Dietary energy and protein requirements for Saudi Arabia: a methodological approach

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تقدير الاحتياجات من البروتين والطاقة المستمدين من الغذاء في المملكة العربية السعودية: أسلوب منهجي

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خلاصة : تم تقدير المتطلبات التي يوصى بأخذها من الطاقة والبروتين المستمدين من الغذاء بالنسبة للسعوديين والسعوديات من مختلف الفئات العمرية، وذلك بناء على المعلومات العلمية المتاحة عن الاحتياجات البشرية. ولقد حُسبت متطلبات الفرد من الطاقة و البروتين (NPU 0.8) على المستوى الوطني ووجد أنها تبلغ 2100 كيلو كالوري من الطاقة و53 غراماً من البروتين يومياً. أما بالنسبة للرجال الذين يبلغ وزنهم 65 كيلو غراماً فقد كان متوسط الاحتياجات الموصى بها 2800 كيلو كالوري من الطاقة و65 غراماً من البروتين يومياً. وبالنسبة للنساء اللواتي يبلغ وزنهن 56 كيلو غراماً، كانت الأرقام المقابلة هي 2100 كيلو كالوري من الطاقة و 56 غراماً من البروتين في اليوم. وتعطى للنساء الحوامل والمرضعات مقادير إضافية يومية من الاحتياجات الموصى بها. وحُسبت النسبة المئوية بين الإحتياجات من البروتين والطاقة فوجد أنها تبلغ 6% من البروتين – 12% من الطاقة. وتقارن المقالة بين المتطلبات الموصى بها من الطاقة والبروتين المستمدين من الغذاء وبين المأخوذ الفعلي المسجل منها.

ABSTRACT Based on the available scientific information on human requirements, recommended dietary allowances of energy and protein for different age and sex groups of Saudis were estimated. The per capita requirements of energy and protein (NPU 0.8) at national level were calculated to be 2100 kcal per day and 53 g per day respectively. For men of reference body size 65 kg, the average recommended allowances are 2800 kcal per day and 65 g of protein per day. For women of reference body weight 56 kg, these are 2100 kcal per day and 56 g of protein per day. Additional recommended daily allowances for pregnant and lactating women are given. Protein–energy ratio percentage was calculated as 6%–12%. RDAs and reported energy and protein intakes are compared.

Besoins alimentaires énergétiques et en protéines pour l'Arabie saoudite: approche méthodologique

RESUME Sur la base des informations scientifiques disponibles en ce qui concerne les besoins de l'être humain, on a estimé les apports protéino-énergétiques recommandés pour différents groupes de Saoudiens par âge et sexe. Les besoins énergétiques individuels et l'apport de sécurité en protéines (UPN 0,8) ont été calculés comme étant de 2100 kcal par jour et de 53 g par jour respectivement. Pour les hommes dont le poids corporel de référence est 65 kg, les apports moyens recommandés sont de 2800 kcal par jour et de 65 g de protéines par jour. Pour les femmes dont le poids corporel de référence est 56 kg, ces valeurs sont de 2100 kcal par jour et de 56 g de protéines par jour. Les apports diététiques quotidiens supplémentaires recommandés pour les femmes enceintes et celles qui allaitent sont indiqués dans cet article. Le rapport protéines/énergie a été calculé comme étant de l'ordre de 6% à 12%. Les apports diététiques quotidiens conseillés et les apports protéino-énergétiques relevés sont comparés.

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Introduction

Dietary allowances of nutrients have been recommended by national and international bodies from time to time, based on the available scientific information on human requirements [*1–4*]. Dietary standards may vary from country to country and serve as guidelines for planning and procuring food supplies for population subgroups, for interpreting food consumption records of individuals and populations, for establishing standards for food assistance programmes, for evaluating the adequacy of food supplies in meeting national nutritional needs, for planning diets, for designing nutrition education programmes and for developing new products in the food industry.

Several variables must be assessed in order to calculate energy and protein requirement values for any given population; these are the total population size and its age structure, body weights of children and adults, basal metabolic rate (BMR), physical activity level (PAL) and the energy cost of different activities, and the number of pregnant women each year [*1,5*]. Most countries, including Saudi Arabia, do not have all the required information for establishing their dietary standards. In the absence of Saudi dietary allowances, we attempted to compute the energy and protein requirements from the available information for the use of planners, nutritionists, food technologists and dieticians.

Population size and body weight

Since the distribution of the Saudi population estimated in a recent survey was not available, the United Nations (UN) population estimate for the year 1990 for Saudi Arabia (14.435 million) was used [*6*]. The UN population estimates and projections (1950–2015) for all countries have been based on a large variety of demographic indicators relating to population composition, growth, fertility, mortality, urbanization and international migration. The estimates for Saudi Arabia, by age and sex for the year 1985 reported in the manual of the Food and Agriculture Organization of the United Nations (FAO) [*5*] were extrapolated to the present population estimates.

Body size is the major determinant of the absolute requirements for energy and protein. The weight and height data for Saudi population groups, currently gathered by the Food Policy and Nutrition Division of FAO [*5*] have been used. These values follow the desirable growth pattern of the National Center for Health Statistics [*7*] and the FAO/WHO/UN standards [*1*]. According to FAO [*8*], the desirable body weights should be used for planning human energy requirements. Reference body weights of 65 kg for Saudi adult men (18–29 years) and 56 kg for Saudi adult women (18–29 years) were used to calculate energy and protein requirements. Using body weight and height data [5], the body mass index (BMI) values for Saudi adult men and women were calculated to be 22.4 and 22.1 respectively and were comparable with the acceptable range of values, 20.1–25.0 in men and 18.7–23.8 in women [*5*]. It has been shown that a BMI of about 22.0 in men and 20.8 in women seems to be associated with the best life expectancy within societies [*9*].

Estimation of national energy requirements

Energy and protein requirements are defined as the amount needed to maintain health, growth and an appropriate level of

physical activity. Since requirements for energy and for protein are closely interrelated, if people consume enough of their traditional diets to meet energy needs, protein needs are usually met and their food problems should be solved [*10,11*]. However, adaptation to changes in food intake can affect energy and protein requirements by alternations in body size and by metabolic adaptation [*12*]. The total energy requirement of the Saudi population was calculated using available information on population structure, desirable body weights, BMR prediction equations and physical activity patterns, according to FAO/WHO/UN [*1*] and James and Schofield [*5*]. The per capita energy requirement of the Saudi population at the national level was calculated to be 2100 kcal per day. These estimates can be used in planning food policy and in assessing food balance sheets and a variety of economic indices. The average per capita energy requirements of the male and female population were estimated to be 2290 kcal per day and 1870 kcal per day respectively. The daily energy requirements for the Saudi reference man (65 kg) and reference woman (56 kg), engaged in light, moderate and heavy physical activity were calculated to be 2595 and 2050 kcal per day, 2975 and 2150 kcal per day and 3515 and 2400 kcal per day respectively.

Estimation of national protein requirements

For estimating the theoretical safe level of protein intake of the Saudi population, data on the age and sex distribution of the population, average body weight and protein requirement per kilogram body weight per day were used.

Since protein requirements vary among different age groups, the per capita requirement will be the weighted average of the requirements of the different sex and age groups. The number of pregnant women (585 000) in the population group was calculated by assuming that there were 10% more pregnant women than infants under 12 months of age, allowing for pregnancy wastage and perinatal mortality [*13*]. The approximate number of lactating women (532 000) was deduced from the number of infants assuming all infants under 12 months of age are breast-fed [*14*]. The per capita protein requirement for the Saudi population was estimated to be 53 g per day, adjusted to the protein quality [net protein utilization (NPU) 0.8] of the Saudi diet [*15*]. It is useful to consider together the protein and energy requirements in terms of the protein–energy ratio percentage (PE%) in assessing the quality of the national diet. The PE% was calculated from the per capita national requirement of protein (53 g per day) and energy (2100 kcal per day) to be 10%. Such a PE% has been reported in the diets of healthy communities [*16*]. Thus, in planning national food supply, at least 10% of the energy should be provided by a mixture of proteins.

Dietary energy and protein availability/consumption versus requirements

The trend in the energy and protein availability of the national food supply from 1961 to 1990 (Table 1) was compared with the national average per capita requirement (2100 kcal per day; 53 g protein per day) as estimated before. From 1961–63 to 1973–75, the available energy was 86%–92% of requirements, and available protein 91%–98% of requirements. Since then, however, there appears to be a rapidly increasing surplus of calories available per capita per day,

Table 1 **Total national energy and protein availability as a percentage of requirements**

Period	Energy (kcal per capita per day)		Protein (g per capita per day)		Protein–energy ratio percentage
	Available[a]	Percentage of requirement	Available[a]	Percentage of requirement	
1961–63	1799	86	48.0	91	10.7
1964–66	1849	88	47.9	91	10.4
1967–69	1868	89	48.1	91	10.3
1970–72	1874	89	48.4	91	10.3
1973–75	1923	92	51.9	98	10.8
1976–78	2243	107	62.5	118	11.1
1979–81	2772	132	77.0	145	11.1
1982–84	2890	138	83.9	158	11.6
1985–87	2807	134	83.8	158	12.0
1988–90	2932	140	85.9	162	11.7

[a] *FAO Food Balance Sheets 1961–63 to 1988–90, FAO, Rome*

from 7% in 1976–78 to 40% in 1988–90, whereas surplus of protein supply per capita per day increased from 18% in 1976–78 to 62% in 1988–90. According to a recent survey, the average consumption per person per day of calories and protein is 3082 kcal and 115 g respectively [*17*]. Comparing these figures with the requirements, there appears to be a surplus of 47% calories and 117% protein per capita per day in Saudi Arabia. Despite this healthy surplus, inequitable distribution of income and resources may result in maldistribution of food and may still leave many individuals below the minimum energy and protein requirements, although the national average requirement is satisfied.

Recommended dietary allowances (RDAs)

The RDAs for energy and protein for Saudis have been developed (Table 2) as safe and adequate levels, enabling most individuals (i.e. 97.5%) to maintain satisfactory growth and development in infants and children and to maintain body weight and good health in adults and pregnant and lactating women according to FAO/WHO/UN [*1*] and James and Schofield [*5*]. These are set relatively high and are intended to apply to population groups rather than individuals. Due to high mechanization in all spheres of life in Saudi Arabia, the light to moderate values for physical activity were considered appropriate to reflect Saudi lifestyle. The energy allowances for reference adult men and women were calculated by multiplying BMR values predicted from FAO/WHO/UN equations [*1*] with a blend of light to moderate activity factors of 1.66, 1.60 and 1.50, and 1.60, 1.55 and 1.50 for 18–29 years, 30–59 years and 60 years and above respectively. For men of reference body weight (65 kg), the average allowances are 2800 kcal per day and 65 g of protein (NPU 0.8) per day. For women of reference body weight (56 kg), these are 2100 kcal per day and 56 g of protein (NPU 0.8) per

Table 2 **Recommended dietary energy and protein allowances for Saudis**

Category	Weight (kg)	Energy (kcal) per kg	Energy (kcal) per day	Protein (g)[a] per kg	Protein (g)[a] per day
Infants					
0–6 m	6	108	650	2.2	13*
6–12 m	9	98	880	1.6	14*
Children					
1–3 y	13	102	1300	1.5	20
4–6 y	20	90	1800	1.4	28
7–9 y	24	77	1850	1.3	31
Males					
10–12 y	33	64	2100	1.3	43
13–15 y	47	51	2400	1.3	61
16–17 y	59	45	2700	1.1	65
Females					
10–12 y	34	55	1900	1.3	44
13–15 y	49	43	2100	1.1	54
16–17 y	56	39	2200	1.0	56
Adult men					
18–29 y	65	43	2800	1.0	65
30–59 y	65	42	2700	1.0	65
60+ y	65	32	2100	1.0	65
Adult women					
18–29 y	56	37	2100	1.0	56
30–59 y	56	36	2000	1.0	56
60+ y	56	32	1800	1.0	56
Pregnant			+ 300		+ 8
Lactating					
0–6 m			+ 500		+ 20
6–12 m			+500		+ 15

[a] *Net protein utilization = 0.8* *y = years* *m = months*
* *Reference protein*

day. It is evident that the recommended allowance for protein (NPU 0.8) for Saudi adult men and women is 1 g/kg body weight per person per day, which is in line with the first internationally recommended allowance for protein needs of human adults proposed by the League of Nations in 1936 [*18*]. An additional allowance of energy of 300 kcal per day and 8 g of protein (NPU 0.8) per day during pregnancy and 500 kcal per day throughout lactation and 20 g per day and 15 g per day of protein (NPU 0.8) during the first 6 months and the second 6 months of lactation, respectively, are recommended (Table 2).

The RDAs are intended as a guide in catering, in institutional feeding, in planning food production and imports and in assessing the adequacy of the average diet in food consumption surveys. RDAs apply to

healthy persons. They do not cover special nutritional needs arising from metabolic disorders, chronic diseases, injuries, premature births or other medical conditions and drug therapies.

The dietary allowances for the Saudi population have been developed for the first time and may also be used for educational and policy purposes in other member states of the Gulf Cooperation Council.

Comparison of RDAs and reported intake

The energy and protein intake of Saudi infants and children (0–6 years) as reported in a dietary survey conducted in the four regions of Saudi Arabia [*19*] were compared with the RDAs shown in Table 2. The energy intake of Saudi children 1–3 years and 4–5 years were 66% and 64% of the RDA whereas the protein intake was 150% and 139% of the RDA respectively, indicating energy deficiency in their diets. Under such situations, the protein in the diet provides energy and may thus become a limiting factor in the diet, resulting in protein energy malnutrition [*20*]. The average per capita consumption of energy (3082 kcal per day) and protein (115 g per day) in Saudi Arabia [*17*] were compared with the RDAs for Saudi adult men and women shown in Table 2. The energy and protein intakes (% of RDA) were 110% and 147%, and 177% and 205% respectively.

Despite high food availability for consumption and diversification of diet in Saudi Arabia, some degree of malnutrition among preschool children has been reported [*15,21*]. Maldistribution of food, dietary imbalance, inappropriate infant and young child feeding practices, childhood illnesses and lack of nutrition education may be the responsible factors for malnutrition in Saudi Arabia.

Protein–energy ratio as a measure of dietary quality

The protein to energy ratio expressed as the percentage energy (PE%) derived from protein has attracted wide interest as an index of dietary quality [*1*]. It has been used in establishing standards of suitable quality, e.g. in the design of diet or in nutrition labelling. Platt et al. [*22*] introduced the concept of ratio of protein energy to total energy (PE ratio) as a convenient and useful index of dietary quality in human nutrition. The ratio of protein requirements expressed as the ratio of protein–calories of the energy requirement (PE%) for different age/sex groups in Saudi Arabia ranges from 6% to 12%. A comparison of this PE% value with the PE% of the diet will indicate whether diets can fulfil protein needs if an adequate quantity of the diet is eaten to meet the energy requirements.

The PE% of Saudi diets available from 1961–63 to 1988–90 (Table 1) was compared with reference PE% ratios. Although the PE% ranged from 10.3% to 10.8% during the period from 1961–63 to 1973–75, the low availability of energy might affect the efficient utilization of dietary protein. However, the diets were adequate to meet the protein requirements of all different age groups except lactating women. The PE% values varied from 11% to 12% with adequate energy available between 1976–78 and 1988–90, indicating that the quality of the diet in terms of protein has never been a limiting nutrient during this period and was adequate for all different age groups. In practice, diets in most part of the world provide 7%–12% of calories as protein and any diet with less than 6%–7% kcal as pro-

tein is presumably inadequate to provide the protein needs of a population [*23*]. According to Khan and Al-Kanhal [*15*], the average Saudi national diet provided 3012 calories, 84 g protein (11% of calories) and 95 g fat (29% of calories) per capita availability per day. The values for digestibility, NPU and net dietary protein calorie percentage (NDPcal%) for this diet were 94%, 0.8 and 9.5% respectively. The protein quality of the Saudi diet was similar to the quality of diet (NPU 0.8) consumed in industrialized countries [*23*].

Conclusion

Saudi Arabia has experienced unprecedented economic and social development in recent decades. The Saudi population, blessed with an assured food supply, has become adapted to an affluent diet, a pattern of eating typified by high consumption of energy dense foods of animal origin and of foods processed or prepared with added fat, sugar and salt.

According to Khan [*24*], increasing trends in the per capita availability of total food (90%), oils and fats (200%), animal fat (171%), animal protein (207%), meat (313%), milk (120%), eggs (648%) and sugar (68%) have been observed in Saudi Arabia over the past two decades. These changes in the dietary pattern during the short span of two decades mimic a transition that took 137 years in Japan and 200 years in the United Kingdom [*25*]. The high consumption of sugar-rich foods, meat and other animal products rich in saturated fats in Saudi Arabia could be associated with the increasing trends in the development of cardiovascular diseases, cancer, obesity, diabetes, gallstones, dental caries and other chronic diseases as indicated by hospital admissions and some studies conducted in the country [*24*].

There is an urgent need to make the population aware of the link between diet and disease and to correct dietary excesses by shifting national diets closer to the desirable dietary patterns developed for Saudi Arabia [*26*]. The challenge is how best to formulate national food policies that capitalize on the usual benefits of an improved food supply and nutritional status and yet minimize the social and economic costs of diet-related chronic diseases.

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