peebrothers.com, for detailed information on pediatrics books, visit our website www.jaypeebrothers.com, for detailed information on pediatrics bo

PEDIATRICS

SPECIAL VOLUME

28

Recent Advances in PEDIATRICS

Child Nutrition in Practice

The most up-to-date compendium of peer-reviewed, evidence-based and state-of-the-art topical issues of special relevance and applicability to the Indian subcontinent and other resource-limited countries, especially in the South-East Asian Region (SEAR)

Academic Editor
Suraj Gupte

Executive Editors
Shamma-Bakshi Gupte
Manu Gupte

JAYPEE

Contents

PART 1: PRINCIPLES OF CHILD NUTRITION

1. **Nutritional Needs in Children** 1
   Suraj Gupte, Aruna Chandra, E William
2. **Antioxidants** 20
   GS Latha
3. **Assessment of Nutritional Status** 32
   Suraj Gupte, Utpal Kant Singh

PART 2: VITAMINS

4. **Vitamins: Essentials and Therapeutics in a Nutshell** 40
   Novy Gupte, Suraj Gupte, Utpal Kant Singh
5. **Vitamin A Deficiency** 64
   Suraj Gupte, Kareena Naidu, Isobel Tanapong
6. **Vitamin D Deficiency** 72
   Harmesh S Bains
7. **Vitamin D Deficiency Rickets and Other Rickets** 78
   Suraj Gupte, Waheeda Shaik, EW Kawasaki

PART 3: MINERALS

8. **Micronutrients and Macrominerals** 95
   Novy Gupte, Suraj Gupte, Utpal Kant Singh
9. **Iron Deficiency Anemia** 109
   VN Tripathi, Piyush Upadhyay, Rakhi Jain
10. **Neuropsychiatric Dysfunctions in Iron Deficiency Anemia** 116
    TM Ananda Kesavan
11. **Zinc in Child Nutrition** 126
    Pushpendra Magon, Harmesh S Bains

PART 4: NUTRITION IN DIFFERENT PEDIATRIC AGE GROUPS

12. **Antenatal Nutrition: Effect on Fetal and Neonatal Outcome** 133
    Rashmi Dwivedi

13. **Infant and Young Child Feeding** 147
Bhavana B Lakhkar

14. **Adolescent Nutrition** 169
Rashmi Dwivedi

PART 5: UNDERNUTRITION AND OBESITY

15. **Protein-Energy Malnutrition: Overview** 184
Suraj Gupte, Utpal Kant Singh

16. **Severe Acute Malnutrition** 227
Harmesh S Bains, Manu Sharma Sareen

17. **Refeeding Syndrome** 235
Pushwinder Kaur, Harmesh S Bains

18. **Immunology of Malnutrition** 242
Ashish Simalti, Sheikh Minhaj Ahmed, Uday Bodhankar

19. **Malnutrition and the Nervous System** 254
TM Ananda Kesavan, Nithya Thuruthiyath

20. **Prevention of Childhood Malnutrition** 261
Pushwinder Kaur, Pushpendra Magon

21. **Feeding of Low Birth Weight Babies** 270
Anita Singh, Anup Thakur

22. **Pediatric Obesity** 286
Noopur Singhal Sud, Harmesh S Bains

PART 6: PEDIATRIC PRACTITONER AND NUTRITION

23. **Handling Nutritional Problems in Office Practice** 303
Anuradha Bansal, Harmesh S Bains

PART 7: NUTRITION IN SYSTEMIC DISEASES

24. **Nutrition in Diabetes** 317
Shaveta Kundra

25. **Nutrition in Pediatric Irritable Bowel Syndrome** 330
Yogesh Waikar

26. **Nutritional Management of Diarrhea** 335
Jatinder Singh, Harmesh S Bains, Vaneeta Bhardwar

27. **Nutrition in Cystic Fibrosis** 342
Thomas L Ratchford, Jeffrey H Teckman, Dhiren R Patel

28. Nutrition in Celiac Disease **356**
Shaveta Kundra

29. Diet in Inflammatory Bowel Disease **369**
Pankaj C Vaidya

30. Diet in Chronic Liver Disease **379**
Aditi, Pankaj C Vaidya, Vibhor V Borkar

31. Nutrition in Acute Kidney Injury **386**
Sumantra Kumar Raut, Rajiv Sinha

PART 8: MISCELLANEOUS

32. Food Intolerance and Allergy **401**
Edwin Dias

33. Drug-Nutrient Interaction **409**
Uday Bodhankar, Sandeep Dhingra, Sheikh Minhaj Ahmed

34. Sports Nutrition **420**
VN Tripathi, Rakhi Jain, Piyush Upadhyay

35. Nutritional Supplements **426**
VN Tripathi, Piyush Upadhyay, Rakhi Jain

Index 433

3 Assessment of Nutritional Status

Suraj Gupte, Utpal Kant Singh

ABSTRACT

Assessment of nutritional status is an important component of pediatric practice. In identifying cases of borderline nutritional disturbances such as mild moderate malnutrition, its role assumes special significance. Besides individual levels as in a health facility, it may be needed in large groups and segments of child population, e.g. times of natural calamities/disasters (earthquake, floods and starvation outbreaks). Its major components include dietary history, clinical signs, anthropometry, investigations, associated disorders and vital statistics. *Weight for age* is the most common and simple criteria employed in practice. *Weight for height* is useful when actual age is in doubt. *Height for age* is of no use for detecting early PEM. Its value lies in detecting chronic malnutrition and stunting. If age of he child is unknown, the age-independent indices of nutritional status are recommended.

Keywords: Anthropometry, Body mass index, Ecological factors, Height for age, Mid upper arm circumference, QUAC stick, Shaker's tape, Skinfold thickness, Stunting, Vital statistics, Weight for age, Weight for height.

INTRODUCTION

Though frank cases of kwashiorkor and marasmus cause little difficulty in their identification, assessment of nutritional status may be rather difficult, especially in borderline nutritional disturbances such as mild moderate malnutrition.[1-4] Furthermore, assessment of nutritional status concerns:

- Individual levels as in hospital/health facility
- Large groups and segments of child population, e.g. times of natural calamities/disasters (earthquake, floods and starvation outbreaks).[1,2]

The overall criteria employed for assessment of nutritional status are listed in Box 1.

JAYPEE BROTHERS

Box 1: Major criteria for assessment of nutritional status in children.

- Dietary history
- Clinical signs
- Anthropometry
- Investigations
- Associated disorders
- Vital statistics
- Ecological factors

DIETARY HISTORY

The assessment must begin with the dietary history. Details about intake of cereals, vegetables, pulses, fruits, eggs and meat, etc. and thereby average daily consumption of proteins and calories should be obtained. A rough idea about the adequacy of vitamins and minerals in the diet should also be formed.

CLINICAL SIGNS

Deficiency signs such as hair changes, anemia, varying grades of edema (Box 2), xerosis, cheilosis, angular stomatitis, rachitic rosary, bleeding spongy gums and dental caries, etc. should be actively looked for.

The observations on the deficiency signs should, however be interpreted very cautiously. As for instance, phrynoderma (toad skin), though traditionally thought to be due to vitamin A deficiency, may also be a feature of scurvy and deficiency of linoleic acid.

ANTHROPOMETRY

Anthropometry is a very valuable index for evaluation of nutritional status and have stood the test of time in various studies.[4-7]

Age-dependent Indices

- ***Weight for age*** is by far the simplest, the most widely used and the most reliable index, provided that it is recorded correctly and is related to the correct age of the individual. Also, what is more important is the serial record of child's weight periodically on a growth chart.
- ***Weight for height*** is useful when actual age is in doubt.
- ***Height for age*** is of no use for detecting early protein–energy malnutrition (PEM). Its value lies in detecting chronic malnutrition and stunting.

Age-independent Indices

Since, it is often difficult to find true age of the child in the underprivileged and ignorant sections of society, the certain truly or relatively age-independent indices of nutritional status are recommended (Box 3).

JAYPEE BROTHERS

Box 2: Grading of edema according to severity.

- ***Grade 1 (Mild):*** Both feet and ankles
- ***Grade 2 (Moderate):*** Both feet and ankles + legs, forearms and hands
- ***Grade 3 (Severe):*** Generalized including face

Box 3: Age-independent indices for assessment of nutritional status.

- Weight for height
- Mid-upper arm circumference
- Mid-upper arm muscle circumference
- Triceps skinfold thickness
- Chest/head circumference ratio
- Quaker upper arm circumference (QUAC) stick method
- Mid-upper arm/height ratio
- Shakir's tape
- Bangle method
- Dugdale index
- Rao's weight/height ratio
- Kanawati index
- Body mass index
- Poneral index
- Quetlet index

- ***Weight for height***, which is only partially age-independent, is calculated as follows:

$$\text{Percentage weight for height} = \frac{\text{Actual weight} \times 100}{\text{Expected weight for actual height}}$$

- ***Nabarrow's thinners chart***, based on weight for height, is recommended by ***save the children fund***. The child is made to stand against the chart which bears the expected weight for height. The child's head touches the upper red zone in the presence of severe PEM.
- ***Mid-upper arm circumference (MUAC)*** is measured midway between the point of the shoulder (tip of acromion process) and olecranon process of ulna. For all practical purposes, the maximum circumference of the upper arm measured when the left arm is hanging by the side of the body would do. Between 1 and 5 years, it remains constant between 16.25 and 16.75 cm. This is because of replacements of the baby fat with muscle tissue. Any child in this age group with a circumference less than 11.5 cm of the reference international standard is to be considered suffering from severe malnutrition, between 11.5 cm and 12.5 cm from moderate malnutrition, and between 12.5 and 13.5 cm from mild malnutrition.
- ***Mid-upper arm muscle circumference (MUAMC)*** is calculated by the following formula:

$$\text{MUAMC} = \text{MAC} - \pi \times \text{triceps skin fold thickness}$$

JAYPEE BROTHERS

- ***Triceps skin fold thickness*** is measured by a standard caliper (Lange, Herpenden). Tanner chart gives the normal values at different ages. On an average it exceeds 10 mm in 1–6 years age group. A measurement between 6 and 10 mm points to mild and moderate malnutrition and under 6 mm to severe malnutrition.
- ***Chest/head circumference ratio less than*** one after first year of life indicates malnutrition.
- ***Mid-upper arm/height ratio*** of less than 0.29 indicates gross malnutrition, the normal being 0.32–0.33.
- ***Quaker upper arm circumference (QUAC) stick method*** is a simple, easy, inexpensive and yet reliable method of detecting early malnutrition of acute onset in a large number of children in a brief span of time in the community settings, especially during natural calamities such as floods and earthquakes. The instrument is a stick graduated with figures for MUAC in relation to height (Box 4 and Fig. 1).
- ***Shakir tape method*** is a simple and age-independent tool for assessing malnutrition. This special tape has colored zones—red, yellow and green, corresponding to less than 12.5 cm (wasted), 12.5–13.5 cm (borderline) and over 13.5 cm (normal) MUAC. Now, new tapes showing less than 11.5 cm as severe malnutrition are replacing the old ones in keeping with the World Health Organization (WHO) recommendations.
- ***Bangle method***, another method not needing age and useful in preschool children, consists of slipping a bangle with a diameter of 4 cm up the forearm. An attempt is made to move it over to the upper arm. In case it can slip over the elbow, malnutrition is present. The method, though simple and easy, is not quite reliable.
- ***Dugdale index*** too is based on relationship between weight and height. It is expressed as:

$$\text{Dugdale index} = \frac{\text{Weight (kg)} \times 1.6}{\text{Height (cm)}}$$

Normal value varies between 0.88 and 0.97. An index of less than 0.79 suggests malnutrition.

Box 4: Quaker upper arm circumference (QUAC) stick method.

- ***QUAC stick*** is an abbreviation for Quacker upper arm circumference measuring stick. The instrument consists of a stick graduated with figures for mid-upper arm circumference in relation to height. For this test, maximum left-upper arm circumference (the arm hanging by the side of the body) is recorded. Then, the child is made to stand in front of the QUAC stick. From the graduations in the stick, his nutritional status in terms of 50, 60, 70 or 80% of the standard can be easily read (Fig. 1).
- ***Modified QUAC stick*** utilizes a rod or stick that is colored green (normal nutrition), yellow (borderline nutrition) and red (severe malnutrition).

JAYPEE BROTHERS

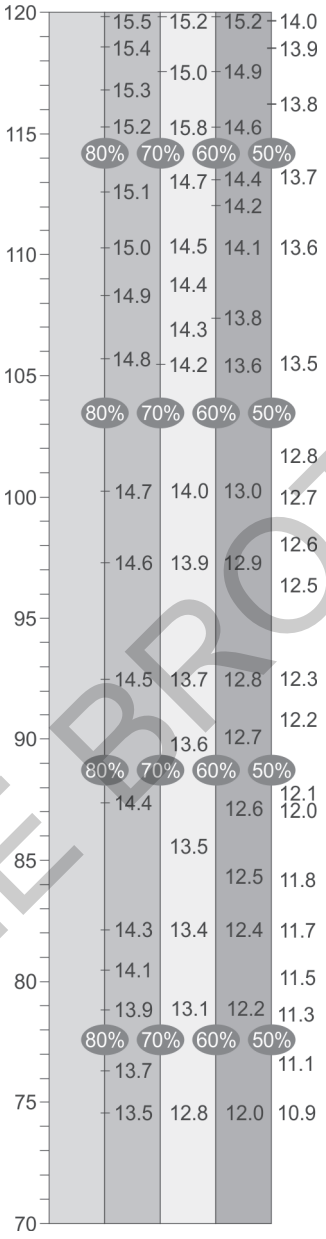

Fig. 1: Quaker upper arm circumference (QUAC) stick method: Quaker upper arm circumference.

- ***Rao's weight/height ratio*** is expressed as:

$$\text{Rap's ratio} = \frac{\text{Weight (g)}}{\text{Height (cm)}^2} \times 100$$

JAYPEE BROTHERS

Normal value is above 0.0015. A value of 0.0013–0.0015 indicates moderate malnutrition and less than 0.0013 indicates severe malnutrition.

- ***Kanawati index***, based on MUAC and head circumference ratio, varies between 0.32–0.33. A ratio of less than 0.25 points to severe malnutrition.
- ***Body mass index (BMI):***

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2} = \text{kg/m}^2$$

  - ***Normal:*** 18.5–22
  - ***Overweight:*** 22–25
  - ***Obesity:*** 25–30
  - ***Morbid obesity:*** More than 30
  - ***Borderline malnutrition:*** 15–18.5
  - ***Moderate malnutrition:*** 13–15
  - ***Severe malnutrition:*** Less than 13.
- ***Ponderal index*** is expressed as:

$$\text{Ponderal index} = \frac{\text{Weight (g)}}{\text{Length/height (cm)}^3}$$

An index less than 2 points to asymmetrical intrauterine growth retardation (IUGR), more than 2 symmetrical IUGR, 2–2.5 borderline malnutrition, and less than 2 severe malnutrition, and more than 2.5 appropriate for gestational age (AGA).

- ***Quetlet's index*** is expressed as:

$$\text{Quetlet's index} = \frac{\text{Weight (g)}}{\text{Length/height (cm)}}$$

Normal value varies between 0.14 and 0.16. In gross malnutrition, it is less than 0.14. It is quite reliable. It is similar to BMI, except that here we take height in centimeters rather than meters.

INVESTIGATIONS

- ***Laboratory investigations*** include complete blood picture especially, hemoglobin, erythrocyte sedimentation rate (ESR), serum proteins and blood levels of nutrients like vitamins, iron, etc.
- ***Tuberculin (Mantoux) test*** to exclude tuberculosis.
- ***Chest X-ray (CXR)*** for superadded lower respiratory infection (say pneumonia) and tuberculosis, etc.
- ***Special biochemical tests*** may detect subclinical malnutrition that could not be revealed by anthropometry.

JAYPEE BROTHERS

- ***Amino acid level*** in blood and urine may be helpful in borderline cases. Hydroxyproline is the most commonly used among the amino acids. Hydroxyproline levels are an indicator of collagen content. Conditions that increase collagen turnover can elevate serum and urine hydroxyproline levels. Urine and serum hydroxyproline levels can be used as a marker for bone resorption.
- ***Hydroxyproline assay kit*** is suitable for hydroxyproline detection in cell and tissue culture supernatants, urine, plasma, serum, and other biological samples. Salivary protein, salivary ferritin and free α-amino nitrogen in leukocyte are reduced in malnutrition.
- ***Skeletal radiographs*** may reveal some retardation of bone age, osteoporosis or classical signs of nutritional rickets or scurvy. Some workers have described transverse lines of arrested growth at the growing ends of long bones months prior to onset of frank PEM.

ASSESSMENT FOR ASSOCIATED DISORDERS

While assessing the nutritional status, one must ascertain for evidence of intestinal parasitic infestations, malabsorption and tuberculosis, etc.

VITAL HEALTH STATISTICS

For evaluation of the nutritional status of a community, the above measures should be supported by vital statistics such as under five mortality, infant mortality, neonatal mortality, perinatal mortality, stillbirth rate and life-expectancy as also the ecological background.

ECOLOGIC FACTORS

Malnutrition is the result of a multitude of ecologic factors. Understandably, it is important to obtain ecologic information on factors such as:

- Food consumption by the community.
- Socioeconomic factors such as knowledge, attitudes, practices (KAPs), beliefs about feeding, education and income.
- Health and education services, e.g. feeding programs, immunization facilities, etc.
- Conditioning influences, e.g. infections that are known causes of precipitating malnutrition.

CONCLUSION

Assessment of nutritional status, an integral part of pediatric practice, is important in identifying cases of borderline nutritional disturbances and severe malnutrition. Besides individual levels as in a health facility, it may be needed in large groups of child population in such emergencies as

JAYPEE BROTHERS

earthquake, floods and starvation outbreaks. Dietary history, clinical signs, anthropometry, investigations, associated disorders and vital statistics are the chief components. *Weight for age* is the most common and simple criteria employed in practice. *Weight for height* is useful when actual age is in doubt. *Height for age* is of no use for detecting early PEM. Its value lies in detecting chronic malnutrition and stunting. Age-independent indices of nutritional status are recommended when child's age is not clear.

KEY LEARNING POINTS

- In identifying cases of borderline nutritional disturbances such as mild-moderate malnutrition, assessment of nutritional status is unique.
- It is required in individual cases as well as large groups and segments of child population at times of natural calamities/disasters.
- Its major components include dietary history, clinical signs, anthropometry, investigations, associated disorders and vital statistics.
- *Weight for age* is the most common and simple criteria employed in practice. *Weight for height* is useful when actual age is in doubt.
- *Height for age* is useful in detecting chronic malnutrition and stunting.
- If age of he child is unknown, the age-independent indices of nutritional status are recommended.
- Age-independent indices are helpful when child's age is not known.

REFERENCES

1. Gupte S, Gomez EM, UK Singh. Normal growth. In: Gupte S (Ed): *The Short Textbook of Pediatrics*, 18th edn. New Delhi: Jaypee 2018:38-65.
2. Gupte S, Gomez EM. Malnutrition. In: Gupte S (Ed): *The Short Textbook of Pediatrics*, 18th edn. New Delhi: Jaypee 2018:197-225.
3. Elizabeth KE. *Nutrition and Child Development,* 5th edn. Hyderabad: Paras 2014.
4. Mehta MN, Mehta NJ. *Nutrition and Diet for Children Simplified*. New Delhi: Jaypee 2014.
5. Ramachandran P, Gopalan SH. Assessment of nutritional status in Indian preschool children using WHO 2006 Growth Standards. *Indian J Med Res* 2011;134:47-53.
6. Tiwari S. Nutritional status of preschool children. *South Asian J. Multidisciplinary Studies* 2015;1(3). Availble at: http:// www.gjms.co.in/index.php/SAJMS/article/view/930. Accessed on 12 January 2018.
7. Sharda K, Babel G. Assessment of nutritional status of pre-school children (2- 5 years) in Girwah tehsil of Udaipur city. *Asian J Home Sci* 2017;12:124-126.

JAYPEE BROTHERS

or detailed information on pediatrics books, visit our website www.jaypeebrothers.com, for detailed information on pediatrics books, visit our website

Recent Advances in PEDIATRICS

(Special Volume 28: *Child Nutrition in Practice*)

The RAP Special Volume 28 presents 35 well-written chapters—all peer-reviewed, evidence-based and state-of-the-art—contributed by 45 experts drawn from India and abroad. Each and every chapter reviews the depth and breadth of knowledge in some aspect of child nutrition with special reference to the Indian subcontinent. The contents are stimulating, mature and, at places, provocative for encouraging further discussion, research and innovation. The book with a multidisciplinary approach in a holistic and easy-to-grasp manner provides an academic feast that contributes to the RAP series goal of translating pediatric advances from benchside to bedside, nay to the community at large, the eventual beneficiary.

Outstanding Features

- Tailor-made to the requirements of forward-looking postgraduates, residents, faculty and practitioners of pediatrics
- Reader-friendly with simple, straight-forward and easy-to-grasp descriptions
- Most up-to-date, peer-reviewed, evidence-based and state-of-the-art topical issues, concerns and controversies in child nutrition
- Reference-supported contents of special applicability to the Indian subcontinent
- Profusely illustrated employing a large number of clinical photographs, illustrations, tables, boxes and flowcharts/algorithms to boost the impact of the text.

Contents

Nutritional Needs in Children; Antioxidants; Assessment of Nutritional Status; Vitamins: Essentials and Therapeutics; Vitamin A Deficiency; Vitamin D Deficiency; Vitamin D Deficiency Rickets and Other Rickets; Micronutrients and Macrominerals; Iron Deficiency Anemia; Neuropsychiatric Dysfunctions in Iron Deficiency Anemia; Zinc in Child Nutrition; Antenatal Nutrition: Effect on Fetal and Neonatal Outcome; Infant and Young Child Feeding; Adolescent Nutrition; Protein-Energy Malnutrition: Overview; Severe Acute Malnutrition; Refeeding Syndrome; Immunology of Malnutrition; Malnutrition and the Nervous System; Prevention of Childhood Malnutrition; Feeding of Low Birth Weight Babies; Pediatric Obesity; Handling Nutritional Problems in Office Practice; Nutrition in Diabetes; Nutrition in Pediatric Irritable Bowel Syndrome; Nutritional Management of Diarrhea; Nutrition in Cystic Fibrosis; Nutrition in Celiac Disease; Diet in Inflammatory Bowel Disease; Diet in Chronic Liver Disease; Nutrition in Acute Kidney Injury; Food Intolerance and Allergy; Drug-Nutrient Interaction; Sports Nutrition; Nutritional Supplements

Suraj Gupte hails from the alumni of the Postgraduate Institute of Medical Education and Research, Chandigarh, India. He occupies pride of place for outstanding contribution as pediatric educationist, author, researcher and innovator globally. He has authored/edited several books, including the international series, *Recent Advances in Pediatrics* (53 volumes released so far) *The Short Textbook of Pediatrics* (now in13th edition), *Differential Diagnosis in Pediatrics, Pediatric Gastroenterology, Hepatology and Nutrition* (an Indo-American project), *Pediatric Infectious Diseases, Case-based Reviews in Pediatric Emergencies,* etc. He has published/presented over 270 papers at national and international periodicals/conferences/workshops/symposia. He, besides holding important positions in the Indian Academy of Pediatrics (IAP) and its subspecialty chapters, has represented India and IAP at several international conferences, workshops, symposia, seminars, etc. worldwide as plenary speaker, guest speaker, chairperson, panelist, etc. He was Advisor, 8th International Congress of Tropical Pediatrics and 8th Asian Congress of Pediatrics. A recipient of several national and international awards and Visiting Fellowships/ Professorships. He is an examiner for many universities, including IGNOU, AIIMS, PGIMER, SKIMS, and a faculty selection expert for AIIMS, UPSC, and State PSCs. He figures in most of the national and international Who's Who volumes, including the Morqui's Who's Who—a pre-eminent database of outstanding global personalities.

Available at all medical bookstores
or buy online at www.jaypeebrothers.com



JAYPEE BROTHERS
Medical Publishers (P) Ltd.
www.jaypeebrothers.com

Join us on facebook.com/JaypeeMedicalPublishers

Shelving Recommendation
PEDIATRICS

ISBN 978-93-5270-476-7

9 789352 704767