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Indian Academy of Pediatrics

IAP-AHA Textbook of Adolescent Medicine

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SECTION 5

Nutrition

Section Editor: *Geeta Patil*

5.1 Adolescent Nutritional Requirements

Elizabeth KE, Bindusha S

INTRODUCTION

Adolescence is considered as a nutritionally critical period in life, as it is the last and final chance for growth and development. Adolescence is the period of pubertal growth spurt, which increases the requirement of both macro- and micronutrients. A balanced diet containing appropriate amount of macronutrients and micronutrients is important to achieve full growth potential. The physique of an adolescent changes from that of a child to an adult, and this change is associated with increase in height, weight, body mass index, and changes in body proportion, body fat content, muscle and bone mass, blood volume, etc.

GENDER-BASED DIFFERENCES

Nutritional requirement of adolescents varies as per gender. This difference in requirement is due to the difference in the rate of pubertal growth between boys and girls. Growth spurt starts and completes earlier in girls compared to boys. Thus, the protein requirement of girls aged 10–12 years is higher than boys of the same age group. Protein requirement of an adolescent girl aged 15–18 years is much lower than a boy of the same age group, as her adult height is already achieved. The energy requirement of adolescents also depends on physical activity in addition to growth. Adolescent boys are more active, and they require more energy than adolescent girls. Other factors such as differences in body composition and requirements of certain nutrients like iron also contribute to this differential recommendation.

MACRO- AND MICRONUTRIENT REQUIREMENTS

Adequate energy intake during adolescence is needed to support linear and muscle growth. Around 4% of total energy requirement is spent to support growth during adolescence. Minimum daily carbohydrate intake of 100–130 g is recommended. This is the minimum intake needed to provide glucose for metabolism in the brain. Whole grains are preferred over processed cereals. Millets should contribute to 20–30% of cereal intake. Sugar intake should be limited to <5% of energy requirement.

Protein requirement of adolescents is almost equal to that for adults. Adequate intake of essential amino acids is critical during this period to support the pubertal growth spurt and development. Even if protein intake is adequate in quantity, protein deficiency can occur due to suboptimal quality of dietary proteins and poor utilization due to recurrent infections. Vegetarian sources are mostly incomplete with rate-limiting amino acids. If the calorie intake is suboptimal, proteins will be wasted for energy instead of tissue building; 1 g for just 4 kcal.

Requirements of calcium, phosphorous, and magnesium are the highest during adolescence, as these minerals are needed for bone growth, mineralization, and increase in the muscle mass. 40% of skeletal mass is added

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during adolescence. Lack of adequate dietary calcium can lead to low bone mineral density and osteoporosis during adulthood. Recommended dietary allowance (RDA) of calcium during early adolescence is 850 mg/day, which increases to 1,050 mg/day in late adolescence. The recommended calcium:phosphorus ratio in diet is 1:1. Zinc is a growth nutrient and is essential for linear growth, sexual maturation, and immunity.

Adequate intake of iron is essential for adolescents, girls to compensate for the menstrual blood loss, and boys to build up muscle mass, red cell mass, and blood volume. Infections and parasitic infestations can lead to iron loss from the body. Nonheme iron contributes to a major source of iron in Indian diet, which is less bioavailable due to antinutrients such as phytates, polyphenols, coffee, and tea. The absorption of iron depends on heme/nonheme iron, meal composition, and other dietary factors. Addition of fruits rich in ascorbic acid like guava and papaya has been found to increase iron absorption from plant sources. The desired ratio of vitamin C:iron is >4:1 and phytate:iron is <0.4:1.

Daily intake of sodium should be limited to 2 g/day, which is equivalent to salt intake of 5 g/day. The recommended sodium:potassium ratio is 1:1.

The requirements of key nutrients are summarized in **Tables 1 and 2**. The desirable amounts in a balanced diet are given in **Table 3** and tolerable upper limits of in **Table 4**.

ACCEPTABLE MACRONUTRIENT DISTRIBUTION RANGE

Carbohydrates should make up 45–65% of energy intake; protein 5–15%; and fat 25–35%. In view of the obesity pandemic, carbs may be restricted to 50% and protein hiked to 20%. Dietary fat should come from sources of saturated:polyunsaturated:monounsaturated fatty acids in the ratio 10:10:10%. For reducing cardiovascular disease (CVD) risk, monounsaturated can be further hiked by

TABLE 1: Recommended dietary allowances (RDAs)* for energy, protein, and micronutrients: Indian Council of Medical Research (ICMR) 2024.

Age group	*Gender*	*Energy kcal/day*	*Protein g/day*	*Fiber g/day*	*Calcium mg/day*	*Magnesium mg/day*	*Iron mg/day*	*Zinc mg/day*	*Iodine µg/day*
10–12 years	Boys	2,220	32	33	850	240	16	8.5	100
	Girls	2,060	33	30	850	250	28	8.5	100
13–15 years	Boys	2,860	45	43	1,000	345	22	14.3	140
	Girls	2,400	43	36	1,000	340	30	12.8	140
16–18 years	Boys	3,320	55	50	1,050	440	26	17.6	140
	Girls	2,500	46	38	1,050	380	32	14.2	140

*There is no RDA for energy. Instead, estimated average requirement (EAR) is given. EAR for energy is equivalent to estimated energy requirement (EER). Adequate intake (AI) is given for dietary fiber.

Source: Adapted from Revised Short Summary Report 2024, ICMR—NIN Expert Group on Nutrient Requirements of Indians, RDA and EAR 2020.

TABLE 2: Recommended dietary allowances for vitamins—ICMR 2024.

Age group	*Gender*	*Thiamine mg/day*	*Riboflavin mg/day*	*Niacin mg/day*	*Vitamin B_6 mg/day*	*Folate µg/day*	*B_{12} µg/day*	*Vitamin C mg/day*	*Vitamin A µg/day*	*Vitamin D IU/day*
10–12 years	Boys	1.5	2.1	15	2.0	220	2.2	55	770	600
	Girls	1.4	1.9	14	1.9	225	2.2	50	790	600
13–15 years	Boys	1.9	2.7	19	2.6	285	2.2	70	930	600
	Girls	1.6	2.2	16	2.2	245	2.2	65	890	600
16–18 years	Boys	2.2	3.1	22	3.0	340	2.2	85	1,000	600
	Girls	1.7	2.3	17	2.3	270	2.2	70	860	600

Source: Adapted from Revised Short Summary Report 2024, ICMR—NIN Expert Group on Nutrient Requirements of Indians, RDA and EAR 2020.

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TABLE 3: Quantity of suggested food groups for a balanced diet to meet EAR for adolescents.

Age	Gender	Cereals (g)	Pulses (g)	GLV (g)	Vegetables (g)	Roots and Tubers (g)	Fruits (g)	Nuts (g)	Milk (mL)	Fats and oils (g)
10–12 years	Boys	280	90	100	200	100	100	30	400	35
10–12 years	Girls	250	85	100	200	100	100	30	400	30
13–15 years	Boys	390	130	100	200	100	100	40	400	45
13–15 years	Girls	300	100	100	200	100	100	35	400	40
16–18 years	Boys	450	150	100	200	100	150	50	400	55
16–18 years	Girls	315	105	100	200	100	150	40	400	40

(EAR: estimated average requirement; GLV: green leafy vegetables)
Source: Adapted from Revised Short Summary Report 2024, ICMR—NIN Expert Group on Nutrient Requirements of Indians, RDA and EAR 2020.

TABLE 4: Tolerable upper limit of nutrients for the adolescents.

Age	Gender	Protein (PE ratio)	Calcium mg/day	Magnesium mg/day	Iron mg/day	Zinc mg/d	Iodine µg/day	Folate µg/day	Vitamin C mg/d	Vitamin A µg/day	Vitamin D IU/day
10–12 years	Boys	<15%	3,000	350	40	23	600	600–800	1,050	1,700	4,000
10–12 years	Girls	<15%	3,000	350	40	23	600	600–800	1,300	1,700	4,000
13–15 years	Boys	<15%	3,000	350	45	34	900	600–800	1,550	2,800	4,000
13–15 years	Girls	<15%	3,000	350	45	34	900	600–800	1,800	2,800	4,000
16–18 years	Boys	<15%	3,000	350	45	34	1,100	600–800	1,950	2,800	4,000
16–18 years	Girls	<15%	3,000	350	45	34	1,100	600–800	2,000	2,800	4,000

Source: Adapted from Revised Short Summary Report 2024, ICMR—NIN Expert Group on Nutrient Requirements of Indians, RDA and EAR 2020.

reducing saturated fat. Omega-6 polyunsaturated fatty acid (PUFA) should contribute to 4–10% and omega 3 PUFA to 0.5–1% of energy. Omega 6:omega 3 ratio of 5–10:1 is desirable. Trans fats that are solid at room temperature, found in animal fat, hydrogenated oils, frozen desserts, and bakery products, should be avoided as they increase serum low-density lipoproteins. Ghee has only 4% trans fats.

KEY MESSAGES

- Adolescence is a nutritionally critical period. Nutritional requirement of adolescents varies as per gender and stage of adolescence.
- Around 4% of total energy requirement is spent to support growth during adolescence.
- The energy requirement of adolescents also depends on physical activity in addition to growth.
- A balanced diet containing appropriate amount of macronutrients and micronutrients is important to achieve full growth potential.
- Carbohydrates should make up 45–65% of energy intake; protein 5–15%; and fat 25–35%.
- Minimum daily carbohydrate intake of 100–130 g is recommended. Sugar intake to be limited to less than 5% of energy requirement.
- Millets should contribute to 20–30% of cereal intake.
- Adequate intake of high-quality protein is needed for optimal growth during adolescence.
- Requirements of iron, calcium, phosphorous, and magnesium are highest during adolescence.
- In view of the obesity pandemic, carbs may be restricted to 50% and protein hiked to 20%.

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RECOMMENDED READING

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5.2 Undernutrition Among Adolescents

Elizabeth KE, Bindusha S

INTRODUCTION

Adolescence is a period of transformative growth. 15–20% of final adult height and 50% of adult weight is gained during adolescence. The "Triple burden" of malnutrition, namely undernutrition, micronutrient deficiency, and overweight/obesity during adolescence can have lasting effects, as they affect the maturation of multiple biological systems. Thinness during adolescence is associated with a higher risk of infectious diseases, delayed puberty and maturation, reduced muscular strength, and work capacity and bone density later in life. In addition, thinness in adolescent girls is associated with adverse pregnancy outcomes, intrauterine growth retardation, and transgenerational malnutrition.

Nutritional status affects both the onset of puberty and its duration. Puberty occurs earlier in children who are overweight, and may be delayed in underweight children. Different studies have shown that higher intake of animal proteins, carbohydrates, and fats during early adolescence is associated with earlier onset of puberty.

ASSESSMENT OF UNDERNUTRITION AMONG ADOLESCENTS

The World Health Organization (WHO) recommends the use of body mass index (BMI) for age and height for the assessment of adolescent growth patterns **(Table 1)**. The terms thinness and underweight are often used interchangeably when making reference to adolescents' low BMI-for-age, <3rd percentile. For Indian children and adolescents, it is recommended to use BMI cut offs of >23 adult equivalents and >27 adult equivalents for overweight and obesity, respectively. This recommendation takes into account the difference in the body composition of Indians compared to westerners.

PREVALENCE OF UNDERNUTRITION AMONG ADOLESCENTS

Global prevalence of underweight among adolescents is 8.4% among girls and 12.4% among boys. Despite the current interventions, the prevalence has not declined over the last three decades. There is significant difference in the prevalence of thinness, stunting, and overweight among different nations. The prevalence of moderate and severe thinness among adolescents is highest in South Asia.

Undernutrition among adolescents in India is a public health issue, which is often overlooked by the researchers and health planners. Even the National Family Health Survey 5 (NFHS-5) groups all individuals above 15 years among adults. Data from the Comprehensive National Nutrition Survey 2018 (CNNS 2018) points to high prevalence of malnutrition among adolescents **(Box 1)**.

TABLE 1: Assessment of abnormal growth patterns among adolescents.

Stunting	Height for age <2 SD below the WHO child growth reference median
Thinness	BMI for age <2 SD below the WHO growth reference median
Overweight	BMI for age >1 SD above the WHO growth reference median
Obesity	BMI for age >2 SD above the WHO growth reference median

(BMI: body mass index; SD: standard deviation)

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