etc. For healthy active individuals, the dietary guidelines are recommendations to be fulfilled in the general pattern of diet. This does entail fulfillment of all dietary goals, recommended food groups and serving sizes on a daily basis. The overall pattern over multiple days should reflect the recommended guide.

For individuals with special health conditions that require individualized recommendations such as therapeutic diet, individuals with special dietary requirements such as athletes and persons with food allergy or sensitivity, the guidelines are recommended with modifications according to each specific condition. These modifications can only be achieved through a professional consultation. This category includes hospitals in-patients, patients with infective and chronic diseases and patients with nutritional deficiencies, etc. On a population level, the FBDG aim to optimize nutritional status, prevent under and over nutrition, and decrease risk of non-communicable diseases.

This is the first attempt to develop food based dietary guidelines for Oman. Some information could not be obtained because of the lack of documented literature. This limitation forced some assumptions to be made based on the international literature or “informed” choices and these are explained wherever applicable. A section for areas of research required is included for future modifications of the guidelines.

This document explains the methods and procedures used to develop the Omani food based dietary guidelines. The dietary guidance which is composed of a quantitative estimate of the recommended food groups and the messages for the public, are to be field-piloted in order to develop the final text of the messages and the visual presentation. The product, Food Based Dietary Guidelines will be promoted to the Omani population through appropriate social marketing methods.

2. BACKGROUND AND RATIONALE:

2.1. *Definitions and the role of dietary guidelines in public health:*

The term “food based dietary guidelines” (FBDG) was defined by the World Health Organization¹ as the expression of the principles of nutrition education mostly as foods intended for use by individual members of the general public. Where they cannot be expressed as foods, they are written in language that avoids the technical terms of nutritional science. In addition, a set of dietary guidelines expressed in scientific terms may also exist for policy makers and health care professionals with quantitative determination of the nutrients and food components. Evidence showed that quantitative determination of recommended nutrients values should be used as the scientific backbone of any nutrition policy².

In 1957 the American Heart Association published a series of reports which suggested that diet plays an important role in the pathogenesis of atherosclerosis- which was translated into recommendations³. The first set of dietary goals for the United States was issued in 1997. Finland adopted the food circle in 1995. The concept of food based dietary guidelines was, however, not widely used until the publication of the World Health Organization technical report on the use and interpretation of FBDG in 1998⁴.

The World Health Organization suggests that the steps required for developing FBDG include

- Establishment of a multi-sectoral working group or committee.
- Collecting data on nutrition related diseases.
- Food availability and food intake pattern data.
- Evaluation: prioritization of nutrition related disease; food production and supply situation; determining the feasibility of implementing FBDG.
- Draft the FBDG and background statement for each.
- The guidelines should then be reviewed, pre-tested and consolidated.

However, experience from some countries and Oman as well as documented procedures as in the United States example indicated that the process could actually be more comprehensive than elaborated in the WHO document. The procedure of drafting the messages involves the following steps: ⁵⁻⁷

1. Identification of issues of public health importance and nutrients of concern.
2. Determination of the energy and nutrients needs and goals.
3. Definitions for food groups that are of local relevance and social acceptability.
4. Identification of the food servings of local dishes.
5. Analysis and modeling of the local food pattern to be consistent with the requirements of each population group.
6. Development of the dietary guidelines messages.
7. Development of the visual presentation of the food pattern.
8. Pre-testing of the FBDG messages for comprehension, implementation,

9. Evaluation of the process and impact of the FBDG on the nutritional and health status of the population.

Table 1: Description of the process of the development of the technical materials of the food based dietary guidelines in Oman

Step	Data	Source of national data	References used
Identifications of issues of public health importance and nutrients of concern.	Morbidity and nutrition disorders prevalence and trends	National surveys on health; chronic diseases; nutritional disorders	Available literature; MoH reports
Estimate energy requirements for each population category	Height for each age-year; fertility rates	National nutrition surveys; census data;	Estimating Human energy requirements (FAO/WHO)- 2004
Estimating nutrients goals (RNI); lower limits (EAR)	Human energy requirements data	-	Preparation and use of food based dietary guidelines WHO-1998; guidelines on food fortification with micronutrients- WHO 2006- Measuring change in nutritional status WHO 1983
Categorization of food groups and servings	Exhaustive of food items locally consumed	Household income and expenditure survey data	Available literature
Food pattern analysis and modeling	Food consumption data	Household income and expenditure survey	Nutrition analysis software (Food processor or equivalent)
Design of messages	Modifications of the food pattern modeling	-	-
Design of visual presentation	Items and quantities of the food items and food groups in the food pattern model generated	Serving sizes of various food items; food items of each food group	-

* Throughout the process, the role of culture and traditional foods and dishes in Oman were taken into account to ensure that the FBDG would be practical and do-able. Therefore, the availability, accessibility and affordability of foods were also considered.

2.2. The health transition, changing lifestyle patterns and resultant nutritional status in Oman:

Over the last 3-4 decades Oman, and its people had witnessed changes on all levels of life, and modernization found its way to every house and village through roads, cars, shopping malls, hospitals, schools and everything a modern civilization has to offer. This however was not without a price, which was most importantly manifested in less physical activity and a more variable diet.

A major development leap was observed between 1970 and 2005 in Oman as its GDP jumped from R.O. 158 to R.O. 4.712 per capita during that period. Simultaneously, the crude death rate declined from 13.3/1000 to 2.53/1000. Infant and Under Five Mortality Rate dropped from 164/1000, and 280/1000 in 1960 respectively to 10.3/1000 and 11.1/1000 in 2005 in the same order. BCG, OPV3, DPT3 and measles immunization rates increased from 54%, 19%, 19%, and 10% in 1980 to 99.0%, 99.9%, 99.9%, and 98.9% in 2005. Maternal mortality remained stagnant at 22 and 23 per 100,000 live births between 1970 and 2001 respectively and consequently dropped to 15.4% in 2005.

2.2.1 Infant and young child nutrition:

Under nutrition or Protein Energy Malnutrition (PEM) as indicated by weight-for-age dropped from 62.9% among children below the age of 5 years in 1980¹⁰ to 24.4% in 1992¹¹. It remained at the same level in the next few years and it was found to be 23.6% in 1995². The National PEM Survey carried out in 1999 showed a prevalence of 17.9 % with no significant difference between males and females.¹³ On average, underweight decreased by about 2.4% per year from 1980 until 1999, mostly during the first 12 years. De Onis, et al¹⁴ compared the results of the Oman Family Health Survey of 1995 and Mussaigher's study of 1992 and observed that the annual rate of decrease in stunting was about 1 %, a trend that continued until 1999.

2.2.2 Micronutrient malnutrition:

Anemia and iron deficiency

A national study in 1986 found that 54% of pregnant women in Oman had hemoglobin (Hb) values less than 11.0 g/dl.¹ In the same year, a national iron supplementation program for all pregnant women was implemented. A WHO evaluation of this program in 1993 showed that 48.5% of pregnant women still had hemoglobin levels less than 11.0 g/dl¹⁶.

For children, the results of a 1992 national study found that 78.2% of school children had Hb levels less than 12.0 g/dl and 60.2% of preschoolers had Hb values less than 11.0 g/dl¹¹. A 1996 national survey found that 51.5 % of school children had hemoglobin levels less than 11.0 g/dl and 19% had serum ferritin levels below 20 ng/dl,¹⁷ suggesting that the anemia in this target population was caused by multiple factors in addition to iron deficiency.

In 2004¹⁸ the prevalence of anemia among preschool children was 42% according to the results of the study of food fortification. The anemia prevalence was significantly higher in children under 2 (66%) compared to those 2-5 years of age (26%). The prevalence of anemia among

non-pregnant women was 39%, compared to 12% in men.

The same study indicated that the prevalence of iron deficiency was 19% and the prevalence of iron deficiency anaemia was almost 8% among pre-school children. A third (33%) of non-pregnant women of child bearing age was iron deficient whereas 19% had iron deficiency anaemia. Iron deficiency accounted for almost 50% of the anaemia among women of childbearing age and 32% of children 6-59 months old.

Vitamin A deficiency

In 1981, the first study of vitamin A status in Oman found that 1.5% of preschool children had Bitot's spot¹⁹. In 1994, a national study of vitamin A status in children 7 months, 18 months, 3 years and 6 years of age was conducted. It was found that 18.7% of the study population had serum retinol levels below 20µg/l and 2.1% had serum retinol levels below 10µg/l²⁰, indicating severe deficiency. As a result, in 1995 a national supplementation program was implemented to distribute vitamin A capsules to all children at 9 and 15 months of age. This program was evaluated in a 1999 national survey and results showed that the prevalence of serum retinol levels less than 20µg/l among children had been reduced to 5.2% and no children had serum retinol levels below 10µg/l²¹.

Studies of vitamin A status have also been conducted among older age groups. In 1995-1996, the modified relative dose response (MRDR), which assesses vitamin A stores in the body, was used to estimate the prevalence of vitamin A deficiency among a nationally representative sample of school children. The findings showed that 11.1% had MRDR ratios below 0.06,¹³ demonstrating a public health problem. Furthermore, a 1998 national study of vitamin A content of breastmilk showed that 38.8% of lactating women had breastmilk retinol levels below 1.05µmol/l.²²

In 2004, the study of food fortification¹⁸ showed that less than 6% of children 6-59 months old had vitamin A deficiency. However, among children <2 years old almost 18% were vitamin A deficient. This was significantly greater than the 3% of children 2-5 years old who were vitamin A deficient. Less than 0.5% vitamin A deficiency was found among non-pregnant women of reproductive age in the same study.

Iodine deficiency

In 1993-4, the Ministry of Health and Sultan Qaboos University carried out the first national survey on iodine deficiency disorders²³. In this study, 22% of households used iodized salt, 50.2% of schoolchildren had urinary iodine levels below 100µg/dl, and 1.2% had goiter. In 1996, the salt iodization program was established and several salt iodization monitoring surveys were conducted through schools. The coverage of salt iodization increased to 61% in 1998, and 68.5% in 2000^{23,25}. Efforts are taking place to reach universal salt iodization, but the study on food fortification showed that the percentage of women with low levels of urinary iodine was 16.8%.

Table 2: Micronutrients deficiencies among a representative sample of pre-school children, non pregnant women and men in Oman (2004)¹⁷

Target Group	Anemia ¹	Iron deficiency ²	Iron deficiency anaemia (IDA) ³	Urinary iodine deficiency (<100 µg/L)	Vitamin A deficiency ⁴
Preschool Children (6-59.9 months)	41.5%	18.5%	7.7%	n/a	5.5%
Non-pregnant women (15-49.9 yrs)	38.8%	33.3%	18.8%	16.8%	0.4%
Men (18-60.0 yrs)	12.1%	n/a	n/a	n/a	n/a

¹ Anaemia defined as Hb<11.0 g/dL in children, Hb<12.0 g/dL in women, and Hb<13.0 g/dL in men (Hb adjusted for altitude, pregnancy status and cigarette smoking)

² Serum ferritin levels <12.0 µg/l for children 6-59 months old, and <15.0 µg/l for women of child bearing age

³ Low haemoglobin and low serum ferritin levels

⁴ Serum retinol <0.70µmol/l.

2.2.3 Obesity and chronic diseases: (Non-communicable diseases: NCDs):

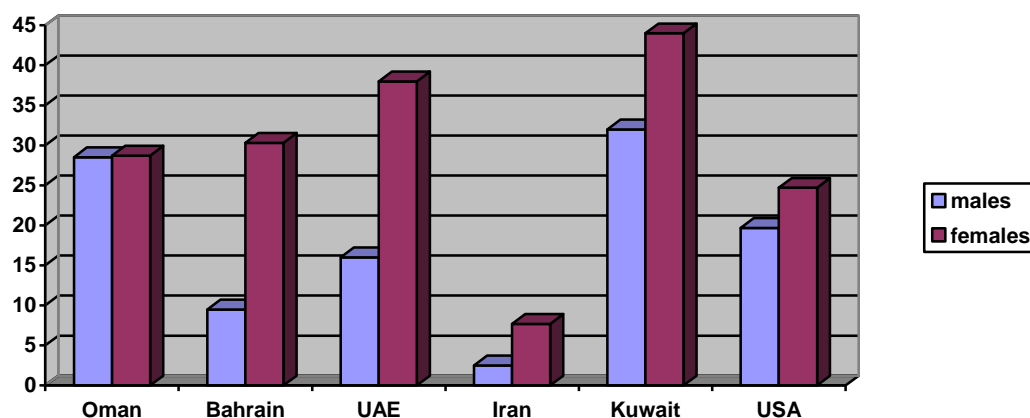
Underweight; overweight and obesity among adults:

A number of studies looked at the obesity rates among adult Omani males and females. The National Diabetes Survey in 1992²⁶ showed that 15.1% of the adult population aged 18 and above were underweight (BMI<18.5%), whereas 28.0% were overweight (BMI>25), 18.4% had BMI levels above 30, and 1.4% had BMI levels above 40. In 2000, the National Health Survey²⁷ found that 7.9% were underweight, and 28.9%, 17.3%, and 1.8% were overweight, obese and severely obese in the same order.

Comparisons of the results of the two studies indicate that underweight prevalence had decreased in the last decade, whereas obesity remained at almost the same prevalence. The prevalence of obesity found was higher than that reported for USA (24.7%)²⁸, but lower than other countries of the Gulf.

Waist-hip ratio (WHR) is a useful indicator of the NCD risk associated with obesity and is considered a risk factor for especially cardiovascular diseases. The prevalence of high waist-hip-ratio in 1992 was 42.6% among both sexes, which increased to 49.1% in 2000. This ratio is significantly higher among females. In 2000 the percentage of females with a WHR more than 0.85 was 64.4% compared to 31.1% of the males (WHR>1.00), compared to 6.2% and 69.8% among males and females in 1992 respectively.

Figure 1: Prevalence estimates of obesity in Oman and some countries of the Eastern Mediterranean Region



Hypertension:

A spectrum of factors, among which excessive intake of salt may pre-dispose hypertension. In 1992, the Diabetes Survey found that the prevalence of high blood pressure among Omani adult males and females was 22%, 27.9% and 15.7% for systolic, diastolic and both respectively compared to 21.5%, 25.2% and 15.2% in 2000.

Hypercholesterolemia:

As a risk factor for atherosclerosis that is highly determined by diet, hyper-cholesterolemia (Cholesterol > 5.2 mmol/L) was found to vary from 43.7% in Muscat to 68.5% in Musendem according to the National Diabetes Survey in 1992 (non-published data). The national average of hypercholesterolemia was found to be 44.4% which went down to about 40% in 2000. The prevalence of familiar hypercholesterolemia, which will not respond satisfactorily to dietary interventions, is not known.

2.2.4 Dietary intake data

A number of studies that employed food frequency methods were conducted in the early 90's. These studies gave an indication of general dietary habits, but the literature on food consumption and physical activity in Oman from is limited.

The first documented study on food intakes, was a national survey conducted by Abdulrahman Mussaigher¹⁰ in 1992. The findings indicated that women of child bearing age consumed rice and bread daily; and most of women consumed meat, poultry and fish 1-3 times a week. Fish consumption was higher than meat and poultry. Carbonated beverages and crisps consumption were already an alarming trend, as more than 30% and 20% of the women consumed carbonated beverages and crisps respectively at least 3 times a week.

Figure 2 The trend of some chronic diseases between 1992-2000 among the Omani adult population

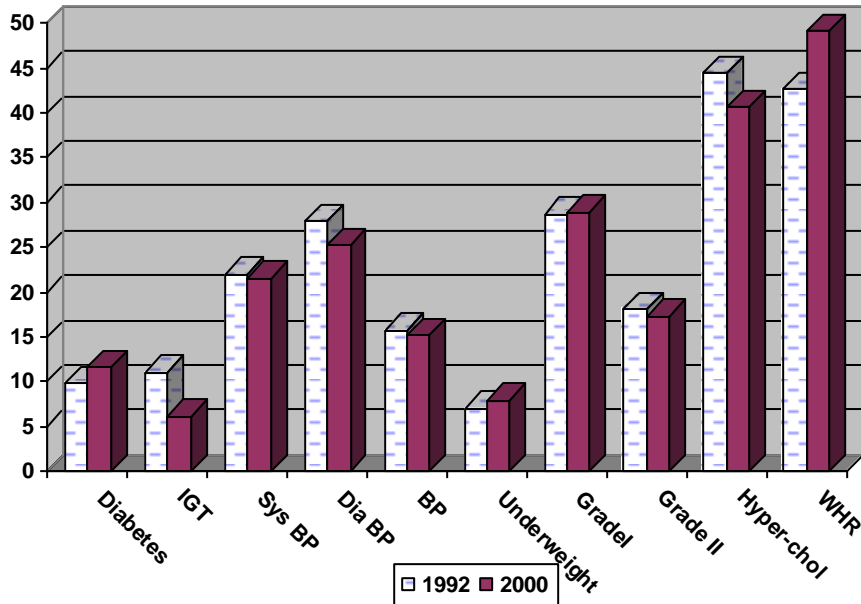
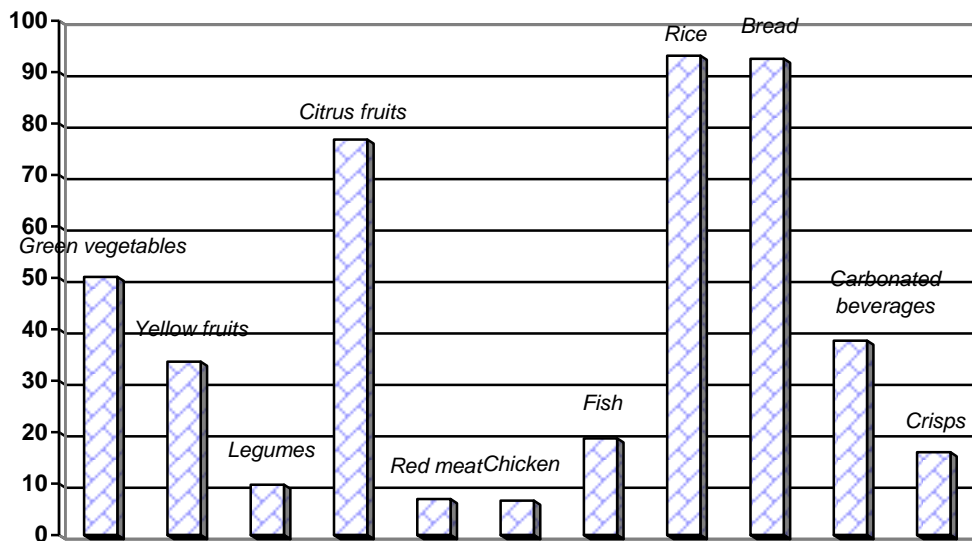


Figure 3 Percentage daily consumption of some food items among Omani women of child bearing age (1992)



The household income and expenditure survey in 1999-2000 collected information on household consumption of food and other commodities²⁹. For the purpose of developing FBDG we used per-capita consumption of foods to assess the general food pattern in the Omani population and to model a recommended food pattern. The results of the analysis indicated that the sources of calories (energy) in the Omani diet are 13% from protein; 56% from carbohydrates and 32% from total fat. Sources of fat indicated were: 12% in saturated fat; 11% Mono-unsaturated fats; and 6% poly-unsaturated fatty acids.

2.3 Existing nutrition interventions:

2.3.1 Supplementation:

National public health policy guidelines recommend that all pregnant women receive 200 mg of ferrous sulfate twice daily and 5 mg of folic acid daily. Iron and folic acid supplementation continue for three months postpartum for all women and for up to six months for anemic women. Within 15 days of delivery, postpartum women should receive a 200,000 IU supplement of vitamin A. Children 9 months of age receive 100,000 IU and children 15 months of age receive 200,000 IU supplement of vitamin A.

2.3.2 Food fortification:

Oman law mandated the iodization of nationally produced household salt with 100-135 mg/kg of potassium iodate in 1996. Imported salt must also be iodized with 60-80 mg/kg of iodine or 78-105 mg/kg of potassium iodide or 101-135 mg/kg of potassium iodate. National law mandated the fortification of white wheat flour with 30 ppm of elemental iron and 35 mg of folic acid in 1997. Imported white wheat flour must be minimally fortified at these levels.

The level of fortification of iodine was modified in 2007 to 20-40 ppm iodine; and the level of iron fortification was modified to 60 ppm iron. Vitamin A fortification was mandated at 60 IU/g; and the level of vitamin D fortification was set to 10 IU/g in edible oils.

3. ISSUES OF NUTRITION-RELATED PUBLIC HEALTH IMPORTANCE AND NUTRIENTS OF CONCERN:

This section will discuss the issues of nutrition-related public health importance in Oman. The following sections detail the nutrition problems and the nutrients of concern for the development of the Food Based Dietary Guidelines.

3.1 Nutrition related diseases:

- **Pre-school children:**

Protein Energy Malnutrition: PEM has been observed in high rates in this age group. Education and training manuals had been developed for infant feeding practices at the age of 0-2 years. However, it had been reported that the problem is persisting through the age group 3-5. Therefore, national food based dietary guidelines should be geared to reducing malnutrition in this age group.

Micronutrients deficiencies: Iron deficiency persists among pre-school children at a high rate as of 2004. Although a trend cannot be observed because of there are no comparative earlier studies. A focus on adequate supply of iron, Vitamin B12 and folate is essential.

Dental caries: Amount and frequency of free sugars consumption are associated with dental caries, whereas soft drinks and fruit juices are risk factors of dental erosion. Fluoride exposure and the consumption of hard cheese and sugar-free chewing gum are associated with decreased risk of dental caries (Table 3).

In Oman the rate of dental decay is on the increase. The percentage of children who have experienced dental caries was 70-73%; where it is 84.5% in the 6 years old according to the Ministry of Health.

Nutrition-related genetic diseases: Spina Bifida witnessed a major decline since the implementation of the flour fortification programs with folic acid in 1996. The graph below shows that the number of discharges with Spina Bifida went down from 147/1000 in 1996 to 13/1000 in 2006.

- **School age children and adolescents:**

The adolescents Health Survey in 2001 found that more than two thirds of the students identified certain sound nutritional behaviors. However 25% had low fruit and vegetable intake. In 2004, it was found that only 45% had breakfast on a daily basis. Fast foods, sugary drinks, skipping breakfast, and high consumption of crisps as well as carbonated drinks were among the most important nutritional behaviors identified by the Global School Survey in 2004. Although obesity was not found to be a significant health problem, the dietary behaviors indicate a risk of increase of obesity and chronic diseases in the future.

- **Adults:**

Adult malnutrition is also a problem in Oman. It is especially a compromising factor for women of child bearing age. The dietary guidelines therefore should take into consideration optimum energy and nutrient allowance, and should target a healthy weight rather than weight reduction. Anemia still affects about 38.9% of pregnant women in spite of supplementation and fortification programs.

On the other hand, obesity rate is constant at 18.4% in 1992 compared to 17.3% in 2000. But this trend is expected to be affected by the poor dietary habits. Diabetes and hypercholesterolemia are showing a slight increase in the same time period whereas no obvious trend had been observed for cardiovascular diseases and cancer. A prevention measure, however, is essential to halt an increasing trend.

Because of these trends, the different nutritional factors known to influence risk of chronic diseases (NCDs) were considered in developing the FBDG and are shown in Table 3.

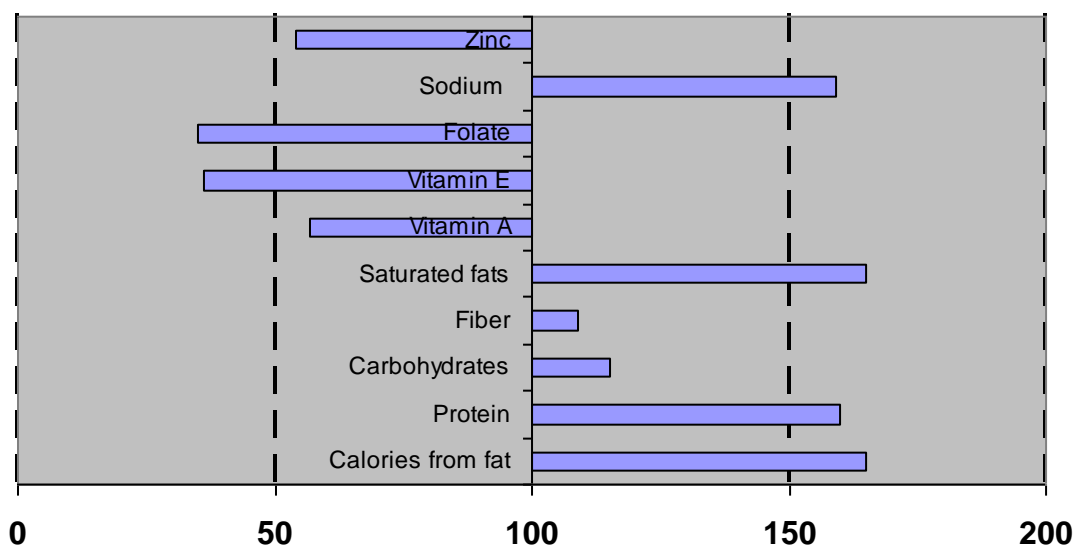
Table 3: Dietary and lifestyles risk factors of chronic diseases (Source: Diet, Nutrition and the Prevention of chronic diseases, WHO 2003)

Diseases	Decreased risk	Increased risk
Weight gain and obesity	-Regular physical activity -High dietary intake of dietary fiber and non-starch polysaccharides (NSP) - Decreased energy intake	High intake of energy-dense micronutrient – poor foods; sugars; sweetened soft drinks and fruit juices
Cancer	- Physical activity (colon, breast) - Fruits and vegetables (oral cavity, esophagus, stomach, colorectum)	- Overweight and Obesity (esophagus, colorectum, breast in postmenopausal women, endometrium, kidney) - Alcohol (Oral cavity, pharynx, larynx, esophagus, liver, breast) - Aflatoxin (liver); Chinese style salted fish (nasopharynx) - Salt preserved foods and salt (stomach); Very hot (thermally) drinks and food (oral cavity, pharynx, oesophagus)
Diabetes	- Voluntary weight loss in overweight and obese people - Physical activity - Intake of fiber and NSP	- Overweight and obesity; abdominal obesity. - Physical inactivity - Maternal diabetes - Saturated fats - Intrauterine growth retardation
Cardiovascular diseases	- Regular physical activity - Fish and fish oils - Vegetables and Fruits - Potassium - Low to moderate alcohol intake - Linoleic acid; α -Linoleic acid; Oleic acid NSP (Fibers); Whole grain cereals; Nuts; Plant sterols/stanols; Folate	- Myristic and Palmitic acid - Trans fatty acids - High sodium intake - Overweight - High alcohol intake - Dietary Cholesterol - Unfiltered boiled coffee
Dental caries	- Fluoride exposure - Hard cheese - Sugar-free chewing gum	- Amount of free sugars - Frequency of free sugars intakes - Undernutrition
Dental erosion		- Soft drinks and fruit juices
Enamel developmental defects	Vitamin D	- Excess Fluoride - Hypocalcaemia
Periodontal disease		- Deficiency of vitamin C; Undernutrition

3.2 Nutrients of concern:

Nutrients of public health concern are those that evidence suggest that a deficiency or excess in their consumption will manifest or could manifest in a rise of morbidity or mortality. In addition, nutrients associated with existing conditions of public health concern, as indicated by the analysis of morbidity pattern in Oman.

Figure 4: The percentage of intake of some macro and micronutrients levels compared to the recommended intake levels (RNI) at an energy level of 1800 Kcal.



3.2.1 Macronutrients:

- Protein:** Analysis of the household consumption of foods in Oman indicated that at an energy intake level of 1800 Kcal, the protein consumption is 57.59 g, compared to the recommended 36-45 g. The World Health Organization recommends that the protein should constitute 8-10% of energy when protein quality is high and 10-12% of energy if animal protein intake is low. The total protein in the Omani diet constitutes 13% of the total caloric consumption. Chicken, red meats, fish, milk and cheese and eggs contribute 45% of the protein whereas cereals contributed 40% and legumes contribute only 4%.
- Total Fat:** The total fat recommended is 29-70 g or 15-30% of energy requirements. Fat contributes 24% of the caloric value of the Omani diet. Per capita consumption of oils and ghee is about 19.8 grams which composes 38% of the total fat. Other sources of fats are meats, chicken and fish (which composes 29% of total fat), milk and cheese constitutes 15%, whereas cereals, eggs and sweets contribute 6%, 2%, and 5% respectively.

- **Saturated fats and Trans Fats:** It is now well documented that the type of fat and not only the total fat content is the determining factor relating dietary fat intake and health³⁰. Saturated fats and Trans Fats are associated with various chronic diseases, and these are often found in vegetable shortenings, some types of margarine, crackers, candies, cookies, snack foods, fried foods, baked goods, and other processed foods made with partially hydrogenated vegetable oils³¹⁻³⁴.

Fish and fish oils, oleic acid, linoleic acids and α - linoleic acids contribute to lowering of cardiovascular diseases risk whereas saturated fats (myristic, palmitic acid), cholesterol and trans fatty acids are associated with high rates of diabetes and cardiovascular disease (Table 3).

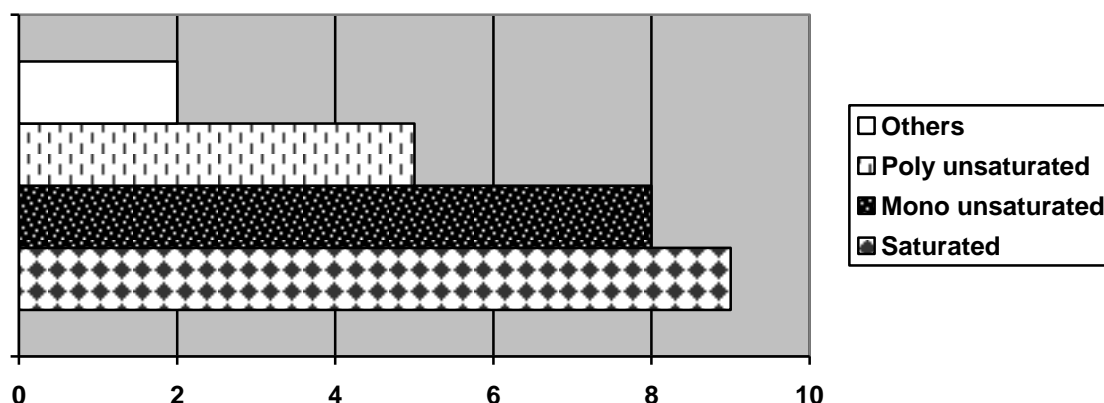
WHO recommends that <10% of calories should be contributed by saturated fats; and 6-10% of poly-unsaturated fatty acids. The ratio of linoleic acid to α -linoleic acid is recommended to range between 5:1, and 10:1, and the level of Trans Fats should be less than 1% of calories. If the ratio of linoleic acid to α -linoleic acid is more than 10:1 it is recommended to increase the intake of n-3 fatty acids.³⁵

The distribution of fat in the Omani diet is shown in Figure 7 below. The ratio of linoleic acid to α -linoleic acid in the Omani diet is estimated to be 7:1; which is in the acceptable range.

The supply of saturated fat in the Omani diet is about 18.3 g per day, which is mostly provided by butter /ghee (36%); chicken and meat (23%). These data do not take into account the contribution of fast foods and snacks: therefore they should be verified by more in depth studies. The FBDG of Oman should take into consideration lowering of intake of saturated and trans fatty acids as well as cholesterol, and substituting these with fish and sources of mono-saturated fat.

- **Labeling fat sources:** A request for nutritional labeling was made to the Gulf Cooperation Council in 2006; a mandatory GCC standard for the labeling of food items with nutritional facts including Trans Fats is an essential contributor to the success of the promotion of the Omani FBDG's.

Figure 5 Percentage contribution of saturated, poly-unsaturated, and mono-unsaturated to the total calories of the Omani diet



3.2.2 Micronutrients:

- Iron and folate:** Iron deficiency has important effects on the physical and mental capacities of individuals. In addition to adverse effects on the defense systems against infection, attention, memory, and learning in infants and small children are associated with iron deficiency. Adequate Folate status is recognized as a protective measure against neural tube defects, and contributes to the elevation of homocysteine which is a risk factor for cardiovascular diseases. Evidence also suggests a link between folate status and colorectal cancer.

As indicated in section 2.2.2. IDA persists to be a problem of public health importance in Oman. The Omani diet provides only 28% of the requirements before fortification. When using the fortified flour at the level of 30 ppm the diet satisfies 64% of the requirements of the average Recommended Nutrients Intake. Before fortification only 35% of the folate requirements were satisfied by the diet, which went up to 93% after fortification of folic acid. At least 59% of the folate is supplied by wheat flour.

The FBDG's should work towards improving the natural sources of iron and folate in the Omani diet, taking into consideration the variations in bio-availability. Heme iron is more readily absorbed in the diet, and non-heme iron absorption is inhibited by the levels of compounds such as tannins and phytates³⁴. Table 4 shows the dietary factors which influence iron status, which have to be considered the development of FBDG.

Table 4: Factors influencing dietary iron absorption (Source: WHO – 2004)

Amount of dietary heme iron, especially from meat
Content of calcium in meal (e.g. from milk, cheese)
Food preparation (i.e. time, temperature)
Non-heme iron absorption.
• Factors determining iron status of subject:
Amount of potentially available non-heme iron (includes adjustment for fortification iron and contamination iron)
Balance between the following enhancing and inhibiting factors:
Enhancing factors:
Ascorbic acid (e.g. certain fruit juices, fruits, potatoes, and certain vegetables)
Meat, fish and other seafood
Fermented vegetables (e.g. sauerkraut,) fermented soy sauces, etc.
Inhibiting factors:
Phytate and other lower inositol phosphates (e.g. bran products, bread made from high-extraction flour, breakfast cereals, oats, rice – especially unpolished rice, pasta products, cocoa, nuts, soya beans and peas)
Iron-binding phenolic compounds (e.g. tea, coffee, cocoa, certain spices, certain vegetables and most red wines)
Calcium (e.g. from milk, cheese).
Soya

- **Vitamin D:**

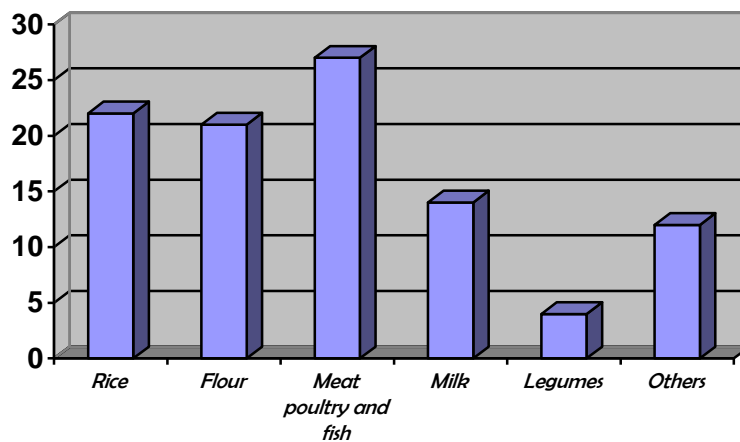
Vitamin D is required to maintain normal blood levels of calcium and phosphate which are needed for bone health, muscle contraction, nerve conduction, and general cellular function in all cells of the body.

Anecdotal reports from hospitals in Oman indicated that some cases of vitamin D responsive rickets had been diagnosed. Analysis of the serum of a representative sample of women of child bearing age revealed that 21.4% of have vitamin D below 27.0 nmol/l. Moreover, the Omani diet currently supplies on average 1.6 µg whereas the requirements are 4.5-9.0 µg per day. There is no information on the status of exposure to sun in Oman, which is a major factor in vitamin D nutrition. It is recommended that strategies to improve vitamin D status should also focus on adequate exposure to sun.

- **Zinc:**

Zinc plays an important role in the immune system, the clinical deficiency of which manifests in growth retardation, delayed sexual and bone maturation, skin lesions, diarrhea, alopecia, impaired appetite, increased susceptibility to infection mediated via defects in the immune system and the appearance of behavioral changes. The Omani diet contributes only 54% of the minimum recommendation of 10.8 mg per day of dietary zinc. Dietary protein improves zinc absorption whereas the presence of phytates inhibits it. It is recommended to promote zinc rich foods, which are lean red meat, whole grain cereals, pulses, and legumes³³.

Table 5: Percentage contribution to zinc sources of the Omani diet (Household income and expenditure survey).



- **Sodium as NaCl:**

High sodium intake and salted foods is associated with hypertension; cardiovascular diseases and stomach cancer. The intake of sodium is estimated to be twice the requirements, of which table salt contributes 87% of the supply. Other sources of sodium in the Omani diet are salted fish, canned tomato paste, sausages and eggs. More research needs to be done on the consumption of crisps and pre-packaged snacks, local salted fish and the levels of sodium in the local production of these to verify levels of sodium intake to launch strategies to reduce its consumption. The dietary guidelines should consider the reduction of sodium and salted foods in the Omani diet.

3.2.3 *Nutrients that needs to be monitored:*

This category includes nutrients that the studies of biological levels in the Omani population showed to be controlled through existing policies and programs or they are consumed in satisfactory amounts according to the analysis of the food pattern. Levels of consumption of some of these nutrients have been controlled through supplementation such as vitamin A or fortification such as iodine.

- **Fiber:**

Dietary fiber contributes to lowering the risk of weight gain, diabetes and cardiovascular diseases. Fruits and vegetables contribute to lowering the risk of oral cavity, esophagus, stomach and colorectum cancers as well as the incidence of cardiovascular diseases. For an energy level of 1800 kcal the Omani diet satisfies 100% of the dietary fiber requirements; and is contributed mostly by fruits and vegetables (48%), grains (37%) and legumes (8%).

It is important to encourage high consumption of fruits and vegetables as sources of dietary fiber, micronutrients, and antioxidants. Currently, per-capita consumption of fruits and vegetables sums up to 300 g which is likely to be an over estimation because wastage was not taken into consideration in the data collection. Nevertheless, the consumption is lower than the WHO recommended 400 g, and only a few items constituted most of the fruits and vegetables consumption. Variety within and between fruit and vegetable groups should be encouraged to ensure an adequate supply of essential nutrients.

- **Vitamin A:**

Vitamin A deficiency manifests in increased morbidity and mortality, risk of irreversible blindness, poor reproductive health, increased risk of anemia and slowed growth and development. Sub-clinical vitamin A deficiency had been controlled in Oman through supplementation programs. However, the Omani diet supplies only 57% of the vitamin A Recommended Nutrient Intake (RNI). Carrots and tomatoes provide 22% of the vitamin A supply in the diet, whereas oils and ghee provide 19% and milks and eggs provide 10%. A recommendation to fortify edible oils with vitamin A and D is being considered. If this takes effect the vitamin A supply will increase from 356 µg to 437 µg which will constitute about 69% of the RNI.

The dietary sources of vitamin A should be considered in the development of the food based dietary guidelines in order to sustain the vitamin A nutrition in this population. Special consideration should be given to verify the intake of fruits and vegetables and incorporate vitamin A rich sources of these into the diet.

- **Iodine:**

The effects of iodine deficiency spans the life stages starting from the fetal stage where abortion, stillbirths, congenital anomalies, increased perinatal and infant mortality as well as neurological cretinism had been associated with iodine deficiency of women of childbearing age. Neonatal goiter and hypothyroidism occur when an infant is iodine deficient. In childhood, adolescence and adulthood goiter, hypothyroidism, impaired mental function and retarded physical development are consequences of iodine deficiency.

The rate of low iodine level in urine among non-pregnant women of childbearing age was 16.8% in 2004, according to the study on food fortification¹⁷. The median urinary iodine among non-pregnant women was 223 µg/L, which is above the international recommended level and about a third of the women had urinary iodine levels above 300 µg/L. The salt iodization coverage, according to the same study, is about 59.3%, where 40% of the households had salt iodized with less than 15 ppm, and the level of iodine was >80 ppm in 13% of the households. Strategies should be put into place to control the variations of the iodine in salt using quality control methods in the industry.

- **Calcium:**

Calcium deficiency is associated with bone health and osteoporosis especially in post-menopausal women. The calcium status is determined by the relationship of calcium intake, calcium absorption and excretion. A positive calcium balance is important throughout life, especially among children less than 2 years old, during puberty and adolescence, pregnant, lactating, and postmenopausal women, as well as elderly men.

The level of calcium intake at an energy level of 1800 kcal is adequate in the Oman dietary pattern, and most of the calcium is supplied by flour and bread (22%), milk and dairy products (37%). The levels of calcium supply throughout the lifecycle should be studied and if needed strategies to improve milk intake should and be put in place.

- **Dietary antioxidants:**

Vitamins C, E and β -carotenes had been linked with prevention of chronic diseases. The Omani food based dietary guidelines should take into considerations adequate supplies of these nutrients through increasing the consumption of fruits and vegetables and whole grains. The current food pattern supplies only 36% of the RNI of vitamin E, and these should be improved through improving the vitamin E sources (eg. vegetable oils). Currently, some milk and dairy products in the Omani market are fortified with vitamin A, and E but the contribution of these to the levels of the diet is not known (Annex 2).

3.2.4 Nutrient considerations for the development of FBDG for Oman.

Table 6 summarizes the considerations expressed above that should inform the development of FBDG for the Omani people. The table is organized to show the condition or disease influenced by nutrient intakes, the population category affected, the evidence supporting these assumptions as well as the recommendation that should address the problem.

Table 6: Considerations for the development of the Food Based Dietary Guidelines in Oman

Condition disease	Population category	Nutrient	Rationale	Recommendation
PEM constrained growth Underweight Stunting Wasting	Children Adults	Energy	High rates of malnutrition among all categories of the population; average calorie supply is lower than national RNI for energy; low supply of zinc and iron in the diet.	Improve energy, iron and zinc supply to all categories of the population. Promote lean red meat, whole grain cereals, pulses and legumes.
Iron deficiency	Children Women	Iron	Persistence IDA among women and children	Increase heme sources of iron; increase variety
Vitamin A deficiency	All	Vitamin A	Dietary Vitamin A supply is lower than the recommended levels	Fortification of oils, improve intake of fruits and vegetables
Overweight and obesity	School children and adults	Energy	High rates of obesity in the adult population	Increase intake of fruits and vegetables, reduce fat intake and educate on good sources of fat
Hypertension	Adults	Salt	High rates of hypertension; increased sodium consumption	Reduce salt intake; educate on sources of sodium
Diabetes; CVD	Adults	Fats, Fiber	High rates of Diabetes	Reduce total, saturated and trans fat intake, increase intake of dietary fiber; and fish oils. Physical activity
Neural tube defects	Women at childbearing age	Folate	Most of the folate is supplied by fortified flour	Vary the sources of folate in the diet
Dental caries	Pre-school and school children	Sugars, sweets and drinks	High rates of dental caries	Reduce consumption of sugary drinks and sweets
Rickets	Children	Vitamin D	Low supply of vitamin D, hospital reports of rickets	Educate on exposure to sun
Cancer	Adults	Sodium	High supply of sodium; and saturated fats	Reduce consumption of table salt, salted fish and canned products. Physical activity. Increase fruit and vegetable intake.

4. ENERGY, NUTRIENT GOALS AND RECOMMENDATIONS FOR THE OMANI POPULATION:

4.1 Background

A principle aim of FBDG is that their use should lead to adequate diets and optimal nutritional status of the population. The FBDG should therefore recommend diets that will satisfy the energy and nutrient requirements of the various population groups. In this section the process and outcome followed to calculate and define energy and nutrient requirements for the Omani population is discussed. This includes energy requirements, contribution of energy by the different macronutrients (protein, carbohydrates and fat) and micronutrient considerations. Because of the complexity of establishing energy and nutrient intake values³⁰ and also because of a lack and limitation of available data on population intakes in Oman, height and weight data were used to calculate energy recommendations. Based on these outcomes, nutrient requirements were defined based on density scores as recommended by WHO³¹.

4.2 Estimating energy requirements for the Omani population:

Energy requirement is the amount of food energy needed to balance energy expenditure in order to maintain body size, body composition and a level of necessary and desirable physical activity consistent with long term health. The recommended level of dietary energy intake for a population group is the mean requirement of the healthy, well-nourished individuals who constitute that group; and are determined by basal metabolism, metabolic response to food, physical activity, growth, pregnancy and lactation. In an advanced setting the total energy expenditure (metabolic response to food and energy cost of tissue synthesis) is calculated using the doubly labeled water technique (DLW) or heart rate monitoring technique. Calculations for growth velocity and the cost of production and secreting of milk had been calculated as well.³⁸ Alternatively, factorial calculations are available to assess the energy requirements for various population groups on the basis of age, gender, and physical activity which was used in this report.

For children at the ages of 1-18 the energy requirements were calculated from the sum of energy deposition and total energy expenditure. A quadratic equation was used to calculate the estimated total energy expenditure, whereas the energy needs for growth were calculated as 2 Kcal/ per gram increase in body weight (Annex 3).

For adults it is not possible to use the same calculations universally; as physical activity level, body size and composition should be considered. Basal Metabolic Rate (BMR) however, could only be measured accurately with calorimetric methods. Factorial methods were developed to measure total energy expenditure from BMR and physical activity levels attributable to the individual population. The alternative approach used here is to estimate the mean BMR using predictive equations based on weight / height measurements.

Considerations in the estimation of the energy requirements for the Omani population:

- Height and weight measurements: The calculations of the energy requirements are designed to satisfy well nourished population requirements and do not take account of underweight or overweight of which the prevalence is high among the various categories of the Omani population. To overcome this issue, the length/ height data

of available survey data was used to generate median reference weights for each population category. These were used for the calculations of Energy Requirements.³⁸

- Physical activity levels: There were not enough data to estimate the physical activity level factor in the calculations. These were set to sedentary lifestyle in all categories of the population based on general observations of the team. It can therefore be expected that calculated energy requirements would be underestimated.

Table 6 shows the target energy requirements for Omanis; detail explanations on the methods used to generate the recommended intakes are outlined in Annex 3. The estimated national energy requirements adjusted for age, gender, population size, pregnancy and lactation was found to be 2100 Kcal per person per day; and ranges between 1700-3000 for various population groups. When compared with the recommended WHO ranges; the calculated energy requirements for Omanis fell in those ranges for all age-gender groups (Table 6).

Table 7: Calculated Energy requirements for various age-gender groups of the Omani population

Gender	Age group	Energy Requirements in Kcal/day	Comparison with WHO Recommendations³⁸
Both	1-3 years	1000	948 – 1129 *
Both	4-8	1400	1252 – 1692 *
Female: general population	9-13	1900	1854 – 2379 *
	14-18	2400	2449 – 2503 *
	19-30	2000	1650 – 3850 #
	31-50	2000	1750 – 3400 #
	51-70	1800	1550 – 3150 #
	>70	1600	1550 – 3150 #
Female : pregnant [@]	<19	2700	
	19-30	2100	
	31-50	2600	
Female : lactating [@]	<19	2900	
	19-30	2400	
	31-50	2400	
Males	9-13	2000	1978 – 2548 *
	14-18	3000	2770 – 3410 *
	19-30	2100	2100 – 4500 #
	31-50	2400	2100 – 4200 #
	51-70	2200	1700 – 3600 #
	>70	1800	

- The WHO data have smaller age categories. Ranges from youngest to oldest age in the category given here.
Range depending on weight, height and physical activity
@ The WHO expressed requirements as total cost of pregnancy: here expressed as requirements per day.

4.3 Estimating macronutrients goals for the Omani population:

Recommended nutrient intake (RNI) is the daily intake set as the estimated average requirements (EAR) plus 2 standard deviations which meets the nutritional requirements of almost all healthy individuals in an age and sex-specific population. For the purpose of the dietary guidelines; this definition is equivalent to the Recommended Dietary Allowance (RDA) as used by the food and nutrition board of the United States national academy of science. The Estimated average requirement (EAR) is the average daily nutrient intake level that meets the needs of 50% of the healthy individuals in a particular age and gender group³⁷.

The recommended macronutrient intake ranges for fats; carbohydrates and proteins are shown in Table 7. The macronutrients in this table are expressed as the percentage contribution of fat, carbohydrate and protein to total energy intake. These values were adopted from the WHO recommendations³¹ aimed at preventing non-communicable diseases.

These values were deemed to be relevant for the Omani population because of the observations of increased fat intakes associated with increased prevalence estimates of overweight, obesity, and non-communicable diseases such as diabetes mellitus. The increased risk of individuals, who were undernourished as children for non-communicable disease, further emphasized the need for the dietary goals in Table 7.

The recommendations for dietary cholesterol and sodium chloride (table salt) are expressed in mg and g/day while a recommendation of fruit and vegetable intake of more than 400g/day is also included. These recommendations are also aimed at the prevention of non-communicable diseases.

Infants and young children have special considerations where exclusive breastfeeding is advised for children up to the age of 6 months, continued breast feeding into the second year and adequate complementary feeding practices and transition to family diet, Oman had adopted a policy of breastfeeding and complementary feeding since the early nineties. Therefore, the dietary guidelines will not cover the age group of 0-2 years. However, the recommendation for pre-school children at the age of 2-5 years of age for energy density liquids should be 2.5-3.1 kj (0.6-0.75 kcal) per ml, whereas the solid foods should have an energy density of 1.5-2.0 Kcal per gram.

The protein; iron and zinc nutrient densities depend on factors such as the quality of protein and absorption enhancements. The following paragraph will discuss the rationale for setting the protein requirement for Oman.

Protein requirements:

WHO recommends 20-25 g (8-10% of total energy) for high protein quality and 25-30 g per 1000 calories (10-12% of total energy) for low animal protein consumption.

According to the data of the Food Income and Expenditure Survey, 33% of the protein consumption comes from meats, poultry and fish. Cheese and milk contribute 12% of the total energy. The total protein intake is 13% of total energy. Therefore the protein consumption can be considered of high quality and the national recommendations are set to 20-25 g per 1000 Kcal.

Table 8: Ranges of population nutrient intake goals (Source: Diet, Nutrition and Prevention of Chronic Diseases; WHO report series 916; Geneva 2003)³¹

Dietary Factor	Goal (% of total energy unless otherwise stated)
Total fat	15-30%
Saturated fatty acids	<10%
Polyunsaturated fatty acids	6-10%
n-6 Polyunsaturated fatty acids (PUFAs)	5-8%
n-3 Polyunsaturated fatty acids (PUFAs)	1-2%
Trans fatty acids	<1%
Monounsaturated fatty acids (MUFAs)	By difference
Total carbohydrates	55-75%
Free Sugars	<10%
Protein	10-15%
Cholesterol	<300mg/per day
Sodium Chloride (Sodium)	<5 g per day (<2 g per day)
Fruits and vegetables	>= 400 g per day

4.4 Estimating micronutrient recommendations for the Omani population

Tables 8, 9 and 10 show recommended micronutrient intakes for the Omani population for different age and gender categories. Table 8 also includes energy and specific recommendations for protein, carbohydrate and fiber (these are macronutrients) while Table 10 gives specific recommendations for the different types of fats and fatty acids.

The micronutrient values were compared to the recommended dietary allowances (RDA) from the USA Food and Nutrition Board (1989) and were found to be within those ranges for specific age and gender categories. As previously mentioned, iron and zinc are two nutrients of concern in the Omani population. Factors influencing their bioavailability are therefore briefly discussed below.

Iron requirements:

Animal foods and ascorbates are important enhancers of non-heme iron absorption, while phytates, polyphenols, tannins and fiber lower it. RNI's are defined in terms of very low or low (<5%; 5-10%) bioavailability for cereal based diets and low ascorbate content and the suggested RNI density for these is 20; and 11 mg per 1000 Kcalories respectively.

An intermediate diet with a bioavailability of 11-18% is based on plant foods with some animal protein and ascorbic acid. The suggested iron density for this diet is 5.5 per 1000 Kcalories.

The high bioavailability diet (19% absorption), is predominantly animal protein diet and with fruits rich in ascorbic acid. This diet, however, should be considered intermediate bioavailability if the consumption of tea is high. The recommended nutrient intake for this is 3.5 mg per 1000 Kcalories¹.

As mentioned earlier, the Omani diet is rich in animal sources of protein and on average has 61 mg of vitamin C which is 22% higher than the average requirements. On the other hand, consumption of tea is generally known to be high, although there are no quantitative estimates. Therefore, the RNI's will be based on the intermediate bioavailability level (5.5 mg per 1000 Kcal).

Zinc requirements:

The absorption of dietary zinc ranges between 10% and 30%, and is dependent on the fiber and phytate content of the diet. The RNI for high bioavailability zinc is 6 mg per 1000 kcal and that of the low bioavailability zinc is 10 mg per 1000 kcal. Because of the moderately high fiber content of the Omani diet, the low bioavailability RNI will be used as reference for estimating national RNI's of zinc; and the nutrient density will be set at 10 mg per 1000 kcal.

Table 9: Recommended nutrient intakes for protein; carbohydrates; and vitamins of public health importance for various population groups of Oman

Population category	Age-group (years)	Energy (kcal)	Protein (g)	Carbohydrates (g)	Fiber (g)	Vitamin A (µg RE)	Vitamin D (µg)	Iron (mg)	Folate (µg)	Zinc (mg)	Calcium (mg)
Young children	1-3	1000	20-25	137.5-187.5	8-20	350-500	2.5-5.0	5.5	150-200	10	250-400
Children	4-8	1400	28-35	192.5-262.5	11-28	490-700	3.5-7	7.7	210-280	14	350-560
Adolescent											
Males	9-13	2000	40-50	275-375	16-40	700-1000	5-10	11.0	300-400	20	500-800
	14-18	3000	60-75	412.5-562.5	24-60	1050-1500	7.5-15	16.5	450-600	30	750-1200
Females	9-13	1900	38-47.5	261.3-356.3	15-38	665-950	4.8-9.5	10.5	285-380	19	475-760
	14-18	2400	48-60	330-450	19-48	840-1200	6-12	13.2	360-480	24	600-960
Adults											
Males	19-30	2100	42-52.5	288.8-393.8	17-42	735-1050	5.3-10.5	11.6	315-420	21	525-840
	31-50	2400	48-60	330-450	19-48	840-1200	6-12	13.2	360-480	24	600-960
	51-70	2200	44-55	302.5-412.5	18-44	770-1100	5.5-11	12.1	330-440	22	550-880
	>70	1800	36-45	247.5-337.5	14.5-36	630-900	4.5-9	9.9	270-360	18	450-720
Females	19-30	2000	40-50	275-375	16-40	700-1000	5-10	11	300-400	20	500-800
	31-50	2000	40-50	275-375	16-40	700-1000	5-10	11	300-400	20	500-800
	51-70	1800	36-45	247.5-337.5	14.5-36	630-900	4.5-9	9.9	270-360	18	450-720
	>70	1600	32-40	220-300	13-32	560-800	4-8	8.8	240-320	16	400-640
Pregnant	All	2100-2700	42-67.5	290-500	17-52	735-1300	5.3-13.5	11-15	315-540	21-27	525-1100
Lactating	All	2400-2900	48-72.5	330-540	19-58	840-1450	6-15	13-16	360-580	24-29	600-1160

Table 10. Recommended nutrient intakes for some vitamins and minerals for various population groups for Oman.

Population category	Age-group (years)	Energy (kcal)	Vitamin E (mg α TE)	Vitamin K (μg)	Vitamin C (mg)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin B6 (mg)	Vitamin B12 (μg)	Fluoride (mg)	Iodine (μg)	Sodium (g)
Young children	1-3	1000	3.5-5.0	20-40	25-30	0.5-0.8	0.6-0.9	6-10	0.5-1	0.5-1	0.5-1	75	2.5
Children	4-8	1400	4.9-7.0	28-56	35-42	0.7-1.12	0.8-1.3	8.4-14	0.7-1.4	0.7-1.4	0.7-1.4	105	3.5
Adolescent													
Males	9-13	2000	7.0-10.0	40-80	50-60	1-1.6	1.2-1.8	12-20	1-2	1-2	1-2	150	5.0
	14-18	3000	10.5-15.0	60-120	75-90	1.5-2.4	1.8-2.7	18-30	1.5-3	1.5-3	1.5-3	225	7.5
Females	9-13	1900	6.7-9.5	38-76	47.5-57	0.9-1.6	1.1-1.7	11.4-19	0.9-1.9	0.9-1.9	0.9-1.9	142	4.8
	14-18	2400	8.4-12.0	48-96	60-72	1.2-1.9	1.4-2.1	14.4-24	1.2-2.4	1.2-2.4	1.2-2.4	180	6.0
Adults													
Males	19-30	2100	7.3-10.5	42-84	52.5-63	1.1-1.7	1.3-1.9	12.6-21	1.1-2.1	1.1-2.1	1.1-2.1	158	5.3
	31-50	2400	8.4-12.0	48-96	60-72	1.2-1.9	1.4-2.2	14.4-24	1.2-2.4	1.2-2.4	1.2-2.4	180	6.0
	51-70	2200	7.7-11.0	44-88	55-66	1.1-1.8	1.3-2.0	13.2-22	1.1-2.2	1.1-2.2	1.1-2.2	165	5.5
	>70	1800	6.3-9.0	36-72	45-54	0.9-1.5	1.1-1.6	10.8-18	0.9-1.8	0.9-1.8	0.9-1.8	135	4.5
Females	19-30	2000	7.0-10.0	40-80	50-60	1-1.6	1.2-1.8	12-20	1-2	1-2	1-2	150	5.0
	31-50	2000	7.0-10.0	40-80	50-60	1-1.6	1.2-1.8	12-20	1-2	1-2	1-2	150	5.0
	51-70	1800	6.3-9.0	36-72	45-54	0.9-1.44	1.1-1.6	10.8-18	0.9-1.8	0.9-1.8	0.9-1.8	135	4.5
	>70	1600	5.6-8.0	32-64	40-48	0.8-1.3	0.9-1.4	9.6-16	0.8-1.6	0.8-1.6	0.8-1.6	120	4.0
Pregnant	All	2100-2700	7.3-13.5	42-108	52.5-81	1.0-2.2	1.3-2.4	12.6-27	1.0-2.7	1.0-2.7	1.0-2.7	157-202	5.3-6.7
Lactating	All	2400-2900	8.4-14.5	48-116	60-87	1.2-2.3	1.4-2.6	14.4-29	1.5-2.9	1.5-2.9	1.5-2.9	180-217	5.9-7.2

Table 11: Recommended nutrient intakes of total and other forms of fats for various population groups of the Omani population.

Population category	Age-group (years)	Energy (kcal)	Total fat (15-30%)	Saturated fats (10%)	PUFA (6-10%)	n-6 fatty acids (5-8%)	n-3 fatty acids (1-2%)	Trans fats (<1%)
Young children	1-3	1000	16.7-33.3	11.0	6.7-11.1	5.6-8.9	1.1-2.2	0.02
Children	4-8	1400	23.3-46.7	15.4	9.3-15.6	7.8-12.4	1.6-3.1	0.03
Adolescent								
Males	9-13	2000	33.3-66.7	22.0	13.3-22.2	11.1-17.8	2.2-4.4	0.04
	14-18	3000	50-100	33.0	20.0-33.3	16.7-26.7	3.3-6.7	0.07
Females	9-13	1900	31.7-63.3	20.9	12.7-21.1	10.6-16.9	2.1-4.2	0.04
	14-18	2400	40-80	26.4	16.0-26.7	13.3-21.3	2.7-5.3	0.05
Adults								
Males	19-30	2100	35-70	23.1	14.0-23.3	11.7-18.7	2.3-4.7	0.05
	31-50	2400	40-80	26.4	16.0-26.7	13.3-21.3	2.7-5.3	0.05
	51-70	2200	36.7-73.3	24.2	14.7-24.4	12.2-19.6	2.4-4.9	0.05
	>70	1800	30-60	19.8	12.0-20.0	10.0-16.0	2.0-4.0	0.04
Females	19-30	2000	33.3-66.7	22.0	13.3-22.2	11.1-17.8	2.2-4.4	0.04
	31-50	2000	33.3-66.7	22.0	13.3-22.2	11.1-17.8	2.2-4.4	0.04
	51-70	1800	30-60	19.8	12.0-20.0	10.0-16.0	2.0-4.0	0.04
	>70	1600	26.7-53.3	17.6	10.7-17.8	8.9-14.2	1.8-3.6	0.04
Pregnant	All	2100-2700	35-90	23-30	14.0-30	11.7-24.0	2.3-6.0	0.06
Lactating	All	2400-2900	40-96.7	26-32	16.0-32.2	13.3-25.8	2.7-6.4	0.06

5. DEFINITION OF FOOD GROUPS:

Foods are defined as food groups to facilitate the development of FBDG and help the public to make informed choices and comply with the recommendations. Food groups had been shown to improve food portion size estimation skills, and thus adherence to dietary guidelines⁴⁴. In addition; the analysis of diet as food groups is used widely and could detect relationships to short and long term body weight changes; and disease risk⁴⁵⁻⁴⁷.

Several food groupings are adopted by different countries, most of which are dependent on the contribution of the foods to energy and nutrients. Following the evolution of evidence relating fiber and whole grain intake to morbidity and mortality of chronic diseases, the US led the initiative to adopt sub-grouping of cereals and grains to whole and refined products⁽⁴⁸⁻⁴⁹⁾.

For the purpose of the Omani FBDG preliminary food groups were suggested by Valstar in 2004⁽⁴⁹⁾. These were:

- Cereals, potatoes, sweet potatoes, bread, pasta
- Vegetables and fruits
- Meat, fish, poultry, eggs, pulses
- Milk and dairy products
- Oil, butter, ghee, margarine, nuts
- Sugar, fizzy drinks, sweets

In order to finalize the food groups, a listing of all food items consumed by Omanis according to the 2001 Income and Expenditure Survey was reviewed. The list, which composed of 217 food items, was looked at in view of the literature available and each food item was assigned to a group. It was agreed to develop two proposals for pilot testing in the community.

Tables 11 and 12 show different proposals for the groups/ sub-groups for the Omani FBDG. The groups should be field-tested and given names that are acceptable and understandable to the Omani population. Because potato consumption was observed to be high in Oman, the potatoes, sweet potatoes, plantain, yams and cassava were included in the cereals, grains and potatoes group in order to promote consumption of other vegetables. Nuts were classified as raw and roasted/salted. Processed meat was added as a sub-group in order to highlight the importance of limiting salt and oil consumption and to create awareness on hidden sources of these.

After discussions with a WHO consultant (Muscat, October 2007) and a workshop with selected dietitians, Table 11 was extended to include water and beverages as a group. The sub-groups were also re-organised to reflect the nutritional needs to be addressed in the FBDG.

<i>GroupName</i>	<i>Subgroups</i>	<i>Classifications</i>	<i>Foods: Example</i>
Starchy foods such as cereals, breads, grains, pastas and potatoes		High fiber	- whole wheat, brown rice
		Low fiber	- White flour, white rice
Vegetables	Vitamin C - rich	Vitamin C - rich	Sweet peppers (capsicum), tomato paste, cauliflower, beetroot, radish
	Vitamin A - rich	Vitamin A - rich	Lettuce, Cabbage, carrots, zucchini (courgette), Green peas
	Iron/Folic Acid – rich	Iron/Folic Acid – rich	Spinach, parsley, mulukhiya
	Others	Others	Onions, okra, cucumber, aubergine (eggplant), garlic
Fruits	Vitamin C - rich	Vitamin C - rich	Citrus fruits, pineapple, guava, cherries, berries
	Vitamin A - rich	Vitamin A - rich	Mango, papaya, apricot, plums
	Potassium - rich	Potassium - rich	Raisins, Dried figs, Dates, Banana, Dried, melons
	Others	Others	Coconut, grapes, apples, pears, figs, dates, dried fruits, fresh fruit juice, canned pineapples
Meat and alternatives		Red meat	Beef, lamb and camel
		Poultry	Chicken and other poultry
		Fish	All fish
		Nuts and seeds	All nuts and seeds
		Eggs	All eggs
		Processed, high fat products	Canned meats, sausages, shawarma, kebab, chicken nuggets, fingers
Legumes (pulses)		Lentils	All types of lentils
		Dry beans and peas	All types of beans, also canned dried peas
Milk and dairy products		Milk	Long-life, fresh, pasteurized, powdered milk
		Yoghurt	All yogurts, laban and kushk
		Cheese	All cheeses
		Others	Labneh
Fats and oils		Saturated	Ghee, butter, evaporated milk, cream
		Unsaturated such as mono-, poly- and omega-3 fatty acids	Vegetable oils and fish
		Trans fats	Snack foods, pastries, cookies, fried foods
Foods high in salt, sugar and fat		Salt & salty food	Chips, salty and high fat snacks
		Sugar & sugary foods	Sweetened condensed milk, sugar, honey, ice-cream, puddings, halwa, sweets etc.
		All foods high in fat	Cookies, biscuits, crisps, chocolate, etc.
Water and beverages		Water	Clean safe drinking water
		Teas, coffee	All teas and coffees
		Natural fruit juices	100% fruit juices without added sugar
		Dinks, cordials, fizzy drinks	Fizzy drinks, cordials and flavored beverages

Table 12: Food groups for the Omani Food Based Dietary Guidelines

6. DEFINITION OF FOOD SERVINGS:

The food servings are the most universally accepted method of quantifying food items and groups; they are used to quantify the recommendations of the FBDG and developing easy to understand materials for the public⁵¹. They are based on four criteria identified by the USDA: Amount of foods from a food group typically reported in surveys as consumed on one eating occasion; amount of food that provide a comparable amount of key nutrients from that food group, for example: the amount of cheese that provides the same amount of calcium as 1 cup fluid milk; amount of foods recognized by most consumers (e.g. household measures) or that can be easily multiplied or divided to describe a quantity of food actually consumed (portion); amount traditionally used in previous food guides to describe servings⁵².

Estimation of food servings is a useful tool for approximation of food consumption for individuals and to assess disease risk in surveys.⁵²⁻⁵³ Methods of classifying foods and assigning pyramid serving size had been well established and the defined food servings are used almost universally. A complete database is available electronically at the following web link: <http://www.ars.usda.gov/Services/docs.htm?docid=8503>.

For these reasons the food servings quantified by the USDA are used as the reference portion sizes in the development of recommendations of food groups quantities. For the estimation of food servings of local dishes the methods available in the literature for converting food recipes into food groups and servings will be employed at a later stage.

7. FOOD PATTERN MODELING:

Dietary patterns describe the types and amounts of food combinations to be consumed. It is important to establish recommended dietary patterns that will satisfy the recommended energy and nutrients intake. Initially, the consumption pattern of the income and expenditure survey data was analyzed and modified to a basic pattern. Modifications of the food pattern included:

1. Replaced one serving of white flour with whole wheat flour.
2. Increased the quantities of the fruits and vegetables consumed.
3. Increased the legumes consumed.
4. Removed the processed and canned foods (to reduce sodium content); replaced with natural equivalents.
5. Replaced the whole milk with skim milk (because of the total and Trans Fat content).
6. Choose chicken without skin.
7. Restructure the fat group to a lower Trans Fats and saturated fats.
8. Increased vitamin A subgroup consumption of fruits and vegetables.
9. Distributed consumption over all groups and subgroups.
10. The iron and folate content of white flour was modified to be consistent with the current local fortified standards.

These modifications led to satisfactory ratios of the 2400 Kcal pattern. The food groups constructed in section 1.5 were weighted accordingly and the pattern was reconstructed for the energy levels shown in Table 13; for food servings.

The patterns for each energy intake were translated into quantitative estimations for each food group in measures and weights (Table 14). An analysis of the nutritional adequacy of each food pattern developed was carried out using specialized software and it was found that all patterns were within acceptable ranges for all nutrients as shown in Table 15.

The analysis of adequacy of the nutrients in the food patterns of different energy levels showed that vitamin D; E; and Zinc were not satisfied in those patterns; therefore measures should be taken to improve the consumption of these nutrients. Fortification of oil with vitamins D and E was not taken into account in these patterns and could substantially improve the consumption of those nutrients; whereas zinc adequacy could be improved through flour fortification. Also; the recommended limit for Trans Fats consumption is <1%; and ranges between 0.02 g- 0.07 g in all patterns; and the analysis revealed that this could not be achieved using reasonable dietary recommendations of fat intake; therefore measures to limit Trans Fats intake should be carried out on a national level through legislations that mandate declaration of Trans Fats content; and elimination of Trans Fats in processed foods wherever necessary.

Table 13: Number of servings recommended for each food group at various energy levels

Food Group	1000	1400	1600	1800	2000	2200	2400	2600	3000
	Child 1-3	Child 4-8	F: >70	M: 70; F:51- 70	M/F 9-13; F 19- 50	M: 19- 30	M: 51-70 M: 31-50 F: 14-18	Pregnant women	M: 14-18; F lactating
Grains									
Whole	0.8	1.2	1.3	1.5	1.7	1.8	2.0	2.2	2.5
Refined	3.2	4.5	5.2	5.8	6.4	7.0	7.7	8.3	9.7
Fruits									
Vitamin A	0.4	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.2
Vitamin C	0.4	0.6	0.7	0.8	0.8	0.8	0.9	1.0	1.2
Potassium	0.3	0.4	0.5	0.6	0.6	0.6	0.7	0.8	0.9
Other fruits	0.7	1.0	1.1	1.2	1.4	1.5	1.7	1.8	2.1
Vegetables									
Vitamin A	0.3	0.5	0.6	0.7	0.7	0.8	0.8	0.9	1.1
Vitamin C	0.4	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.3
Iron rich	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Other vegetables	0.6	0.9	1.0	1.1	1.3	1.3	1.6	1.6	1.8
Meats and Alternatives	0.5	1.2	1.0	1.1	1.3	1.3	1.3	1.5	1.8
Legumes (pulses)	0.3	0.5	0.6	0.7	0.7	0.7	0.8	0.9	1.1
Milk and dairy	0.2	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.8
Fats and oils	1.8	2.4	2.8	3.1	3.5	3.8	4.2	4.6	5.3

Table 14: Recommended amounts of various groups/sub-groups at various energy levels¹

Food Group²	1000	1400	1600	1800	2000	2200	2400	2600	3000
	Child 1-3	Child 4-8	F: >70	M: 70; F:51-70	M/F 9- 13; F 19-50	M: 19- 30	M: 51-70 M: 31-50 F: 14-18	Pregnant women	M: 14-18; F lactating
Grains³ (c)									
Whole	0.4	0.6	0.7	0.8	0.9	0.9	1.0	1.1	1.3
Refined	1.6	2.3	2.6	2.9	3.2	3.5	3.9	4.2	4.9
Fruits (c)⁴									
Vitamin A	0.4	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.2
Vitamin C	0.4	0.6	0.7	0.8	0.8	0.8	0.9	1.0	1.2
Potassium	0.3	0.4	0.5	0.6	0.6	0.6	0.7	0.8	0.9
Other fruits	0.7	1.0	1.1	1.2	1.4	1.5	1.7	1.8	2.1
Vegetables (C)									
Vitamin A	0.3	0.5	0.6	0.7	0.7	0.8	0.8	0.9	1.1
Vitamin C	0.4	0.6	0.7	0.8	0.8	0.9	1.0	1.1	1.3
Iron rich	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Other vegetables	0.6	0.9	1.0	1.1	1.3	1.3	1.6	1.6	1.8
Meats and Alternatives (g)	35	84	70	77	91	91	91	105	126
Legumes(pulses) (c)	0.3	0.5	0.6	0.7	0.7	0.7	0.8	0.9	1.1
Milk and dairy (c)	0.2	0.4	0.5	0.5	0.5	0.6	0.6	0.7	0.8
Fats (g)	29	40	47	52	59	63	70	77	81

¹ The food groups definitions are from reference 49: Report of the Dietary guidelines advisory committee on the Dietary guidelines for Americans; and reference 7.

² Food groups are shown in cups (c) for grains, fruits, vegetables, legumes and dairy, in grams for meats and fats.

- 1serving (1 ounce eq or 28.35g) grains = 1 slice of bread; ½ cup cooked cereal rice or pasta or 1 cup ready to eat cereal flakes.
- Fruits and vegetables: 1 cup = 1 cup raw fruits or vegetables or ½ cup chopped, cooked or canned fruit or vegetable, ¾ cup of fruit or vegetables juice.
- Milk and dairy: 1 cup equivalent=1.5 oz (42.5g) natural cheese (e.g cheddar); or 2 oz (56.7g) processed cheese (e.g. American).

Table 15: Comparison of the nutrient contribution of each food intake pattern to the RNI's of the same pattern

Age gender group		1000	1400	1600	1800	2000	2200	2400	2600	3000
		Child 1-3	Child 4-8	F: >70	M: 70; F:51-70	M/F 9- 13; F 19-50	M: 19- 30	M: 51-70 M: 31-50 F: 14-18	Pregnant women	M: 14-18; F lactating
Calories	% goal	97	118	102	102	101	105	99	97	102
Protein	% RNI	175	172	152	152	146	153	145	179	151
Protein	% kcal	14	14	14	14	14	14	14	14	14
Carbohydrates	% RNI	107	88	82	83	81		81	108	83
Carbohydrates	% kcal	59	53	58	59	58	59	59	59	59
Total Fiber	% RNI	206	93	87	89	85	84	85	209	88
Total Fat	% RNI	178	133	96	93	97	99	90	179	96
Saturated fat	% AI ⁹	72	96	77	75	76	78	73	72	77
Trans Fats	% AI	1021	944	826	906	1021	880	973	891	877
Vitamins										
Vitamin A RE	% RNI	139	104	106	107	98	104	101	141	105
Thiamin B1	% RNI	140	109	91	89	92	94	91	141	93
Riboflavin B2	% RNI	132	92	97	96	89	94	94	133	94
Niacin B3	% RNI	145	95	92	93	89	93	89	145	92
Vitamin B6	% RNI	157	99	84	85	83	86	82	160	85
Vitamin B12	% RNI	699	374	382	388	349	374	364	711	378
Vitamin C	% RNI	241	216	217	220	203	215	209	245	216
Vitamin D	% RNI	12	7	7	7	6	7	6	13	7
Vitamin E	% RNI	52	45	39	39	38	40	38	53	39
Folate	% RNI	143	116	113	113	109	109	110	143	112
Minerals										
Calcium	% RNI	128	90	88	88	83	83	84	131	86
Iron	% RNI	137	182	147	147	146	144	141	139	148
Zinc	% RNI	41	61	45	44	45	44	42	42	45

⁹ AI=Allowable intake

8. DESIGNING THE FOOD BASED DIETARY GUIDELINES MESSAGES

Initially; a review of the literature was carried out; and several focus group discussions with dietitians were conducted to synthesize a proposal for a set of messages. The outcome of these was the messages outlined in Table 15.

Table 16: First proposal for the Food Based dietary guidelines messages for Oman

1. Enjoy a variety of nutritious foods and drink plenty of water.	1. استمتع بأنواع مختلفة من الطعام، واشرب الكثير من الماء
2. Maintain a healthy weight and control caloric intake.	2. حافظ على وزن صحي و تحكم بالسعرات الحرارية
3. Be active daily.	3. كن نشيطاً يومياً
4. Limit your intake of fats, sugar and salt.	4. قلل من تناول الدهون، السكريات و الملح
5. Eat plenty of vegetables and fruits daily.	5. تناول الكثير من الخضروات والفواكه يومياً
6. Include a variety of cereals, grains, rice, breads and pasta, preferably wholegrain daily	6. ضمن في وجباتك أنواع مختلفة من الحبوب والأرز والخبز والمعكرونة يومياً
7. Consume dairy products, preferably low fat	7. تناول منتجات الألبان، ويفضل قليلة الدهون
8. Include meats, chicken, fish, pulses or eggs in your meals daily.	8. ضمن اللحوم، الدواجن والأسماك والبقوليات والبيض في وجباتك يومياً
9. Ensure your food is safe: In preparation and storage.	9. تأكد من سلامة غذائك في التحضير والتخزين
10. Encourage breastfeeding; adequate complementary feeding and transition to family diet.	10. شجع الرضاعة الطبيعية وإدخال الأطعمة المكملة بطريقة ملائمة والانتقال إلى أطفلة العائلة

In addition to that; the literature review and the food pattern modeling revealed a number of issues and considerations to be incorporated in those messages such as:

1. Energy: The energy consumption of the Omani basic diet is lower than the recommended average population intake by 200 kcal. It is unknown whether this difference is an underestimate due to reporting errors; or it is real. However; according to the data of 2001 there is a problem of malnutrition among Omani adults as well as children.
2. Variety: In each food group it was observed that a few commodities constituted the major consumption. For example citrus fruits; and fruits composed the bulk of the fruit consumption whereas the vitamin A fruits and vegetables intake was low and chicken composed most of the meat. Legumes and fish consumption was extremely low and whole cereals were almost non-existent.
3. Low fiber intake: The basic food pattern lacked in high fiber food items; the sources of these being various fruits and vegetables and whole cereals. The importance of whole wheat flour should be highlighted.
4. Fish consumption: fish is a national commodity that had many nutritional benefits; however the consumption of fish is extremely low; legumes also are high in fiber and protein and cheap and they need to be exploited as a stable food.
5. The Trans Fats content of the diet is very high; even after several modifications: Whole milk was replaced with skimmed milk; and the chicken was chosen without skin. The consumption of butter; and ghee and hidden fats in biscuits and ice cream contribute to the increased intake of saturated and Trans Fats; and this should be taken into considerations when designing the messages.

6. Vitamins E; D could not be satisfied on the patterns developed: The role of lifestyle; exercise and exposure to sun need to be incorporated in the messages.
7. The basic diet was too high in salt; fat and sugar: natural products should be encouraged such as fresh made meats as opposed to sausages and luncheon; fresh fruits as opposed to canned ones;
8. There are fortified products on the market and these are flour with iron and folic acid; salt with iodine; and almost 75% of the milk in the market is fortified with vitamin A and D.
9. The snacks should be healthy; so the message should encourage replacement of high fat salty snacks such as crisps with healthier alternatives such as raw nuts (low salt).
10. Low intake of fruits and vegetables was evident in the analysis therefore the messages should reflect the importance of fresh fruits and vegetables.
11. The messages should reflect the importance of knowing the food groups; and the sub-groups and their constituents.

The messages in their final format and the visual presentation should reflect these points and the amounts of each food group to be consumed.

The above considerations led to in-depth discussions with several stakeholders (from 20 – 30 October 2007) after which the FBDG were adapted (Table 17). These guidelines are in a suitable format for field-testing. After this process, supporting explanatory papers for each guideline should be written. Educational material aimed at specific target groups could then be developed for implementation of the guidelines.

Table 17: Final Proposal for the Food Based Dietary Guideline messages for Oman

No	Food based dietary guidelines message for Oman	Notes (items) for explanatory support papers
1	Enjoy a variety of nutritious foods and drink plenty of water	<ul style="list-style-type: none"> ▪ Explain the words variety, nutritious and plenty ▪ Focus on water for drinking
2	Maintain a healthy body weight by balancing total food (energy) intake with activity	<ul style="list-style-type: none"> ○ Define healthy weight ○ Quantify activity desired ○ Mention also other benefits of increased activity
3	Eat regular meals with healthy (light meals, in-between, starting the day with breakfast before school or work	<ul style="list-style-type: none"> • Choose right word for snacks • Advice on meal frequency • Explain why breakfast is the most important meal of the day
4	Consume foods and drinks low in fat, sugar and salt	<ul style="list-style-type: none"> ➤ Give examples ➤ Touch on issue of iodised salt
5	Eat at least 5 servings (portions) of different fruit and vegetables every day	<ul style="list-style-type: none"> ✓ Explain why different (variety): yellow, etc. ✓ Because of diabetes problem: 3 vegetables, 2 fruits
6	Include a variety of starchy foods such as cereals, grains, rice, breads and pasta in your diet, preferably as wholegrain or potatoes in their jackets	<ul style="list-style-type: none"> ✓ Give examples of wholegrain
7	Consume milk and dairy products every day, preferably low-fat products	<ul style="list-style-type: none"> • Give examples • Give amounts for each stage of life cycle • Emphasize dairy as main Calcium source
8	Include meat or poultry or fish or eggs or nuts in your daily diet	<ul style="list-style-type: none"> ○ Give portion sizes ○ Fish : 3 – 4 times a week ○ Explain how to exchange
9	Eat lentils, dry beans and peas regularly	<ul style="list-style-type: none"> ▪ Legumes or pulses-choose right word ▪ Rich source of fibre to help control blood glucose
10	Ensure that your food and drinking water is safe and hygienic during production, storage and preparation	<ul style="list-style-type: none"> ❖ Give hygienic principles ❖ Show how to make water safe ❖ Examples of contaminants

9. POLICY IMPLICATIONS FOR THE FOOD BASED DIETARY GUIDELINES:

1. A sound distribution system for fruits and vegetables: The fruits and vegetables are perishable items and therefore a sound distribution system should be put in place for them to be available for all people at affordable cost.
2. Subsidy for fish and sea produce: Fish is a national commodity that is under-utilized and a distribution system as well as price control should be imposed.
3. Production of whole flour: The flour industry and the bakeries should be encouraged to produce whole flour items.
4. Appropriate labeling control: control on the labels should be imposed to ensure transparency in the labeling of breads and flour produce (whole wheat vs. brown); and the content of fats and Trans fats in the pre-packaged foods items.
5. Fortification legislations: Vitamins E and D was not satisfied in the food pattern; one possible reason was the fortification of drinks and milk was not accounted for in the analysis. Fortification should be legislated in oils and milk of vitamins A, E and D.
6. Zinc levels were found to be no more than 50% of the requirements: therefore legislation to fortify flour with zinc should be put into place.

10. IMPLEMENTATION OF FOOD-BASED DIETARY GUIDELINES

Below are different steps that are planned for the implementation for the FBDG, after they have been tested for comprehensibility:

1. Develop Technical Support Papers (TSPs) for each guideline to motivate and explain the guideline. At least two (2) types of TSPs are needed:
 - i. TSPs to inform and educate all relevant health personnel and other stakeholders that will be involved in the implementation.
 - ii. TSPs that can be used as basis for the development of material aimed at the different groups in the population to motivate dietary changes. A basic suggested structure for these TSPs is included.
2. Identify policy and legislative issues that could help in the implementation of the FBDG. For example, review and evaluate supplementation and fortification programs, and consider legislation for nutrient and health claims on certain products.
3. Develop strategies for social marketing of the FBDG in partnership with other stakeholders.
 - These stakeholders should include other, relevant Government Departments (Primary Health Care, Non-communicable diseases, School Health, Agriculture, Economics, Trade, etc.) Also the food importers, marketers, the media, schools, restaurants (food service industry), University (medical and dental schools), the police, etc.
 - Identify specific target groups: eg. School children, women, adults screened for NCDs, etc.
 - Plans of actions (with time schedules) could include for example:

- National announcement of FBDG with media exposure and “free” reporting in papers, radio, television, etc.;
 - Advertisements : papers, radio, television;
 - Lectures and talks by health personnel at health centres, clinics and schools;
 - Competitions and prizes for example for best painting in schools (age-category specific) of healthy foods, the food groups, what to eat only seldomly, etc.
4. Identify suitable and needed infrastructures to implement, e.g. distribution of fresh fruit and vegetables in rural areas and motivate improvements where necessary
 5. It is important to develop a monitoring and evaluation plan for the FBDG’s that includes process and impact indicators; and to ensure success of the process the plan needs to be put together at an early stage.

11. RESEARCH NEEDS FOR THE FOOD BASED DIETARY GUIDELINES:

1. Pilot-testing of the FBDG messages for comprehensibility.
2. Market survey of the availability; accessibility and affordability of the low consumption items such as fruits and vegetables and fish.
3. Market survey and analysis of vitamins E; D content of foods;
4. Labeling of various pre-packaged foods with nutritional data on fats, saturated fats, and Trans fats, and the impact of labeling on consumption pattern of specific products.
5. Because both the process and impact of FBDG need to be evaluated, it is now timely to do a study on the dietary habits and nutrient intakes of the Omani population. Such a study would provide baseline data for later comparisons. It is suggested that such an epidemiological study also include other measures of nutritional status (anthropometry and biochemistry) and that risk factors for the most common NCDs are also measured. These data will help to assess the relationships between dietary patterns (nutrient intakes) with risk of NCDs and how implementation of the FBDG influenced these relationships.
6. The FBDG can also be used in any intervention study or therapeutic practice to improve the diet of subjects, clients or patients

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Annex 1: Summary of nutrition related diseases, trends and risk factors in Oman

Malnutrition and micronutrient deficiencies				
	Prevalence and Trend	Impact of programmes	Nutrients	Foods and other
PEM	W/A: < -2 s.d. 1995: 23% 1999: 17.9% H/A: < - 2 s.d. 1999: 10.6% W/H: < - 2 s.d. 7.0 % and 12.5 % of 1 year old	Dietary guidelines are available for children < 2 PEM decreases with about 1 % per year in young children	Protein, energy Micronutrients?	Contamination is a factor, diarrhea is common Related to education level of mothers
Under nutrition	BMI < 18.5 2000: 7.9% male: 5.9% females: 9.8% 1992: 15.1%	No programme Decrease of about 1 % per year	Energy, protein	Maternal depletion as a result of high fertility?
Anemia	Pregnant women Hb < 11 g/dl '93: 48.5% '95: 39 % '99: 39% Women 2000: Hb < 12 g/dl 28.4% Schoolchildren: Hb < 11 g/dl '92: 60.2% '96: 51.1%	Iron fortication of flour since 1997, gradual decline in anemia among pregnant women found. Pregnant women receive supplements since 1986 Decrease of over 1 % per year (preg.women and school children)	Iron, folic acids, Vit. C, phytates + tanine	Non nutritional anaemia occurs (19% ferritine < 20ug). Meat, chicken, fish consumption is high, but probably not in all socio-econ. groups. Tea. Low consumption of green leafy veg. and of fruits
VAD	Children < 3: serum retinol < 20 ug: '94/'95: 20.8% '98/'99: 5.2%	Fast reduction in young children as result of supplementation, 5.2 % is still public health problem. Possibly worse in older groups. Oil fortification remains in the pipeline	Vitamin A,	Ghee, butter, dairy products, liver, coloured vegetables and fruits, dark leafy veg. Dairy products are fortified with A+D voluntarily by industry
IDD	Iodised salt used by 22 % of	Salt iodised since 1996.	Iodine	Iodised salt

Annex 1: Summary of nutrition related diseases, trends and risk factors in Oman

	households in '92 versus 68.5% in 2000	Strong impact, still needs further push.		
Non communicable diseases				
	Prevalence and Trend	Impact of programmes	Main Nutrients	Foods and other
Obesity and overweight	BMI 1992: > 30: 18.4% > 25: 28 % BMI 2000 > 30: 17.3% > 25: 28.9% In children < 5 1 % (> + 2 sd) but Dhofar 3.5 in 1999	Trend: stable No preventive programmes	Energy intake higher than expenditure. High energy density of foods (fat, sugar).	Fats, sugar, fizzy drinks, helwa, low veg/fruit intake Lack of physical exercise.
Diabetes	1992: 9.8% 2000: 11.6 % of which 9% undiagnosed males: 11.8 % females: 11.3 % Impaired fasting glucose: 6.1% in 2000	Slight increase No primary prevention programmes	Via overweight: see above Carbohydrates, ratio saturated : unsaturated fat, fiber	Thrifty genes theory High prevalence of high waist to hip ratio: 6 x higher risk of DM Dates, fizzy drinks, helwa, ghee, low veg/fruit intake
Hyper-cholesterolemia Coronary Heart Disease	> 5.2 mmol/ L 1992: 44.4% 2000: 40% CHD leading cause of death in 2000	Slight decrease No programmes	Saturated fats, lack of unsaturated fats, fiber, salt	Ghee, blended oils (palm oil), meat Fruits and veg, corn oil could protect Overweight/ hypertension/ Stress
Hypertension	High diastolic and/or systolic: 33%, both: 15.2% (2000) Similar to 1992	Stable trend No programmes	Saturated fat, salt. Overweight: see above.	Salt Overweight Stress
Cancer	Main cause of death in age	No clear trend	Numerous relations	Salted fish popular in region

Annex 1: Summary of nutrition related diseases, trends and risk factors in Oman

	group 45 year and older (1999)	No programmes	Protective: anti-oxidants	with high colon cancer. Low veg and fruits consumption.
Dental caries	Dental caries or past experience in children in 1996 ranged from 71.3 % in Dhofar to 95.6% in Dhahira. Increase since '93	No programmes related to nutrition	Sacharide	Sugar, helwa, fizzy drinks,

Annex 2: A list of the fortified dairy products available in the Omani market

N	Name	Iron	Iodine	Folic Acid	Vit A IU	Vit D IU
1	Al-Marai Laban	-	-	-	-	400 IU
2	Al-Marai/long life	-	-	-	2000 IU	400 IU
3	Alrawabi	0	0	0	0	Yes
4	Al-Rawaby laban	-	-	-	-	400 IU
5	Anchor	7 mg	50 mcg	-	270 IU	332 IU
6	Anchor 1	5.3 mg	-	-	12800 IU	140 IU
7	Anchor 3	8 mg	40 mcg	-	18800 IU	240 IU
8	Dano / High	-	-	-	2000 IU	450 IU
9	Dano Nitakids	9.3 mg	50 mcg	-	18800 IU	312 IU
10	Galaxy chocolate flavor	-	-	-	-	40 IU
11	Klim	10 mg	50 mcg	200 mcg	1800 IU	230 IU
12	Lancor	-	-	-	100 IU	30 IU
13	Moocao strawberry flavor	-	-	-	200 IU	40 IU
14	Nido	10mg	50 mcg	200 mcg	1800 IU	230 IU
15	Nido 1	7 mg	50 mcg	150 mcg	1200 IU	184 IU
16	Nido 3	-	50 mcg	150 mcg	1200 IU	184 IU
17	Rainbo	0.17 mg	25 mcg	23 mcg	718 mcg	10.4 mcg
18	Zain	0	0	0	500 mcg	162.5 mcg
19	Zain /chocolate flavor	-	-	-	200 IU	40 IU
20	Zain Full cream	-	-	-	200 IU	40 IU
21	Zain low fat	-	-	-	200 IU	40 IU
22	Zain Strawberry	-	-	-	200 IU	40 IU

* Values per 100g product as of 2005.

Annex 3: Method of energy requirements calculations for the Omani population

The energy requirements of the Omani population were developed based on the required energy for maintenance and through the following steps:

1. Estimation of daily energy requirement of each age year.
2. Estimation of the percentage of pregnant and lactating .
3. Estimation of the population requirements for each age-gender category.

Step 1: Estimation of daily energy requirements for each age year:

On an excel spread sheet; the mean height of the Omani males and females from the National PEM Survey, and the 2001 Income and expenditure surveys were tabulated for each age year; the median weight for that height was generated from reference population estimates. The reference populations were: The WHO growth charts of 2005 for children age 0-5; the BMI for age for children 6-18; and BMI for adults.

1.0 Children aged 1-8 years old the calculation was:

1.1 Determination of the optimum weight for height: For each age group, data from national PEM survey; income and expenditure survey were used to generate the average heights. For each age year and height; the median weight of the reference population was tabulated Weights for the mean height for age-years 0-8 was obtained from the WHO growth reference (2005) (Table 1).

1.2 Weight gain per age- year was recorded from the FAO report: Human energy requirements: Page 23.

1.3 Total energy expenditure (TEE) was calculated through the quadratic equation

Boys: $TEE \text{ (Kcal/day)} = 310.2 + 63.3 \text{ kg} - 0.263 \text{ kg}^2$

Girls: $TEE \text{ (Kcal/day)} = 263.4 + 65.3 \text{ kg} - 0.454 \text{ kg}^2$

1.4 Energy deposited was calculated as weight gain $\times 2$ kcal/g body weights.

1.5 Energy requirement was calculated as the Energy Deposition in growing tissue + TEE.

Annex 3: Method of energy requirements calculations for the Omani population

AGE	Average height	Median Wt/Ht	Weight gain	TEE	Energy deposited in tissue	Energy requirement
1	72.262	8.7	6.6	797.1467	13.2	810.3467
2	80.053	10.1	6	876.6175	12	888.6175
3	87.76	12.1	5.2	987.0599	10.4	997.4599
4	94.225	13.8	4.7	1078.08	9.4	1087.48
5	101.713	15.8	4.9	1181.803	9.8	1191.603
6	108.592	18	6.3	1291.704	12.6	1304.304
7	113.138	19.8	8.2	1378.354	16.4	1394.754
8	117.884	22	10.1	1480.264	20.2	1500.464

Table 1. The energy requirements calculations for females at the age of 1-8

2.0 Females and males aged 9-18 years old:

1.1 Determination of the optimum weight for height: For each age group, data from the income and expenditure survey were used to generate the average heights. The median height of the reference population was calculated from the weight data of the Omanis based on the reference optimum BMI using the equation: $BMI = \text{weight (kgs)} / \text{height in meters squared}$.

(Physical Status: The use and interpretation of anthropometry) (Table 2).

Age	Male 50 th percentile	Female 50 th percentile
9	16.17	16.33
10	16.72	17.0
11	17.28	17.67
12	17.87	18.35
13	18.53	18.95
14	19.22	19.32
15	19.92	19.69
16	20.63	20.09
17	21.12	20.36
18	21.45	20.57
19	21.86	20.80
20-24	23.07	21.46

Table 2: 50th Percentiles for BMI for age: female and male adolescents: (Source: WHO Expert committee on physical Status; the use and interpretation of anthropometry. Physical Status: The use and interpretation of anthropometry. Report of a WHO Expert Committee - (WHO technical report series 854. Geneva 1995.)

Annex 3: Method of energy requirements calculations for the Omani population

AGE	Average height	Median BMI	Ht squared	Weight corresponding to the median BMI for height
9	123.916	16.33	15355.17506	25.07500087
10	128.495	17	16510.96503	28.06864054
11	135.154	17.67	18266.60372	32.27708877
12	140.175	18.35	19649.03063	36.0559712
13	144.961	18.95	21013.69152	39.82094543
14	150.081	19.32	22524.30656	43.51696028
15	151.331	19.69	22901.07156	45.0922099
16	153.823	20.09	23661.51533	47.5359843
17	153.613	20.36	23596.95377	48.04339787
18	154.145	20.57	23760.68103	48.87572087
19	155.126	20.8	24064.07588	50.05327782
20	154.198	21.46	23777.0232	51.0254918

Table 3: Calculations of the weights corresponding to the median BMI for the average weights of Omanis.

1.2 Energy requirements for the weights were calculated using the same quadratic equation as children at the age 1-8 years.

2.0 Females and males age 18-24 years old:

2.1 Determination of the optimum weight for height: similar to the section 2.1 above; e for each age year, data from the income and expenditure survey were used to generate the average height of the Omanis. For each age year and height; the median weight of the reference population was calculated from the 50th percentile BMI for age by the equation: $BMI = \frac{\text{weight (kgs)}}{\text{height in meters squared}}$. (Physical Status: The use and interpretation of anthropometry) (Table 2,3).

2.2 For the calculated weight in 3.1; the BMR per kg body weight was calculated from the equations for estimating BMR from body weight (WHO/FAO: Human energy requirements page 37; Table 5.2).

2.3 For the lack of information on physical activity; the Physical activity level was set at the mean for sedentary and low activity level (Table 5.3 page 38): Human energy requirements: Report of a joint FAO/WHO/UNU Expert consultation.

2.4 Energy Requirements were calculated as the $PAL * BMR$ for each age group adjusted for the population distribution.

Step 2: Estimate the percentage of pregnant and lactating women:

Annex 3: Method of energy requirements calculations for the Omani population

Data of the National Health Survey data were used first to calculate the percentage of ever married women as shown in the table below. The proportion of women currently pregnant multiplied by the number currently married in the age-year population was used to generate the number currently pregnant. The percentage of currently pregnant women was generated from the number of women currently pregnant divided by the total female population in the age group.

<i>Age</i>	<i>Pop'n</i>	<i>Percentage of women currently married, P24 Table 2.1</i>	<i>Number of women currently married</i>	<i>Proportion of women currently pregnant/ of married women, P51 Table 3.13</i>	<i>Number of women currently pregnant</i>	<i>Percentage of women currently pregnant/of all women</i>
15-19	117141	0.076	8902.716	0.337	3000.215292	0.025612
20-24	221334	0.449	99378.966	0.292	29018.65807	0.131108
25-29	77836	0.753	58610.508	0.198	11604.88058	0.149094
30-34	59603	0.863	51437.389	0.177	9104.417853	0.152751

Table: Calculations of the percentage of currently pregnant women.

Calculations of the percentage of lactating women of all women:

The number of women ever married was calculated from the percentage ever married in the national health survey and the population estimate in the age group. The percentage of women with children less than two years was calculated from the proportion of women with children less than 2 years and the number ever married

The number of women with children < 2 years, and the percentage of those lactating were used to calculate the number of lactating women in the population.

The number of lactating women in the age group divided by the number of all women was used to calculate the percentage of lactating women of all women in the age group.

Step 3: Estimate of the population energy requirements for the various age groups:

As pregnancy and lactation have different energy requirements than the general population; the energy requirements for each age group was calculated using the formula:

Energy needs for non-pregnant/non-lactating population + energy needs for pregnant women+ energy needs for lactating women.

The energy needs obtained from step 1; and the percentage of pregnant and lactating women obtained from step 2 as well as the population estimate in each age – year were used to generate the energy requirements for each population category.

Annex 3: Method of energy requirements calculations for the Omani population

To adjust for the population distribution in each age group; the proportion of age year in the age group was calculated ; the energy needs for each age year was adjusted by multiplying the energy requirement of the age year (step 1); by the proportion of age year in the age group.

The number of pregnant and lactating women in the age year was generated by multiplying the percentage of pregnant and lactating women * the population estimate.

The energy needs for pregnant women was calculated as the energy requirements of the general population + 273Kcal; and the energy for lactating women was calculated as energy needs of the general population + 505 Kcal.

Annex 3: Method of energy requirements calculations for the Omani population

<i>Age</i>	<i>Pop'n(1000's)</i>	<i>% ever married</i>	<i>Number ever married</i>	<i>% children < 2 years</i>	<i># with children</i>	<i>% of women with one child</i>	<i>Number of women with one child/ of all women</i>	<i>Total number of mothers with children < 2 years</i>	<i>Percentage lactating, page 61 Table 4.3 WHO feeding indicators</i>	<i>Number lactating</i>	<i>Percentage lactating of total mothers</i>
Females											
15-19	117141	0.006	702.846	0.637	447.7129	0.026	3045.666	3493.3789	0.556	1942.3187	0.016581
20-24	221334	0.157	34749.44	0.433	15046.51	0.122	27002.75	42049.255	0.5	21024.627	0.094991
25-29	77836	0.627	48803.17	0.322	15714.62	0.095	7394.42	23109.041	0.656	15159.531	0.194762

Table: Calculations of the percentage of lactating women of all women in each age group.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Gender	Age group	Estimated energy requirements (Kcal)	Rounded energy requirements
Both	1-3 years	1014	1000
Both	4-8	1330	1400
Females general population	9-13	1920	1900
	14-18	2416	2400
	19-30	2017	2000
	31-50	2014	2000
	51-70	1849	1800
	>70	1690	1700
Female pregnant	<19	2683	2700
	19-30	2149	2100
	31-50	2623	2600
Female lactating	<19	2915	2900
	19-30	2425	2400
	31-50	2446	2400
Males	9-13	1980	2000
	14-18	3014	3000
	19-30	2119	2100
	31-50	2378	2400
	51-70	2157	2200
	>70	1862	1800

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age group distribution	Population in thousands (from Census)	Percentage of males/females of the Omani population	Energy needs	Energy requierments
Males				
1+	24,606	0.165749429	1010.072946	167.4190141
2+	25182	0.169629445	1121.594066	190.2553789
3+	25707	0.173165918	1181.714595	204.6326925
Females				
1+	23687	0.159558918	821.5786331	131.0901974
2+	24344	0.163984561	917.0790634	150.3868074
3+	24927	0.16791173	1012.299483	169.976957
Total	148,453			1,014

Table 1: Energy Requirements calculations for children at the age of 1-3 years old; adjusted for population size.

Annex 4: Summary of energy requirements for various categories of the Omani population.

<i>Age distribution</i>	<i>group in thousands</i>	<i>Percentage of males/females of the Omani population</i>	<i>Energy needs</i>	<i>Energy Requirements</i>
Males				
4+	26159	0.099593388	1181.714595	117.690959
5+	26516	0.10095257	1275.068028	128.721393
6+	26759	0.101877727	1378.235743	140.411524
7+	26871	0.102304137	1474.372235	150.834379
8+	26842	0.102193727	1580.737439	161.541450
Females				
4+	25418	0.096772229	1090.785001	105.557695
5+	25796	0.098211362	1190.013756	116.872872
6+	26045	0.099159363	1293.161694	128.22909
7+	26150	0.099559123	1366.59805	136.057302
8+	26102	0.099376375	1446.519796	143.749894
Total	262,658			1,330

Table 1: Energy Requirements calculations for children at the age of 4-8 years old; adjusted for population size.

<i>Age group distribution</i>	<i>Population in thousands</i>	<i>Percentage of males/females of the Omani population</i>	<i>Energy needs</i>	<i>Energy requirements</i>
9+	25915	0.205171445	1563.583347	320.802654
10+	25619	0.202827985	1676.513907	340.043938
11+	25266	0.200033252	1840.40032	368.141261
12+	24913	0.197238518	2236.983132	441.219238
13+	24596	0.1947288	2309.920817	449.808109
Total	126,309			1,920

Table 3: Energy Requirements calculations for females at the age group 9-13; adjusted for population size.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (*1000)	% of age in group	Energy needs	Energy adjusted for pop'n	# pregnant	# lactating	# non-preg/non-lact	preg energy	lactation energy	Pop'n adjusted for pregnant and lactation	Percentage of pregnant total population	Percentage lactating of total population	Energy requirements of adjusted population
14+	24288	0.207853	2379.579	494.6019	0	0	24,288	0	0	0.207853	0	0	494.6019
15+	23909	0.204609	2389.958	489.0076	612.0704	394.4985	22,902	2662.958	2894.958	0.195995	0.005238	0.003376	492.1424
16+	23432	0.200527	2414.813	484.2355	599.8592	386.628	22,446	2687.813	2919.813	0.192085	0.005133	0.003309	487.3078
17+	22903	0.196	2407.751	471.9194	586.3168	377.8995	21,939	2680.751	2912.751	0.187748	0.005018	0.003234	474.9224
18+	22320	0.191011	2428.666	463.9015	571.392	368.28	21,380	2701.666	2933.666	0.182969	0.00489	0.003152	466.8281
Total	116,852			2,404			112,955	10,733	11,661	1	0	0	2,416

Table 4: Energy Requirements calculations for females at the age group 14-18; adjusted for population size; pregnancy and lactation.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (*1000)	% of age in group	Energy needs	Energy adjusted for pop'n	# pregnant	# lactating	# non-preg/non-lact	preg energy	lactation energy	Pop'n adjusted for pregnant and lactation	Percentage of pregnant total population	Percentage of lactating of total population	Energy requirements of adjusted population
19+	21666	0.117989	1936.272	228.4579	554.6496	357.489	20,754	2209.272	2441.272	0.113021	0.003021	0.001947	230.2656
20+	21025	0.114498	1922.142	220.081	2756.378	1995.273	16,273	2195.142	2427.142	0.088621	0.015011	0.010866	229.6662
21+	20292	0.110506	1933.082	213.6172	2660.281	1925.711	15,706	2206.082	2438.082	0.085532	0.014487	0.010487	222.8682
22+	19259	0.104881	1920.67	201.4409	2524.855	1827.679	14,906	2193.67	2425.67	0.081178	0.01375	0.009953	210.221
23+	17843	0.097169	1919.305	186.4975	2339.217	1693.301	13,810	2192.305	2424.305	0.075209	0.012739	0.009221	194.632
24+	16169	0.088053	1928.085	169.7737	2119.756	1534.438	12,515	2201.085	2433.085	0.068153	0.011544	0.008356	177.1451
25+	14395	0.078392	1907.796	149.5563	2144.855	2802.707	9,447	2180.796	2412.796	0.051449	0.01168	0.015263	160.4529
26+	12743	0.069396	1909.728	132.527	1898.707	2481.062	8,363	2182.728	2414.728	0.045544	0.01034	0.013511	142.173
27+	11345	0.061783	1911.571	118.1017	1690.405	2208.872	7,446	2184.571	2416.571	0.040548	0.009206	0.012029	126.6895
28+	10323	0.056217	1934.562	108.7551	1538.127	2009.888	6,775	2207.562	2439.562	0.036895	0.008376	0.010945	116.5693
29+	9604	0.052301	1936.088	101.2601	1430.996	1869.899	6,303	2209.088	2441.088	0.034325	0.007793	0.010183	108.53
30+	8964	0.048816	1900.055	92.75323	1368.803	1103.468	6,492	2173.055	2405.055	0.035353	0.007454	0.006009	97.82291
Total	183,628			1,923	23,027	21,810	138,791	26,335	29,119	1	0	0	2,017

Table 5: Energy Requirements calculations for females at the age group 19-30; adjusted for population size; pregnancy and lactation.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (*1000)	% of age in group	Energy needs	Energy adjusted for pop'n	# pregnant	# lactating	# non- preg/non- lact	preg energy	lactation energy	Pop'n adjusted for pregnant and lactation	Percentage of total population	Percentage lactating of total population	Energy requirements of adjusted population
31+	8337	0.066022	1940.735	128.1313	1273.477	1026.285	6,037	2213.735	2445.735	0.04781	0.010085	0.008127	134.9887
32+	7870	0.062324	1969.099	122.7217	1202.143	968.797	5,699	2242.099	2474.099	0.045132	0.00952	0.007672	129.195
33+	7575	0.059988	1961.239	117.6501	1157.081	932.4825	5,485	2234.239	2466.239	0.04344	0.009163	0.007384	123.8808
34+	7412	0.058697	1952.164	114.5858	1132.183	912.4172	5,367	2225.164	2457.164	0.042505	0.008966	0.007226	120.6825
35+	7345	0.058166	1950.162	113.4336	920.3285	1005.531	5,419	2223.162	2455.162	0.042915	0.007288	0.007963	119.4446
36+	7299	0.057802	1939.932	112.1319	914.5647	999.2331	5,385	2212.932	2444.932	0.042646	0.007243	0.007913	118.1052
37+	7209	0.057089	1956.991	111.7231	903.2877	986.9121	5,319	2229.991	2461.991	0.04212	0.007153	0.007816	117.6228
38+	7025	0.055632	1937.495	107.7869	880.2325	961.7225	5,183	2210.495	2442.495	0.041045	0.006971	0.007616	113.536
39+	6773	0.053636	1934.551	103.7625	848.6569	927.2237	4,997	2207.551	2439.551	0.039573	0.006721	0.007343	109.3054
40+	6529	0.051704	1954.019	101.031	30.35985	452.4597	6,046	2227.019	2459.019	0.047881	0.00024	0.003583	102.9061
41+	6321	0.050057	1958.861	98.05476	29.39265	438.0453	5,854	2231.861	2463.861	0.046355	0.000233	0.003469	99.87012
42+	6100	0.048307	1951.605	94.27596	28.365	422.73	5,649	2224.605	2456.605	0.044735	0.000225	0.003348	96.02785
43+	5864	0.046438	1921.477	89.22947	27.2676	406.3752	5,430	2194.477	2426.477	0.043004	0.000216	0.003218	90.91359
44+	5618	0.04449	1958.299	87.12443	26.1237	389.3274	5,203	2231.299	2463.299	0.0412	0.000207	0.003083	88.7379
45+	5369	0.042518	1938.783	82.43313	233.0146	864.9459	4,271	2211.783	2443.783	0.033823	0.001845	0.00685	86.39596
46+	5127	0.040602	1918.205	77.88209	222.5118	825.9597	4,079	2191.205	2423.205	0.032299	0.001762	0.006541	81.66631
47+	4904	0.038836	1925.174	74.76522	212.8336	790.0344	3,901	2198.174	2430.174	0.030894	0.001685	0.006256	78.38484
48+	4707	0.037275	1911.091	71.23684	204.2838	758.2977	3,744	2184.091	2416.091	0.029653	0.001618	0.006005	74.71106
49+	4531	0.035882	1910.194	68.54105	196.6454	729.9441	3,604	2183.194	2415.194	0.028544	0.001557	0.005781	71.88536
50+	4361	0.034535	1931.401	66.70183	16.17931	702.5571	3,642	0	0	0.028844	0.000128	0.005564	55.70871
Total Population	126,276			1,943	10,459	15,501	100,316						2,014

Table 6: Energy Requirements calculations for females at the age group 31-50; adjusted for population size; pregnancy and lactation.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (*1000)	% of age in group	Energy needs	Energy adjusted for pop'n	# pregnant	# lactating	# non- preg/non- lact	preg energy	lactation energy	Pop'n adjusted for pregnant and lactation	Percentage pregnant of total population	Percentage lactating of total population	Energy requirements of adjusted population
51+	4194	0.073496	1921.094	141.1935	0	0	4,194	0	0	0.073496	0	0	141.1935
52+	4036	0.070728	1958.542	138.523	0	0	4,036	0	0	0.070728	0	0	138.523
53+	3887	0.068117	1956.145	133.2457	0	0	3,887	0	0	0.068117	0	0	133.2457
54+	3744	0.065611	1923.54	126.2045	0	0	3,744	0	0	0.065611	0	0	126.2045
55+	3608	0.063227	1912.756	120.9383	0	0	3,608	0	0	0.063227	0	0	120.9383
56+	3474	0.060879	1931.82	117.6073	0	0	3,474	0	0	0.060879	0	0	117.6073
57+	3341	0.058548	1971.791	115.445	0	0	3,341	0	0	0.058548	0	0	115.445
58+	3208	0.056218	1930.572	108.5321	0	0	3,208	0	0	0.056218	0	0	108.5321
59+	3075	0.053887	1888.742	101.7784	0	0	3,075	0	0	0.053887	0	0	101.7784
60+	2945	0.051609	1931.566	99.68563	0	0	2,945	0	0	0.051609	0	0	99.68563
61+	2816	0.049348	1691.008	83.44801	0	0	2,816	0	0	0.049348	0	0	83.44801
62+	2680	0.046965	1759.416	82.63063	0	0	2,680	0	0	0.046965	0	0	82.63063
63+	2532	0.044371	1796.139	79.69691	0	0	2,532	0	0	0.044371	0	0	79.69691
64+	2377	0.041655	1679.972	69.97923	0	0	2,377	0	0	0.041655	0	0	69.97923
65+	2234	0.039149	1669.605	65.36341	0	0	2,234	0	0	0.039149	0	0	65.36341
66+	2100	0.036801	1718.98	63.25982	0	0	2,100	0	0	0.036801	0	0	63.25982
67+	1955	0.03426	1645.846	56.3863	0	0	1,955	0	0	0.03426	0	0	56.3863
68+	1794	0.031438	1725.898	54.25945	0	0	1,794	0	0	0.031438	0	0	54.25945
69+	1632	0.028599	1663.383	47.57187	0	0	1,632	0	0	0.028599	0	0	47.57187
70+	1432	0.025095	1717.086	43.08964	0	0	1,432	0	0	0.025095	0	0	43.08964
Total	57,064			1,849	0	0	57,064						1,849

Table 6: Energy Requirements calculations for females at the age group 51-70; adjusted for population size; pregnancy and lactation.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (*1000)	% of age in group	Energy needs	Energy adjusted for pop'n
70+	1432	0.087141727	1717	149.629837
71+	1257	0.076492424	1671	127.8234901
72+	1216	0.073997444	1691	125.1302359
73+	1355	0.082456034	1746	143.9614389
74+	1626	0.09894724	1705	168.7293968
75+	9547	0.580965131	1678	974.9671407
Total Population	16,433			1,690

Table 6: Energy Requirements calculations for females at the age group 70+; adjusted for population size.

Age	Pop'n (*1000)	% of age in group	Energy needs	Energy adjusted for pop'n	Number pregnant	Number lactating	% pregnant	Percentage of lactating women	Energy requirements for pregnant women	Energy requirements for lactating women
15+	23909	0.258297	2389.958	617.319	612.3095	396.4112	0.258296962	0.258296962	687.8340268	747.758922
16+	23432	0.253144	2414.813	611.2947	600.0935	388.5026	0.253143771	0.253143771	680.4029952	739.13235
17+	22903	0.247429	2407.751	595.7471	586.5458	379.7317	0.247428806	0.247428806	663.2951275	720.6986105
18+	22320	0.24113	2428.666	585.6253	571.6152	370.0656	0.241130461	0.241130461	651.4539249	707.3961919
Total Population	92,564			2,410	2,371	1,535	1	1	2,683	2,915

Table 7: Calculations for energy requirements for pregnant and lactating Omani women at the age of 15-18 years old.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (*1000)	% of age in group	Energy needs	Energy adjusted for pop'n	Number pregnant	Number lactating	% pregnant	Percentage of lactating women	Energy requirements for pregnant women	Energy requirements for lactating women
19+	21666	0.117989	1936.272	228.4579	554.6496	359.2223	0.02408079	0.016460315	53.20099291	40.18409781
20+	21025	0.114498	1922.142	220.081	2756.378	1997.165	0.11967147	0.091514258	262.6959122	222.1181278
21+	20292	0.110506	1933.082	213.6172	2660.281	1927.537	0.11549934	0.088323773	254.8010052	215.340602
22+	19259	0.104881	1920.67	201.4409	2524.855	1829.412	0.10961964	0.083827496	240.4693477	203.3378695
23+	17843	0.097169	1919.305	186.4975	2339.217	1694.907	0.10155996	0.077664158	222.650442	188.281637
24+	16169	0.088053	1928.085	169.7737	2119.756	1535.893	0.09203177	0.070377838	202.5697676	171.2352703
25+	14395	0.078392	1907.796	149.5563	2146.295	2803.57	0.09318398	0.12846544	203.2152598	309.9609135
26+	12743	0.069396	1909.728	132.527	1899.981	2481.827	0.08248999	0.11372248	180.053216	274.6088547
27+	11345	0.061783	1911.571	118.1017	1691.54	2209.552	0.07344024	0.101246295	160.4354024	244.6688397
28+	10323	0.056217	1934.562	108.7551	1539.159	2010.507	0.06682447	0.09212565	147.5191411	224.7462142
29+	9604	0.052301	1936.088	101.2601	1431.956	1870.475	0.06217012	0.085709071	137.3392922	209.2234091
30+	8964	0.048816	1900.055	92.75323	1368.803	1103.468	0.05942823	0.050563226	129.1408021	121.6073231
Total Population	183,628			1,923	23,033	21,824	1	1	2,194	2,425

Table 8: Calculations for energy requirements for pregnant and lactating Omani women at the age of 19-30 years old.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (*1000)	% of age in group	Energy needs	Energy adjusted for pop'n	Number pregnant	Number lactating	% pregnant	Percentage of lactating women	Energy requirements for pregnant women	Energy requirements for lactating women
31+	8337	0.066022	1940.735	128.1313	1273.06	1026.201	0.10770005	0.066187318	238.419319	161.8766096
32+	7870	0.062324	1969.099	122.7217	1201.749	968.7183	0.10166719	0.062479812	227.9478732	154.5812166
33+	7575	0.059988	1961.239	117.6501	1156.703	932.4068	0.09785629	0.060137812	218.6343111	148.314201
34+	7412	0.058697	1952.164	114.5858	1131.812	912.3431	0.0957506	0.058843757	213.060826	144.588782
35+	7345	0.058166	1950.162	113.4336	920.3285	1006.177	0.0778592	0.064895792	173.0936125	159.3296806
36+	7299	0.057802	1939.932	112.1319	914.5647	999.8754	0.07737159	0.064489365	171.2180636	157.672116
37+	7209	0.057089	1956.991	111.7231	903.2877	987.5465	0.07641756	0.063694182	170.4104783	156.8145095
38+	7025	0.055632	1937.495	107.7869	880.2325	962.3407	0.0744671	0.062068474	164.609138	151.6019171
39+	6773	0.053636	1934.551	103.7625	848.6569	927.8197	0.07179583	0.059841961	158.4929774	145.9875344
40+	6529	0.051704	1954.019	101.031	291.5199	452.5446	0.02466239	0.029187949	54.92362344	71.77372997
41+	6321	0.050057	1958.861	98.05476	282.2327	438.1275	0.0238767	0.028258083	53.2894869	69.62400001
42+	6100	0.048307	1951.605	94.27596	272.365	422.8093	0.0230419	0.027270101	51.25913585	66.99186698
43+	5864	0.046438	1921.477	89.22947	261.8276	406.4514	0.20566793	0.026215061	451.3335412	63.61024103
44+	5618	0.04449	1958.299	87.12443	250.8437	389.4004	0.02122122	0.025115316	47.35088181	61.86653696
45+	5369	0.042518	1938.783	82.43313	233.02	864.9459	0.01971334	0.055786762	43.60162999	136.3307421
46+	5127	0.040602	1918.205	77.88209	222.5169	825.9597	0.01882479	0.053272254	41.2489808	129.0896163
47+	4904	0.038836	1925.174	74.76522	212.8385	790.0344	0.018006	0.050955165	39.58032161	123.8299146
48+	4707	0.037275	1911.091	71.23684	204.2885	758.2977	0.01728268	0.048908231	37.74693137	118.1667164
49+	4531	0.035882	1910.194	68.54105	196.6499	729.9441	0.01663646	0.047079497	36.32061637	113.7061227
50+	4361	0.034535	1931.401	66.70183	161.9239	702.5571	0.01369866	0.045313107	30.19734458	110.4009108
Total Population	126,276			1,943	11,820	15,505	1	1	2,623	2,446

Table 9: Calculations for energy requirements for pregnant and lactating Omani women at the age of 31-50 years old.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (1000's)	% age	Age energy needs	Energy needs adjusted for pop'n
9+	26681	0.204425	1688.8726	345.2485865
10+	26419	0.202418	1811.3314	366.6462138
11+	26104	0.200005	1993.6748	398.7441289
12+	25793	0.197622	2106.6336	416.3166505
13+	25520	0.19553	2318.9594	453.4263315
Total Population	130,517	1	9,919	1,980

Table 9: Calculations for energy requirements for male Omani adolescents at the age of 9-13 years old.

Age	Pop'n (1000's)	% age	Age energy needs	Energy needs adjusted for pop'n
14+	25253	0.206961	2850.353	589.9127
15+	24919	0.204224	2984.235	609.4524
16+	24483	0.200651	3065.189	615.0323
17+	23975	0.196487	3056.928	600.6478
18+	23388	0.191677	3123.141	598.6332
Total Population	122,018	1	15,080	3,014

Table 10: Calculations for energy requirements for male Omani adolescents at the age of 14-18 years old.

Age	Pop'n (1000's)	% age	Age energy needs	Energy needs adjusted for pop'n
19+	22710	0.116894	2415.826	282.395
20+	22035	0.113419	2426.565	275.2194
21+	21268	0.109471	2435.427	266.6097
22+	20206	0.104005	2435.146	253.2675
23+	18771	0.096619	2460.336	237.7147
24+	17085	0.087941	2436.535	214.2702
25+	15290	0.078701	2443.042	192.2705
26+	13607	0.070038	2449.199	171.5381
27+	12174	0.062662	2450.744	153.5697
28+	11114	0.057206	2418.47	138.3519
29+	10349	0.053269	2417.829	128.7948
30+	9670	0.049774	2464.676	122.6763
Total Population	194,279	1	29,254	2,437

Table 11: Calculations for energy requirements for male Omani males at the age of 19-30 years old.

Annex 4: Summary of energy requirements for various categories of the Omani population.

Age	Pop'n (1000's)	% age	Age energy needs	Energy needs adjusted for pop'n
31+	8990	0.073535	2430.552	178.7317
32+	8419	0.068865	2396.907	165.0626
33+	7952	0.065045	2330.234	151.5698
34+	7570	0.06192	2376.07	147.1269
35+	7271	0.059475	2394.47	142.41
36+	7018	0.057405	2403.021	137.9456
37+	6765	0.055336	2421.736	134.0083
38+	6486	0.053053	2388.368	126.7113
39+	6193	0.050657	2369.997	120.0566
40+	5922	0.04844	2339.551	113.3281
41+	5692	0.046559	2378.686	110.7488
42+	5487	0.044882	2381.695	106.8952
43+	5308	0.043418	2358.651	102.4075
44+	5150	0.042125	2404.086	101.2731
45+	5010	0.04098	2376.095	97.37296
46+	4878	0.039901	2352.73	93.87519
47+	4746	0.038821	2341.05	90.88148
48+	4607	0.037684	2401.247	90.48821
49+	4465	0.036522	2320.182	84.73843
50+	4325	0.035377	2335.855	82.63594
Total Population	122,254	1	47,501	2,378

Table 11: Calculations for energy requirements for male Omani males at the age of 31-50 years old.

Age	Pop'n (1000's)	% age	Age energy needs	Energy needs adjusted for pop'n
51+	4195	0.067623	2315.018	156.5487
52+	4078	0.065737	2291.236	150.6191
53+	3978	0.064125	2392.703	153.4323
54+	3888	0.062674	2340.558	146.6929
55+	3804	0.06132	2368.376	145.2294
56+	3715	0.059886	2357.275	141.1667
57+	3617	0.058306	2300.246	134.1176
58+	3504	0.056484	2353.658	132.9446
59+	3378	0.054453	2307.339	125.6419
60+	3250	0.05239	2302.173	120.6103
61+	3123	0.050343	1911.345	96.222
62+	2988	0.048166	1849.093	89.06405
63+	2845	0.045861	1861.732	85.38128
64+	2697	0.043475	1909.21	83.00378
65+	2557	0.041219	1911.283	78.78054
66+	2420	0.03901	1862.804	72.66844
67+	2268	0.03656	1939.441	70.90597
68+	2098	0.03382	1885.833	63.77813

Annex 4: Summary of energy requirements for various categories of the Omani population.

69+	1921	0.030966	1854.692	57.4331
70+	1711	0.027581	1905.158	52.54654
Total				
Population	62,035	1	42,219	2,157

Table 12: Calculations for energy requirements for male Omani males at the age of 51-70 years old.

Age	Pop'n (1000's)	% age	Age energy needs	Energy needs adjusted for pop'n
71+	1522	0.101365	1832.971	185.7996
72+	1441	0.095971	1852.957	177.8296
73+	1508	0.100433	1798.895	180.6682
74+	1666	0.110956	1875.032	208.0455
75+	8878	0.591275	1877.364	1110.039
Total				
Population	15,015	1	9,237	1,862

Table 13: Calculations for energy requirements for male Omani males at the age of 70+ years old.

Annex 5: Recommendations for micronutrients densities

Nutrient	Density per 4.184 MJ (1000 Kcal)	Comments
Energy	Age-, sex and activity specific	Energy density 2-5 years of age: 2.5-3 KJ (0.6-0.75) Kcal _{th} /g for liquid foods; 6.3-8.4KJ (1.5-2.0) Kcal _{th} /g for solid foods
Protein	20-25g	8-10% of total energy if protein quality is high 10-12% of total energy if animal protein intake is low
Total fats	16-39g (max)	Refer to table 7 on page 25
Fiber	8-20 g	
Vitamin A (retinol)	350-500 retinol equivalents	1 retinol equivalent=1 µg retinol or 6 µg β-carotene as provitamin A
β-carotene		Functions as antioxidant; No RNI
Vitamin D	2.5-5.0 µg	Promotes bone health
Vitamin E	3.5-5.0 mg α-tocopherol equivalents	Inhibits lipoprotein oxidation
Vitamin K	20-40 µg	
Vitamin C (ascorbic acid)	25-30 mg	Functions as antioxidant; reduces iron absorption
Thiamine (vitamin B ₁)	0.5-0.8 mg	
Riboflavin (Vitamin B ₂)	0.6-0.9 mg	
Nicotinic acid (niacin or equivalent)	6-10 mg	60 mg tryptophan equivalent to 1 mg niacin
Vitamin B ₆	0.5-1.0 µg	
Vitamin B ₁₂ (cyanocobalamin)	0.5-1.0 µg	Reduces homocysteinemia
Folate	150-200 µg	Intakes of 400 µg /day associated with reduced risk of neural tube birth defects: Reduces hyperhomocysteinemia
Iron	3.5, 5.5, 11 or 20 mg	For high; intermediate; low and very low bio availability
Zinc	6 or 10 mg	For high and low bioavailability diets
Calcium	250-400 mg	Calcium rich foods; especially for adolescents and lactating and pregnant women
Iodine	75 µg	100-200 µg/day in regions free of goiter; salt fortification usually required
Fluoride	0.5-1.0 mg (maximum)	If water has ≥1 mg /l requirement is met
Sodium (as NaCl)	<2.5g	Total sodium as NaCl <6 g/day (population mean)

Annex 6: Proposal 2 for the Food Groups for the Omani Food Based Dietary Guidelines

<i>Suggested Name</i>	<i>Subgroups</i>	<i>Foods</i>
Cereals, grains and potatoes	High fiber Low fiber	-
Vegetables	Vitamin C	Sweet peppers (capsicum), tomato, cauliflower, beetroot, radish
	Vitamin A	Cabbage, carrots, zucchini (courgette)
	Iron/Folic Acid	Spinach, parsley, mulukhiya
	Others	Onions, okra, peas, cucumber, aubergine (eggplant), garlic
Fruits	Vitamin C	Citrus fruits, pineapple, guava, cherries, berries
	Vitamin A	Mango, papaya, apricot, plums
	Potassium	Banana, melons (watermelon, honey dew, cantaloupe)
	Others	Coconut, grapes, apples, pears, figs, dates, dried fruits, fresh fruit juice, canned pineapples
Meats & alternatives	Meats	Red meat cuts (beef, lamb, camel), poultry, fish
	Eggs	
	Legumes	All beans
	Nuts	All nuts
	Processed Meats	Canned meats, sausages, shawarma, kebab, chicken nuggets, fish fingers
Milk & dairy products	Milk	Including long-life, fresh, pasteurized, powdered
	Yoghurt	All yogurts, laban and kushk
	Cheese	All cheeses
	Others	labneh
Fat, sugar & salt	<ul style="list-style-type: none"> • Fat • Sugar • Salt 	<ul style="list-style-type: none"> • Fats, oils, evaporated milk, cream, fried foods, cakes • Sugar, sweetened condensed milk, sweets, fizzy drinks, halwa • Salt, salty foods