NFI BULLETIN

Bulletin of the Nutrition Foundation of India

Volume 44 Number 2 April 2023

Nutrient Recommendations and Food Consumption Pattern Among Adults in India

R. Hemalatha

Introduction

India is undergoing sociodemographic, dietary, lifestyle, nutrition and health transitions. While undernutrition and communicable diseases continue to be major public health problems, a concomitant increase in overnutrition and related non communicable diseases has been observed due to a steep fall in physical activity and a relatively lower decline in energy intake. Micronutrient deficiencies are still common, but with the availability of many food stuffs fortified with multiple micronutrients, there is a risk of the tolerable upper limits of some micronutrients being reached in some segments of the population[1].

The 2020 Report defines the nutrient requirements for Indians based on concepts related to the distribution of nutrient requirements in normal individuals. The median of this distribution is called the Estimated Average Requirement (EAR) and is used to assess the nutrient requirements of the defined population group. EAR is used for planning dietary intake needed to meet the requirements of healthy individuals in the defined population. The 97.5th percentile of the distribution is called the Recommended Daily Allowance (RDA); this level of intake will satisfy the nutritional needs of specific nutrients in the defined population group and ensure that the risk of inadequate nutrient intake is very low. However, dietary intake at the level of RDA is associated with the risk of excess intake in half of the population. To prevent the risk of adverse side effects associated with excessive intake of nutrients the report also provides "Tolerable Upper Limit (TUL)" for some important nutrients.

The detailed version of the "Report on Nutrient requirements for Indians- 2020" provides the scientific database, analytical framework followed, and details of the methods used to arrive at the requirement of each of the nutrients in different groups. The shorter summary report can be used as a ready reckoner for information on EAR, RDA and TUL needed for the practicing clinicians, nutritionists, dietitians and public health professionals.[2] It is hoped that at a time when India is undergoing rapid nutrition transition, the report will enable the clinicians and nutritionists to provide clear personalised recommendations to all their clients and over time all Indians learn to eat right and remain optimally nourished and healthy.

Nutrient requirements of Indians

The Nutrient Requirements report defines nutrient distribution and requirements for normal individuals of all age groups, physiological groups and different physical activity groups of the Indian population. The nutrient requirement is not the same in all persons and can vary considerably (distributed) even among normal, healthy individuals. The first report on Nutrient Recommendations was developed in 1944, and was revised by the NAC of the ICMR in

CONTENTS

Fig 1 Nutrient requirements for Indians

1958, followed by the Food and Agriculture Organization (FAO) reports on energy and protein requirements[1,2]. Subsequently, in 1968 and 1978 the ICMR committee revised the requirements for all nutrients except energy. The ICMR 2010 committee further revised and upgraded the RDAs for Indians based on the international data provided by the FAO/WHO/UNU 2004 expert committee. However, in doing so, it followed the earlier practices wherein RDAs were the only values available to health professionals and nutritionists for planning and assessing the diets of individuals and groups and for making decisions about adequacies[3,4,5]. However, considering RDA as the reference standard shifts the distribution to the right with RDA as the mean; consequently, the entire population will shift beyond and above the requirements and a significant proportion may reach the TUL. Hence, in the late 1990's, the "Dietary Reference Intakes (DRIs) were developed that includes Adequate Intakes (AIs), Tolerable Upper Intake Levels (ULs), and Estimated Average Requirements (EARs) along with the RDAs; with each metric having specific uses[6,7].

For regular diet planning it is preferable to follow EARs as most of the nutrient requirements depend mainly on energy intakes and body weights, and most individual requirements are close to the average requirements with a variation above and below the EAR. EAR is adjusted for absorption, which is tightly regulated and varies between individuals depending on nutrient intakes and deficiency status etc. EAR statistically represents the requirement of 50% of the population. It is generally believed that nutrient intakes below the EAR are inadequate; however, there is no scientific basis for such a conclusion. The EARs are approximately 80% of the nutrient intake values compared to the RDAs; and, in a healthy population, the distribution of nutrient requirements and dietary intake is expected to superimpose.

The Nutrient Requirements 2020 (Fig 1) committee used recent data on energy expenditure and protein metabolism, and applied the latest statistical approaches to derive the Estimated Average Requirements (EARs), with the upper 95th percentile of the distribution representing the RDAs (Fig 2).

Energy Requirements

The total energy requirement or the Total Energy Expenditure (TEE) is the product of the Basal Metabolic Rate (BMR) and Physical Activity Level (PAL): TEE = BMR x PAL. The BMR is calculated by using double-labelled water or whole-body calorimeter or by a factorial approach. The Physical Activity Level (PAL) is the ratio of the energy expenditure to the BMR over 24 hours. The physical activity ratio (PAR) is the ratio of the energy cost of an individual activity per minute to the cost of the basal metabolic rate (BMR) per minute. The aggregate of PAR values of a 24-hour period yields the PAL values[1,5].

In the 2020 Nutrient Requirements, the gender- and age- specific equations that were derived by the FAO/WHO/UNU 2004 were used to predict energy requirement[5]. However, the data generated for the Schofield equation used in FAO/WHO/UNU data were found to over-estimate the energy requirements for Indians, perhaps due to the fact that these data were derived from studies conducted on muscular

Fig 2 EAR, RDA and TUL

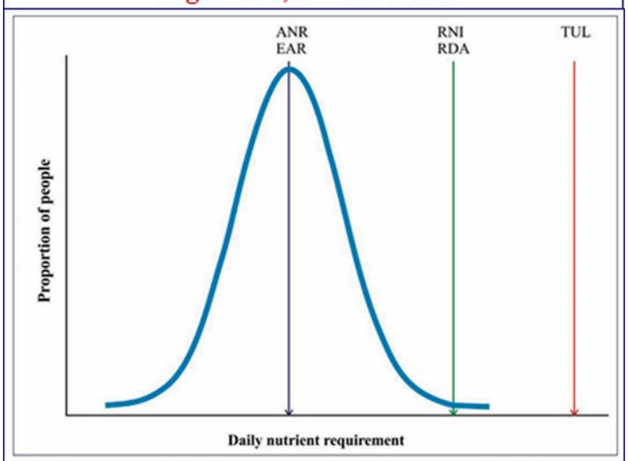


Table 1a. Physical activity ratio for different activities					
PAR values for Activities	FAO/WHO/ UNU (2004)	RDA (2010)	NIN-Sujatha *et al.*, (2000)	Kuriyan *et al.*, (2006)	Rao *et al.*, (2007)
Sleeping	1.00	1.00	1.00	1.00	-
Lying resting	1.20	-	1.00	-	0.84
Sitting	1.20	1.50	1.06	1.21	1.01
Standing	1.50	-	1.13	1.30	1.15
Household work (general, cooking)	2.80	2.50	1.87	2.27	1.74
Arranging vessels and folding beds	3.40	-	3.01	-	-
Light leisure activity	-	1.40	-	-	-
Desk-work (sitting and writing)	1.40	1.50	-	1.34	-
Walking at 3-2 km/hr	3.00[b]	2.00	2.67	2.86	2.35

young men[8]. Secondly, the energy spent for each physical activity, the PAR (Physical Activity Ratio), was also found to be lower for Indians (Table 1a and 1b)[9,10,11]. Altered body composition with relatively more fat and lower lean mass among Indians has been hypothesised to account for the observed lower BMR and PAR values in studies conducted in India[12,13]. While in principle, a constant PAR is used for each specific activity for all ranges of body weight, the PAR is lower by 15% among those with a BMI <18 kg/m^2 compared to those with a BMI>25 kg/m^2[2,10] It is therefore important to consider the possibility of lower PAR values among lighter individuals[11].

In order to correct this anomaly, the earlier ICMR-NIN, Report of the Expert Group on Nutrient Requirements and Recommended Dietary Allowances for Indians 2010 (hence forth referred to as 2010 RDA committee report), which used the FAO/WHO/UNU 2004 equation, reduced the BMR value by 5% while deriving energy requirements for Indian adults; while the 2020 report of the ICMR-NIN Expert group on Nutrient requirement for Indians, estimated Average requirements, and Recommended Dietary Allowances (hence forth referred to as - 2020 Nutrient Requirement committee) reviewed the literature on BMR and based on the evidence, reduced the BMR by a further 5 % for adults, resulting in a total of 10% reduction from the global values of FAO/WHO/UNU 2004 (Table 2)[1,4,5].

Hence, the recommended energy requirement (ICMR-NIN, 2020) is lower by 3 to 8 kcal/kg/day for

Table 1b. Physical activity level for different categories				
PAL values	ICMR 1989	ICMR2010	ICMR 2020	FAO/WHO/UNU 2004
Sedentary Work	1.60	1.53	1.40	1.40-1.69
Moderate Work	1.90	1.80	1.80	1.70 – 1.99
Heavy Work	2.50	2.30	2.30	2.00 – 2.40

adults compared to the previous recommendation (ICMR-NIN, 2010)[1,4]. Conversely, since there was no recent evidence to show that the BMR of Indian children is lower than that of their western counterparts, the BMR derived from the FAO/WHO/UNU 2004 was retained in respect of children.

Protein Requirements

The intake of proteins should satisfy the essential or indispensable amino acid (IAA) requirements as recommended by the FAO/WHO/UNU 2007[14]. However, the ICMR 2010 RDA, which followed the FAO/WHO/UNU 1985 amino acid scoring (AAS) pattern derived from balance studies carried out in a limited number of 2-year-old children recovering from malnutrition, did not represent normal healthy preschool-age children[15, 16].

The FAO/WHO/UNU 2007 consultation considered all the available nitrogen (N) balance studies[17,18]. A zero N balance was considered to be the criterion for estimating the protein requirement. The 2020 Nutrient Requirement committee adopted these approaches, and considered systematic studies on N balance and protein accretion studies in Indian infants, children, and pregnant and lactating mothers consuming habitual diets while arriving at the protein requirements for these physiological groups[19,20,21,22]. A median obligatory nitrogen loss (WHO, 2007) has been used to compute the mean (0.66 g/kg/day-EAR) and safe (0.83 g/kg/day-RDA) protein requirements for healthy Indian adults.

In addition, considering high-quality protein sources as the premise and recommending an improved

Table 2. Recommended energy requirement comparison ICMR-NIN 2010 and 2020			
Age Group	Category	Energy Requirement (kcal/kg/day)	
		RDA 2010	RDA 2020
Men	Sedentary work	39	32
	Moderate work	46	42
	Heavy work	58	53
Women	Sedentary work	35	30
	Moderate work	41	39
	Heavy work	52	49
	Pregnant		
	Lactating		
Infants	0-6 m	92	90
	6-12m	80	80
Children	1-3y	82	83
	4-6 yrs	75	74
	7-9 yrs	67	67
Boys	10-12y	64	64
Girls	10-12y	57	57
Boys	13-15y	58	57
Girls	13-15y	50	49
Boys	16-17y	55	52
Girls	16-17y	47	45

Table 3. Recommended protein requirements for Indians 2020						
		Body weight (kg)	EAR (g/kg/d)	RDA (g/kg/d)	EAR (g/d)	RDA (g/d
Adult Men*	Sedentary Moderate Heavy Work	65	0.66	0.83	43	54
Adult Women#	Sedentary Moderate Heavy Work	55	0.66	0.83	36	46
Pregnant Women	2nd Trimester				46	55
	3rd Trimester				58	68
Lactating Women	0-6 months				50	63
	6-12 months				47	59
Infants	0-6 months	5.8	1.16	1.40	6.7	8.1
	6-12 months	8.5	1.04	1.23	8.8	10.5
Children	1-3y	12.9	0.79	0.97	10.2	12.5
	4-6y	18.3	0.70	0.87	12.8	15.9
	7-9y	25.3	0.75	0.92	19.0	23.3
Boys	10-12y	34.9	0.75	0.91	26.2	31.8
Girls	10-12y	36.4	0.73	0.90	26.6	32.8
Boys	13-15y	50.5	0.72	0.89	36.4	44.9
Girls	13-15y	49.6	0.70	0.87	34.7	43.2
Boys	16-18y	64.4	0.70	0.86	45.1	55.4
Girls	16-18y	55.7	0.67	0.83	37.3	46.2

* For people consuming cereal-based diet with low quality protein, the protein requirements are 1 g/kg per day. For reference man it is 65g/day # For reference woman it is 55g/day

cereal-pulses-milk ratio of 3:1:2.5 (ICMR-NIN, 2020), as compared to the earlier 11:1:3 (ICMR-NIN, 2010) ratio, the EAR was estimated as 0.66 g/kg/day, and the RDA as 0.83 g /kg/day[20,21,22].

However, for people consuming protein from a cereal-based diet with lower quality protein, the requirement was estimated to be 1 g/kg per day, similar to the 2010 RDA. An EAR of 0.66 g/kg/day and an RDA of 0.83/kg/day translates to an EAR of 43 g protein /day and an RDA of 54 g protein/day for a person weighing 65 kg, regardless of physical activity or gender (Table 3). This recommended amount of protein can be easily met through a judicious combination of grains, pulses, nuts and milk.

In pregnancy, an extra allowance of about 22-26 g protein/day, with a PE ratio of 11-13% has been recommended, based on a study that used the total body potassium (TBK) method and estimated 686 g protein deposition and converted the potassium accretion to nitrogen accretion[22]. To meet this extra allowance of protein during pregnancy, consumption of high-quality protein foods (such as milk or eggs) is recommended (Table 4).

For children above 6 months of age, the mean maintenance requirement from all the N balance studies[14,19] showed a requirement of 0.68 g protein/kg/day. Since this requirement was close to the adult maintenance value of 0.66 g protein/kg/day, the same maintenance value was set for children (Table 3) above 6 months and an additional requirement for growth was added based on the average daily rates of protein deposition derived from the measurement of whole-body potassium[14,19,23].

An important consideration while recommending proteins intake levels is to ensure adequate non-protein energy from carbohydrates and fats which are of paramount importance for dietary amino acid utilization, as was demonstrated by nitrogen balance studies[24,25,14]. The nitrogen balance improved by 1 mg/kg/day for every additional 1 kcal/kg/day intake. Reduction in energy intake by 20% resulted in a negative N balance[14,24,25]. Secondly, despite the protein requirement remaining constant at different levels of activity, the energy requirement changes with activity levels; therefore, the PE ratio also changes with physical activity levels. Thus, the PE ratio will differ with different levels of calorie intake and within individuals engaged in different levels of physical activity (lifestyles); hence the PE ratio does not indicate the protein adequacy at an individual

Table 4. Additional Protein recommendation as per gestational weight gain (GWG) for Pregnant women			
	Additional Protein (g/d)		
	Trimester 1	Trimester 2	Trimester 3
GWG 12 kg			
ICMR 2010	0.6	8.3	27.2
ICMR 2020[a]	0.6	11.4	26.3
GWG 10 kg			
ICMR 2010	0.5	6.9	22.7
ICMR 2020[a]	0.5	9.5	22.0
GWG 8 kg			
ICMR 2010	0.4	5.5	18.2
ICMR 2020[a]	0.4	7.6	17.6

Table 5a. Nutrient values comparison ICMR-2010 and 2020 males

Nutrients	ICMR		
	2010	2020 RDA	2020 EAR
Calcium (mg)	600	1000	800
Magnesium (mg)	340	440	370
Iron (mg)	17	19	11
Zinc (mg)	12	17	14
Iodine (µg)	150	150	95
Thiamine (mg)	1.4	1.8	1.5
Riboflavin (mg)	1.6	2.5	2.1
Niacin (mg)	18	18	15
Vitamin B6(mg)	2	2.4	2.1
Folate (µg) DFE	200	300	250
Vitamin B12 (µg)	1	2.2	2
Vitamin C (mg)	40	80	65
Vitamin A (µg)	600	1000	460
Vitamin D (IU)	400	600	400

level. As per the data from the NNMB nutritional surveys, most people easily meet this level of 10 to 15% energy from protein from a cereal-based diet[26,27]. However, qualitatively, the total protein consumed may not necessarily provide all the essential amino acids (EAA). It is therefore important to understand that, in order to achieve adequate levels of all amino acids (quality), a food-based allowance is the ideal method of recommendation for protein quality adequacy. Cereals have lower levels of lysine and higher levels of sulphur-containing amino acids (methionine and cysteine) and the reverse is true for pulses.[28] An appropriate combination of cereals with pulses (and/or beans) in the ratio of 3:1 (raw weight) and adding 250 ml milk per day to the diet can provide good quality proteins, wherein all the EAA requirements are met. Non-vegetarians can easily source their proteins from the recommended level (700 to 900 g/week; marine water fish, poultry or lean meat) of flesh food consumption for adults.

The third and the most important fact is that one should be physically active and ensure that the protein consumed is utilised and not turned into fat. Muscle atrophy sets in despite good protein intake if physical activity is poor.

Fat Requirements

Dietary fats [vegetable cooking oils (seed oil), ghee, butter, lard, tallow] provide high energy value (9 kcal or 37.7 kJ/g) as compared to carbohydrates or proteins (4 kcal or 16.7 kJ/ g). Hence the fat content of a diet contributes significantly to its caloric density. There are three types of fatty acids (FA) in our diets: saturated fatty acid (SFA), mono unsaturated fatty acids (MUFA) and poly unsaturated fatty acids (PUFA). Animal foods such as fatty meat, fish, eggs and milk contain varying levels of cholesterols in addition to fatty acids, while vegetable oils or seed oils used in cooking do not contain cholesterol. Our bodies can synthesize SFAs and MUFAs besides obtaining them from our diets, whereas the PUFAs, namely, linoleic acid (also known as n-6 or omega 6 or LA) and alpha linolenic acid (also known as n-3 or omega 3 or ALA) cannot be synthesized in the human body. PUFAs and their derivatives (long-chain derivatives (LC-PUFAs: EPA, DHA and AA) are essential for many functions in the body and therefore must be obtained through diets. Cholesterol, which also performs many functions in the body is actively synthesised in the liver from carbohydrates and fats in our diet.

Table 5b. Nutrient values comparison ICMR-2010 and 2020 Females

Nutrients	ICMR		
	2010	2020 RDA	2020 EAR
Calcium (mg)	600	1000	800
Magnesium (mg)	310	370	310
Iron (mg)	21	29	15
Zinc (mg)	10	13.0	11
Iodine (µg)	150	150	95
Thiamine (mg)	1.1	1.7	1.4
Riboflavin (mg)	1.3	2.4	2.0
Niacin (mg)	14	14	12
Vitamin B6 (mg)	2	1.9	1.6
Folate (µg) DFE	200	220	180
Vitamin B12 (µg)	1	2.2	2
Vitamin C (mg)	40	65	55
Vitamin A (µg)	600	840	390
Vitamin D (IU)	400	600	400

Considering elevated serum LDL cholesterol as a major risk factor for coronary heart disease (CHD), an upper limit of 10% energy from SFAs and <300 mg/d of dietary cholesterol were recommended by WHO[29]. It is recommended that between 4-10% of total energy/day should be obtained from LA and

Fig 3 ICMR-NIN My Plate for the Day

ALA, based on data from breast milk content and brain development studies[30,31]. The consumption of leafy vegetables, legumes, fish and sea foods has to be encouraged to achieve the recommended intake levels of PUFAs, especially ALA; LA (the second essential fatty acid) is available in many foods and is also consumed widely in the form of cooking oils in India. Adequate consumption of nuts, oilseeds, leafy vegetables, fish and sea foods will meet the requirements of both the essential PUFAs (6.6 grams of n-6 PUFA and 2.2 grams of n-3 PUFA). Although n-6 PUFA is essential, an excess intake of cooking oils rich in n-6 PUFA enhances inflammation, platelet aggregation, and vasoconstriction and increases the risk of cardio vascular diseases (CVDs)[30].

Based on estimations, it can be concluded that there is no nutritional need for visible fats (used for cooking), as dietary fats should be able to meet the needs. The long chain PUFA such as DHA can be formed from n-3 PUFA or can be met from consuming sea foods, algae etc. However, today's dietary patterns and consumption habits are such that almost all recipes are made with visible fats. Therefore, visible fats cannot be avoided; however, depending on the level of energy (calorie) requirement based on physical activity and physiological, visible fat (cooking oil) should be limited to 20-30g (4 to 6 teaspoons) per person/ day.

The intake of Saturated Fatty Acids (SFA) as a percentage of total energy per day should not exceed 10% E, while TFA, which has no nutritional value and which increases the risk of CVDs, should be avoided or limited to less than 1% of total energy per day.

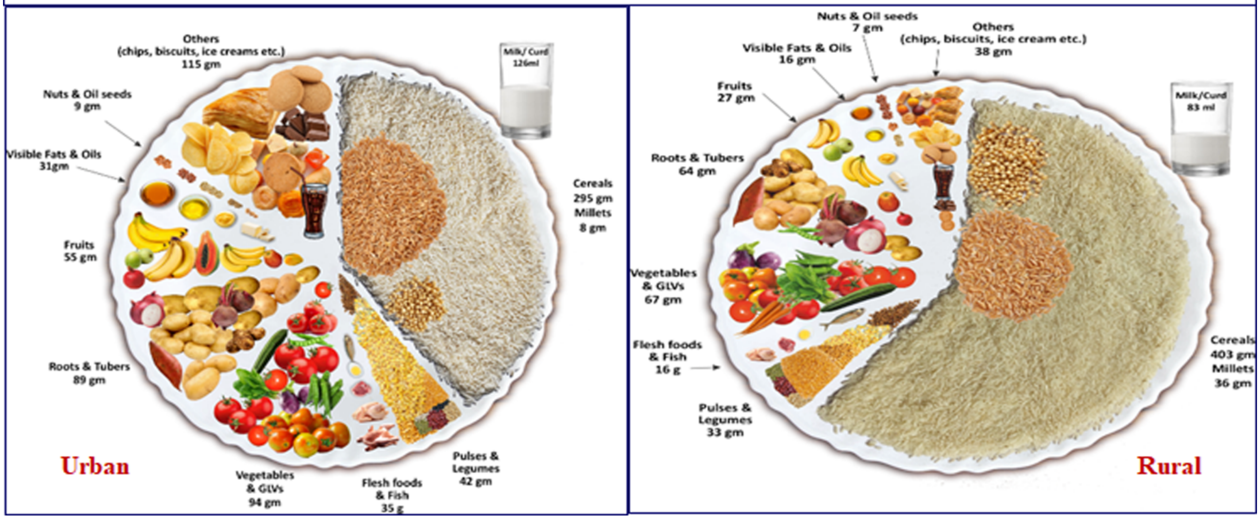
Vitamins and Mineral Requirements

For vitamins and minerals, the 2020 Report used the recent data on absorption and loss studies, balance studies or enzyme functions (activity) to derive the EAR and the RDA values. The RDAs in the 2020 Nutrient Requirements report are higher for all the vitamins and minerals when compared to those in the 2010 RDA report, except niacin and iodine which are similar to the previous version (Table 5a and 5b). The EAR levels recommended in the 2020 Nutrient Requirements report are lower as compared to RDA 2010 report but are aligned with global recommendations, for population requirement, adequacy estimations, menu or diet planning for individuals or population[31].

My Plate for the Day - ICMR-NIN

The "My Plate for the Day" developed by the ICMR-NIN has been designed to fulfill the needs of all macro and micronutrients in a 2000 kcal diet (Fig 3). Converting the nutrient recommendations, as given above, to food-based guidelines as depicted in the "My Plate for the Day", makes it much easier to understand how to meet the daily requirement of nutrients from foods in terms of quality, quantity and diversity of foods for normal individuals. It helps to make a judicious choice to achieve a balanced diet, while also promoting a variety of foodstuffs from different food groups. The quantities of different food groups are recommended in such a way that cereals would provide not more than 45 % of the calorie requirement with at least 14 % Energy (henceforth referred as E) from pulses and beans, and roughly 10 % calories each from vegetables & fruits; nuts & seeds; and milk and milk products. The amounts of most food groups will remain the same for adults, but the amounts of cereal/millets and legumes will differ with varying energy and protein requirements depending on the body weight; and energy requirement will increase further with increasing physical activity. In terms of nutrients, the Plate provides 50-60% of total calories (E) from carbohydrates, about 20-30% E from total fats/oils and a minimum of 10-15% energy from proteins. Also, the recommendation ensures that all essential macronutrients (essential amino acids and essential fatty acids) and the EAR levels of all micronutrients are met, especially if whole grains, varieties of greens and pulses and beans are included along with the recommended level of milk. In non-vegetarian diets, a portion of pulses can be substituted with calorie-equivalent fish, flesh foods or eggs. No supplement can provide as many micronutrients, bioactive compounds and antioxidants together as the

Fig 4 Food group consumption pattern among adults in urban and rural India



diversified food items depicted in the model plate. Added sugar has not been prescribed as a part of the model plate; restriction of sugar intake has been mentioned as a measure to follow.

For quantifying the nutrient values, the average of nutrients derived from most commonly consumed items in their raw forms was considered for each food group separately. The nutrient values were calculated from Nutritive Value of Indian Foods (NVIF)[32] and Indian Food Composition Tables (IFCT)[33]; wherever Indian data were not available, USDA values were used[34]. Based on these estimations it was found that sourcing energy and protein from food groups as indicated in the plate provides essentially all the macronutrients and micronutrients required for a healthy life. The content of all essential amino acids, especially lysine, methionine, cysteine, phenylalanine and tyrosine in the food plate have been found to be within the recommended values of WHO/FAO/UNU 2007.

Food group consumption and nutrient intake of rural and urban populations in India

Food intake data collected by 24-hour diet recall method from the NNMB Rural (2012) and Urban (2016) surveys were computed for all age groups using IFCT, NVIF data[25,26,32,33]. For foods that are not listed in the IFCT or NVIF, such as instant foods, biscuits, chips and so on, the data were collected from food labels and the United States Department of Agriculture (USDA) database[34]. Computations were made using SPSS (19.0 version) and R package.

Energy intake from different food groups

The mean calorie intake of adults (all States) in urban areas was 2129 kcal/day with 308 g of carbohydrate (CHO) and 62g and 72g of fat and protein intake per day, respectively; in rural areas, the mean calorie intake was 2152 Kcal/day with 372g of carbohydrates, 37g of fat and 67g of protein. In urban areas, cereals contributed to 1040 Kcal/day of the total energy/calorie intake, while visible fats and pulses contributed to 266 Kcal/day and 135 Kcal/day, respectively. In contrast, in rural areas the total energy intake from cereals was much higher (1508) Kcal/day, and that from fats and pulses was considerably lower (fats, 146 Kcal/day and pulses, 106 Kcal/day respectively). The contributions from milk and milk products varied widely between urban (258 Kcal/day) and rural (170Kcal/ day) areas. Food group consumption patterns among adults in urban and rural India are provided in Fig 4.

The percentage of energy derived from different food groups showed that cereals and millets contributed 49% of energy intake per day in urban areas and 69% of energy in rural areas, while the recommendation is that not more than 45% of energy should come from cereals. Together, pulses, meat, poultry and fish contributed to 8.8% of the total energy per day in urban areas and 6% of energy in rural areas as against the recommended intake level of 14% of total energy from these foods. Moreover, energy from fruits and vegetables was only 3% in urban areas and 1.8% in rural areas as against the minimum requirement of 8-11% from these sources per day. Similarly, whole nuts and oilseeds formed only 2.2% of the energy requirement in urban areas and 1.7% E in rural areas as against the recommendation of 8% per day. Other foods (which include chips, biscuits, chocolates, sweets, juices, etc.,) contributed to 10% of energy per day in urban areas, while it was lower, but still substantial in rural areas (4%).

These results show that the major portion of calories in Indian diets come from cereals. Also, carbohydrates which contributed to 49% and 69%

energy among urban and rural populations, respectively, were from refined cereals.

Ideally, the bulk of the diet should consist of food stuffs which are high in non-starch polysaccharides (NSP) and oligosaccharides such as whole grains, pulses, vegetables, beans, fruits, nuts and seeds. Epidemiological studies have shown the benefits of consuming nuts and seeds [35]. Foods high in NSP and oligosaccharides are also rich in micronutrients and short chain fatty acids (SCFAs) that lower the risk of fat mass accumulation and obesity[35,36]. Our studies in rats and hamsters, have consistently shown adverse effects such as hypertriglyceridemia and inflammation with diets containing 78% energy from carbohydrates (58%) from starch and 20% from sucrose[37,38]. Also, pregnant hamsters fed with 65% energy from carbohydrate sources (high carbohydrate diet showed low placental and foetal weight gain and inflammatory cytokines in gestational tissues[37,38].

Percentage of proteins from different food groups

Cereals were the major contributors of total protein with 28.2g and 41g protein/day in urban and rural areas, respectively; cereals formed 39% and 61% of total protein intake per day in these two population groups, respectively. Pulses and flesh foods together represented 23.4% and 10.8%, respectively of total contribution of protein among all food groups in urban and rural India. Milk and milk products contributed to 21.6% (15.6 g protein /d) and 15% (10 g protein/day) of total protein intakes in urban and rural India, respectively. When compared to rural areas, the urban intakes are closer to the food-based "My Plate for the Day" reference, which recommends <34% from cereals and up to 27 % protein from pulses, beans, meat. It is important that milk should contribute 14 to 15% protein separately; and that 7% of total daily protein should come from nuts and seeds. The indicated proportions help achieve the right balance of all essential amino acids.

Percentage of fats from different food groups

A significant proportion of the population (NMMB) derived more than 30% energy per day from total fats, mostly from ω 6 fatty acid-rich oils. A multivariate analysis on data from >5 lakh participants, aged 50-71 years, prospectively followed, showed that for each 1-tablespoon/day increment of saturated fats there was an increased hazards ratio of cardiometabolic risk, but no such effect with cooking oil rich in ω 6 PUFA oils[39]. In Indian diets, the issue is not saturated fat, but excessive consumption of cooking oils (rich in ω 6 PUFA oils); much of this consumption is from foods from restaurants or hotels, about which data are not available. A recent study on the effects of fatty acids on coronary heart disease (CHD) found that replacing saturated fatty acid (SFA) with n-6 polyunsaturated fatty acid (PUFA) had no beneficial effect on CHD/CVD mortality and total mortality, which is consistent with earlier meta-analyses reports[39,40,41]. Replacing SFA with PUFA has been consistently shown to reduce the total C:HDL-C ratio, but does not appear to affect the incidence of CHD or CHD mortality as shown in various randomized controlled trials.

Studies on replacing SFA with PUFA to the extent of 5 to 10% energy does not necessarily reflect the conditions in the Indian population[39,40,41]. People in India consume high levels of ω 6 PUFA rich oils, which has skewed the balance of essential fatty acids in general, and may adversely affect overall health and development. Half of the human brain is composed of fat, mostly cholesterol, with 20% of dry weight being contributed by LC-PUFA, including 6% of arachidonic acid (AA) and 8% of docosahexaenoic acid (DHA)[42]. The effects of high consumption of ω 6 PUFA during pregnancy when the foetal brain is developing rapidly have not been documented. Given the data available, it would be prudent to limit ω 6 PUFA (cooking oils) during pregnancy and increase the consumption of oilseeds, nuts and fish. which supply balanced amounts of both PUFAs including long chain (LC)-PUFAs. The health impact of plant-derived PUFA-containing cooking oils, which are widely used in India, remains unclear. Guidelines should therefore address this issue and give specific recommendations.

A common observation across most population groups was that starchy cereals are being consumed in excess of recommended levels; at the same time, there is far less consumption of protective foods such as pulses, milk, nuts, vegetables and fruits than recommended. In addition, there is a rising trend of consumption of extracted vegetable/seed oils and ultra-processed foods high in fat, sugar and salt (HFSS foods). Abdominal obesity has been found to be prevalent in 53.1% and 18.8% of the urban and rural populations, respectively. Odds ratio adjusted for age, gender, BMI, total fats and percentage energy showed an increased risk of diabetes associated with a lower consumption of vegetables and fruits and an increased risk of hypertension with lower intake of milk and milk products.

Conclusion

We need a systemic change in our food system. At present, production and consumption revolve around a very limited number of crops. Increasing the production of traditional food items such as millets, pulses, seeds and nuts should be explored, with focus on their yields and resilience to pests. Empowerment of rural women in best practices, home gardens, and training for healthy recipes in both low- and high-income settings may potentially improve positive choices for healthy diets. Policy support for formulation of healthy foods and making them available at affordable cost and regulations in areas such as food taxes, food labelling and food marketing will help reduce the consumption of unhealthy foods. There is an urgent need for a community drive and policy efforts to discourage unhealthy dietary habits and improve healthy food behaviour.

Dr Hemalatha is Director, National Institute of Nutrition, Hyderabad and President, Nutrition Society of India. The write up is based on the Dr Srikantia Oration that she delivered in the 54th Annual Conference of Nutrition Society of India in December 2022.

References

1. ICMR-NIN Expert Group on Nutrient Requirement for Indians, Recommended Dietary Allowances (RDA) and Estimated Average Requirement (EAR) – 2020.
2. Nutrition Advisory committee of the Indian Research Fund Association (IRFA). A report of the twelfth meeting. New Delhi, India; 1944.
3. Indian Council of Medical Research. Nutrient requirements and recommended dietary allowances for Indians. A Report of the Expert Group of the Indian Council of Medical Research, National Institute of Nutrition, Hyderabad; 2010.
4. Joint FAO/WHO/UNU. Human Energy Requirements. Report of the Joint FAO/WHO/UNU Expert Consultation, Rome, 17-24 Oct.2001. Rome, FAO/WHO/ UNU, 2004
5. Department of Health. Dietary reference values for food energy and nutrients in the United Kingdom. Report of the panel on Dietary Reference Values of the Committee on Medical Aspects of Food Policy. London: HMSO, 1991.
6. Food and Nutrition Board: Institute of Medicine. Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. Washington DC, National Academy Press, 1998a.
7. Soares MJ, Shetty PS. Validity of Schofield's predictive equations for basal metabolic rates of Indians. Indian J Med Res 1988; 88:253-260.
8. Sujatha T, Shatrugna V, Venkataramana Y, Begum N. Energy expenditure on household, childcare and occupational activities of women from urban poor households. Br J Nutr 2000; 83: 497-503.
9. Kuriyan R, Easwaran PP, Kurpad AV. Physical activity ratio of selected activities in Indian male and female subjects and its relationship with body mass index. Br J Nutr 2006; 96: 71-79.
10. Rao S, Gokhale M, Kanade A. Energy cost of daily activities for women in rural India. Public Health Nutr 2008; 11:142-150.
11. Piers LS, Shetty PS. Basal metabolic rate of Indian women. Eur J Clin Nutr 1993; 47:586-591.
12. Shetty PS, Soares MJ, Sheela ML. Basal Metabolic rates of South Indian males. Report of FAO, Rome, 1986,
13. FAO/WHO/UNU, Expert Consultation on Protein and Amino Acid Requirements in Human Nutrition. WHO Technical Report Series No.935, 2007.
14. Joint FAO/WHO/UNU, Energy and Protein Requirements. Report of Joint FAO /WHO.UNU Expert Consultant. WHO Technical Report Series 724, 1985.
15. Torun B., PSW Davies, MBE Livinstone, M. Paolisso, R. Sackett, GB Sputr. Energy requirements and dietary energy recommendations – for children and adolescents 1-18yr old, European Journal of Clinical Nutrition (1996), 50, Suppl.1. S37-S51.
16. Pineda, O., Torun, B., Viteri, F. E. & Arroyave, G. (1981) Protein quality in relation to estimates of essential amino acid requirements. In: Protein Quality in Humans (Bodwell, C. E., Adkins, J. S. & Hopkins, D. T., eds.), pp. 29 – 42. AVI Publishing Company, Westport, C.
17. Rand WM, Pellet PL, Young VR. Meta-analysis of nitrogen balance studies for estimating protein requirements in healthy adults. The American Journal of Clinical Nutrition. 2003 Jan 1: 77(1):109-27.
18. Pillai RR, Elango R, Muthayya S, Ball RO, Kurpad AV, Pencharz PB. Lysine requirement of healthy, school-aged Indian children determined by the indicator amino acid oxidation technique. The Journal of nutrition. 2009; 140(1): 54-9.
19. Kurpad AV, Young VR. Human indispensable amino acid requirements: new paradigms of measurement and the implication for protein quality. Indian Journal of Physiology and Pharmacology. 1999 Jan 1; 43(1):5-24.
20. Kurpad AV, Raj T, El-Khoury A, Beaumier L, Kuriyan R, Srivatsa A, Borgonha S, Selvaraj A, Regan MM, Young VR. Lysine requirements of healthy adult Indian subjects, measured by an indicator amino acid balance technique. The American Journal of Clinical Nutr. 2001 May 1; 73(5):900-7.
21. Kuriyan R, Naqvi S, Bhat KG, Thomas T, Thomas A, George S, Nagarajarao SC, Sachdev HS, Preston T, Kurpad AV. Estimation of protein requirements in Indian pregnant women using a whole-body potassium counter. The American Journal of clinical nutrition. 2019 Apr 1; 109 (4): 1064-70.
22. Butte NF, Hopkinson JM, Wong WW, Smith EO, Ellis KJ. Body composition during the first 2 years of life: an updated reference. Pediatric research. 2000 May; 47(5): 578-85,

23. Iyengar AK, Rao BN, Reddy V. Effect of varying protein and energy intake on nitrogen balance in adults engaged in heavy manual labour. British Journal of Nutrition. 1979 Nov; 42(3):417-23.
24. Iyengar A, Rao BN. Effect of varying energy and protein intake on nitrogen balance in Indian pre-school children. British Journal of Nutrition. 1979 Nov; 42(3):417-23.
25. NNMB. Report for the year 2012. Technical Report Series, National Nutrition Monitoring Bureau, National Institute of Nutrition (ICMR), Hyderabad, 2012.
26. NNMB. Report for the year 2016. Technical Report Series, National Nutrition Monitoring Bureau, National Institute of Nutrition (ICMR), Hyderabad, 2016.
27. Rao BN, Pasricha S, Gopalan C. Nitrogen balance studies in poor Indian women during lactation. Indian Journal of Medical Research. 1958; 46:325-31
28. World Health Organization. Interim summary of conclusions and dietary recommendations on total fat & fatty acids. From the joint FAO/WHO expert consultation on fats and fatty acids in human nutrition. 2008 Nov 10:10-4.
29. Brenna JT, Lapillonne A. Background paper on fat and fatty acid requirements during pregnancy and lactation. Annals of nutrition & metabolism. 2009 Jan 1; 55(1/3):97-122.
30. Roncaglioni MC, Tombesi M, Avanzini F, Barlera S, Caimi V, Longoni P, Marzona I, Milani V, Silletta MG, Tognoni G, Marchioli R. Risk and Prevention Study Collaborative Group; n-3 fatty acids in patients with multiple cardiovascular risk factors. N Engl J Med. 2013 May 9;368(19):1800-8. doi: 10.1056/NEJMoa1205409. Erratum in: N Engl J Med. 2013 May 30;368(22):2146. PMID: 23656645.
31. Lindsay H Allen, Alicia L Carriquiry, and Suzanne P Murphy. Perspective: Proposed Harmonized Nutrient Reference Values for Populations. Adv Nutr. 2020 May; 11(3): 469–483. Published online 2019 Nov 8. doi: 10.1093/advances/nmz096
32. Gopalan, C, Rama Sastry BV and Balasubramanian SC: Nutritive Value of Indian Foods. First Edition 1971. Revised and updated by Narasinga Rao BS, Deosthale YG and Pant KC 1989, National Institute of Nutrition, Hyderabad.
33. Longvah T, Ananthan R, Bhaskara Chary K and Venkaiah K (2017). Indian Food Composition Tables – 2017, ICMR-National Institute of Nutrition. USDA
34. U.S. Department of Agriculture, Agricultural Research Service. FoodData Central, 2019.
35. Bindels, LB, Delzenne, NM, Cani, PD, & Walter J. Opinion: Towards a more comprehensive concept for prebiotics. Nature Reviews Gastroenterology and Hepatology, 12, 303– 310. https://doi.org/10.1038/nrgastro. 2015.47
36. Vikas Kumar, Amit K Sinha, Harinder PS Makkar, Gudrun de Boeck, Klaus Becker. Dietary roles of non-starch polysaccharides in human nutrition: a review. PMID: 22747080 DOI: 10.1080/10408398.2010.512671
37. Shujauddin Mohammed, Rajkumar Hemalatha, Syed Shah Yousuf, Hussain Qadri and Vure Venkata Annapurna. 'Semi-synthetic diet versus diet using natural ingredients - Comparative study in female Golden Syrian hamsters'. Journal of Animal Physiology and Animal Nutrition, 2019; 1–8.
38. Vure Venkata Annapurna, Hemalatha R, Raviteja Akkaladevi, Ramaraju AVS, Narendra Babu K, ThirupathaiahYeruva, Shujauddin Mohd, Harishankar N and Balakrishna N. Selective ceacal bacterial changes mediate the adverse effects associated with high palmolein or high starch diets: prophylactic role of flax oil. Intern J of Pharmacy and Pharmaceutical Sciences. 2015; Vol 7, Issue 11, 89-95
39. Steven Hamley et al. The effect of replacing saturated fat with mostly n-6 polyunsaturated fat on coronary heart disease: a meta-analysis of randomised controlled trials. Nutrition Journal (2017) May 19;16(1):30. doi: 10.1186/s12937-017-0254-5
40. Zhang, Y., Zhuang, P., Wu, F. et al. Cooking oil/fat consumption and deaths from cardiometabolic diseases and other causes: prospective analysis of 521,120 individuals. BMC Med 19, 92 (2021). https://doi.org/10.1186/s12916-021-01961-2
41. Rajiv Chowdhury et al. Association of dietary, circulating, and supplement fatty acids with coronary risk. A systematic review and meta analysis. Annals of Internal Medicine. 2014;160:398-406).
42. Irina A. Guschina, Benjamin H. Maskrey, Mark Good, Valerie B. O'Donnell, John L. Harwood. Dietary DHA supplementation causes selective changes in phospholipids from different brain regions in both wild type mice and the Tg2576 mouse model of Alzheimer's disease Cécile Bascoul-Colombo.

FOUNDATION NEWS

Dr. Kamala Krishnaswamy, Chairperson Governing Body of Nutrition Foundation of India was conferred the 'Living Legend' award by the International Union of Nutrition Sciences in December 2022