Childhood Nutritional Disorders

objectives:

- Describe the nutritional requirements for growth and maintenance of health for infants,children and adolescents.
- Compare breast and formula feeding.
- Emphasis on Breastfeeding benefits & Mother-Baby bonding.
- Explain and demonstrate the ability to use growth charts in the longitudinal evaluation of height, weight and head circumference
- Recognize normal variants of growth, such as familial short stature and constitutional delay.

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Special thanks to team 437 & Faisal alsaif

Notes

Important

Book

Nutrition

Importance of nutrition in infancy and early childhood.

- ❖ Adequate nutrition is essential for:
  - ○ Normal health
  - ○ Normal growth and development to full potential.

- ❖ Inadequate nutrition cause:
  - ○ Failure to grow normally (FTT).
  - ○ Poor health with increased morbidity and mortality. It increase the incidence of diseases mainly infections.
  - ○ Overweight and obesity with all related complications; because of excess nutrition.

Breastfeeding:

Recommendations (WHO):

1. Exclusive (only) breastfeeding from birth to 6 months of age. It is optimal for infants to be on breastfeeding not even use water until reach 6m.
2. Complementary feeding starting from the age of 6 months. Because after 6m breastfeeding isn't enough for growth.
3. Continue breastfeeding up to 2 years of age or beyond.

Advantages of breast milk:

1. Contains all nutrients needed by the infant during the first 6 months of life. (including macronutrients fat, carbohydrates, proteins, vitamins, minerals and water).
2. Contains bioactive immunologic factors to support the immature immune system. Not available in formula milk.
3. Contains factors that enhance digestion, absorption of nutrients.
4. Readily available and free.
5. reduced risk of developing gastroenteritis and otitis media, and lower respiratory tract infections
6. protective effect against necrotizing enterocolitis in extremely preterm infants
7. overall increase in IQ (intelligence quotient) score by approximately 3 points
8. reduction in risk of SIDS (sudden infant death syndrome)
9. lower incidence of obesity, diabetes mellitus and hypertension in later life.

Breastfeeding:

Composition of breast milk: In comparison to formula milk. **you need to know it**.

1. **Fat:**
   - Quantity: 3.5 g of fat per 100 ml of milk (about 50% of the energy content).
   - Quality: contains long chain polyunsaturated fatty acids (docosahexaenoic acid (DHA), and arachidonic acid (ARA), *not available in animal milks;* important for the neurological development (This is one of the major advantages).

2. **Carbohydrates**:
   - Quantity: 7 g/100 ml (higher than others)
   - Quality: contains mainly lactose + oligosaccharides.

3. **Proteins:** Compared to formula, the protein is lower than formula and it's easy digestible by the immature digestive system of the infant.
   - Quantity: 0.9 g/100 ml (lower than animal milks), this is advantage for baby b/c of less protein load to the kidneys.
   - Quality: Less casein (large curds) and more whey proteins (smaller, softer curds). More lactalbumin and no lactoglobulins (cow's milk intolerance); Lactoglobulins have been implicated as a cause of cow's milk protein allergy or intolerance.

4. **Vitamins**:
   - adequate except vitamin D, We need to provide Vit D supplements to babies when they are discharged from nurseries.

5. **Minerals**:
   - Iron and zinc smaller quantity but good bioavailability sufficient for the first 6 m; It's sufficient for the first 6 months, and after that the babies will start take complementary as we said before.

6. **Immunologic factors:**
   - Immunoglobulins (mainly secretory IgA); Secretory IgA have an essential role in protecting against infection , these can't be found in other formulas milk
   - Whey proteins (lysosomes, lactoferrins).
   - Epidermal Growth Factors.

Breastfeeding:

Potential complications and Contraindications of breastfeeding:

1. Unknown volume of milk intake: monitor weight gain.
2. Transmission of infections (HIV, untreated TB, CMV).
3. Transmission of drugs: (antimetabolites and others). Always check drug formulary.
4. Infants metabolic diseases: Galactosemia, lactase deficiencies, glucose-galactose
malabsorption, and Phenylketonuria.

Milk Formulas:

General introduction:

- These are non human breast milk preparations. Could be from gouts, cow's or camels these are the three main sources but mostly cow.
- They are indicated only when the mother cannot breastfeed. It's not the standard feeding.
- Quantitative composition approximates human breast milk.
- However, fails to provide other qualities of human milk such as immunological factors.

Indications for common milk formulas

Pediatric On Squares

@OnSquares

Type of formulas	Example	Indication
Term formula	Similac, S26, NAN	Term > 2000 gm
Preterm formula	Special care, Neosure	Preterm < 2000 gm
Soy based formula	Isomil, NurSoy	Cow milk protein allergy Galactocemia , Lactase deficiency
High Calories formula	< 1y.o Infintrini , > 1y.o Pediasure	FTT
Lactose Free formula	Lactofree	Galactocemia , Lactase deficiency
Fructose free formula	Similac	Fructosemia
Glucose free formula	Galactomin 19	Glucose – Galactose malabsorption
Partial hydrolyzed formula	Hypoallregic (HA)	Cow milk protein allergy, Infantile colic
Extensively hydrolyzed formula	Allernova	Cow milk protein allergy, Infantile colic, Multiple food allergy
Elemental formula	Neocate	Cow milk protein allergy, Infantile colic Short bowel syndrome , Intractable diarrhea
Fat modified formula	Monogen, Portagen	Steatorrhea, Lymphangiectasia, Chylothorax

Milk Formulas:

Types of infants formulas:	Formula types usually range between three types.
1- Regular cows-milk based formulas: Cow's milk has been modified to approximate the composition of breast milk.	- First type of cow milk and is used by most mothers. - Most common (normal children). - Regular formulas for infants till 12 months. whole milk afterwards. Fresh cow milk is contraindicated in the first 12 months due to allergy.
2- Follow on formulas (cow-milk based): Has two types and both are not indicated for children that eat well. Only for children who don't take other sources of nutrition other than milk after 6 months.	- Second type of cow milk. 1. Follow on formulas designed for 6 to 12 months old contain more proteins, Ca, Ph, Fe, and vitamin C may be used. 2. Follow on formulas designed for 1 to 3 years are not indicated in children eating balanced diet.
3- Soy-based formula:	- Not for normal children; used for diseases caused by CMPA (cow's milk products allergy), lactose intolerance.
4- Other animal-milk formula:	- Such as goats and camels (CMPA). Sometimes it is helpful in some problems of cow milk. Their protein are different from cow's protein.
5- Special formulas:	- Hydrolyzed proteins (oligopeptides and amino-acids): CMPA, intestinal injury. Hydrolyzed proteins: there is no longer lactoglobulin, they are hydrolyzed to smaller competent. 21:30 Hydrolysis reduces amino acid and produces oligopeptide. Indicate in allergy that not tolerate whole milk or normal formula b/c of protein like in intestinal injury can't absorb big protein. - Specialized formulation for specific diseases (phenylketonuria).

Fluid and caloric requirements **(milk formula)**: Imp

- The first 6 months:
  - Fluid (water) requirement: 150-130 ml/Kg/24h. Make sure that in your history taking you ask the mother about day and night (24h) intake of milk not only during the day.
  - Caloric requirement: 110-120 Kcal/kg/24h.
  - Regular milk formulas provide 20 Kcal/ounce (0.67 Kcal/ml). Use for evaluation; if baby takes adequate calories, if not then the child will be affected

Milk Formulas:

Volume and number of formula feedings: Total 150-140 ml/kg/24H

Age	Volume of feed (ml)	Number of feed/24 hours
0 - 2 weeks	50 - 70	7 - 8
2 - 6 weeks	70 - 110	6 - 7
2 months	110 - 180	5 - 6
3 months	180 - 220	5
6 months	220 - 240	4

just remember if the child is younger the number of feed/hour will increases.

Guidelines for bottle milk formula feeding preparation: Doctor skipped it

These are found on the can, the mother need to read It before preparing the milk.

1. Clean the bottle and teat in hot soapy water as soon as after a feed using a bottle brush.
2. Rinse before sterilizing.
3. Sterilize using cold water or steam apparatus according to manufacturer instructions.
4. Boil water and allow to cool for about half an hour.
5. Put the water in the bottle before the milk powder.
6. Fill the scoop with milk powder then level it. Do not compact the milk powder.
7. Follow the recommended ratio (1 scoop of powder to 30ml (1 oz) water.
8. Close the teat and shake gently until the powder is dissolved.
9. Make fresh feed each time. Refrigeration risks bacterial contamination.
10. The feed should be warm not hot . Test temperature by allowing a few drops to fall on the inside of the wrist.
11. When feeding, the baby should lie comfortably in the crook of the arm, and the bottle be held at an angle so that the teat is always full of milk; this stops excessive ingestion of air during the feed.

Complementary feedings:

Purpose:

- The basic reason to use it is that the breast or formula milk both of them are not sufficient after 6 months.
- Breast or formula milk are insufficient for growth after 6 months of age. Therefore, the purpose of complementary feedings is to provide additional nutritional factors to meet growth requirements beyond the age of 6 months.

Age at introduction: This for normal infants (different for infants with Allergic parents).

1. General rules:

- Continue breastfeeding till 2 years and beyond.
- Start with small amount and increase gradually as tolerated. To test that the baby can tolerate it because they are not used to it.
- Start with one food item at at a time. Do not start with mixtures. Because if there is intolerance or allergy we will not be able to know which is the cause, once the baby can tolerate all types, now you can give them mixtures.

2. At 6 months of age:

Iron- fortified cereals (rice cereal سرلاك), and mashed or ground fruits (apples, banana, etc).

3. Around 8 months: may introduce other items such as corn cereals, boiled pumpkin, carrots and potatoes).

4. Around 10 months: may introduce other food such as rice, pasta, ground animal meat and egg yolk.

5. From 12- 24 months: Balanced family food.

i'm just filling the spaces, don't mind me

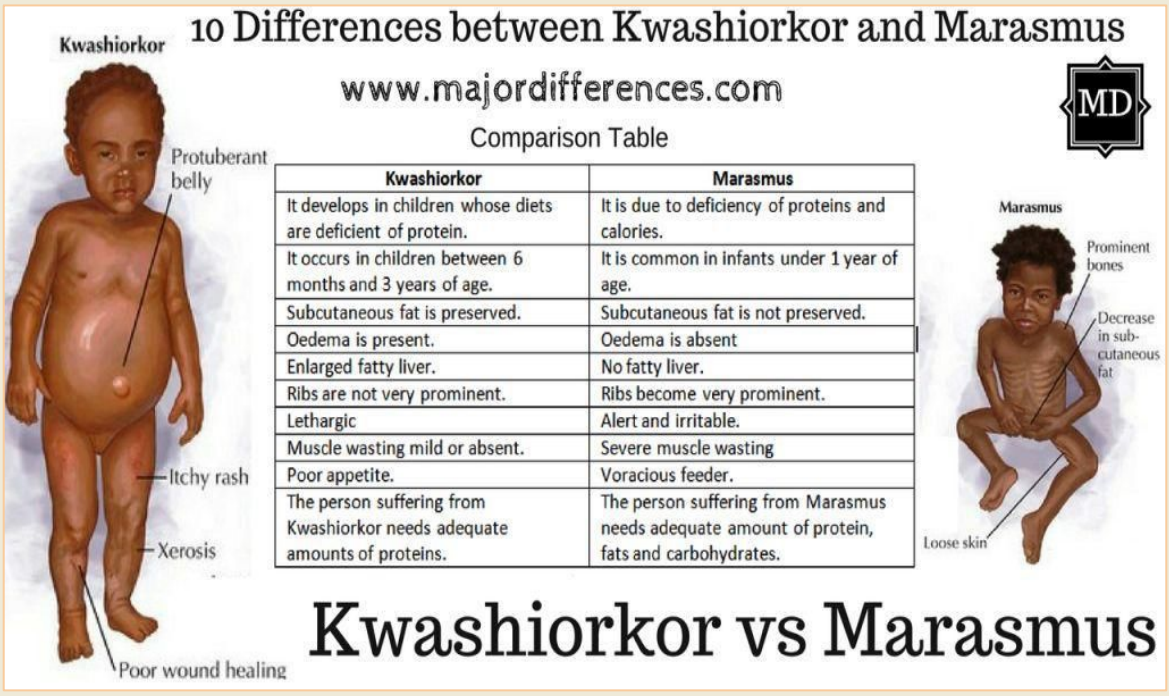
Nutritional disorders:

Nutritional clinical disorders:

1. Global disorders: Failure to thrive, overweight, obesity.
2. Selective: Minerals and vitamins. deficiency in one mineral.

Global disorders

Malnutrition (Failure to thrive): starts from underweight and then continues to short stature.	● Underweight: weight for age < 3 rd percentile. ● Thinness: BMI for age < 3 rd percentiles. If we use the weight, we call them underweight and if we use the BMI we call them thinner. ● Short stature: length/height for age < 3 rd percentile. What is the difference between length/height? Children under 2 years ⟶ length and we measure it in supine position with no gravity affect. While in >2 years old ⟶ height and we measure it while they are standing.
Overnutrition: the prevalence is extremely high and it defines by BMI not by weight.	● Overweight: BMI for age > 85th and < 95th percentile. It is the window of opportunity to help the child before becoming obese. ● Obesity: BMI for age > 95th percentile.
Marasmus and Kwashiorkor:	● Mostly cause by chronic diseases which lead to malnutrition. ● Seen in wars, disaster and poor areas.



Kwashiorkor	Marasmus
It develops in children whose diets are deficient of protein.	It is due to deficiency of proteins and calories.
It occurs in children between 6 months and 3 years of age.	It is common in infants under 1 year of age.
Subcutaneous fat is preserved.	Subcutaneous fat is not preserved.
Oedema is present.	Oedema is absent
Enlarged fatty liver.	No fatty liver.
Ribs are not very prominent.	Ribs become very prominent.
Lethargic	Alert and irritable.
Muscle wasting mild or absent.	Severe muscle wasting
Poor appetite.	Voracious feeder.
The person suffering from Kwashiorkor needs adequate amounts of proteins.	The person suffering from Marasmus needs adequate amount of protein, fats and carbohydrates.

Selective disorders:

Minerals:	● *Iron deficiency* (you can develop iron deficiency before anemia) and iron deficiency anemia are the most common single-nutrient deficiency ⟶ Hypochromic microcytic anemia. ● Others: calcium, phosphorus, zinc, magnesium, selenium are more rare.
Vitamins:	● Vitamin D deficiency is the most common ⟶ Rickets and osteopenia. ● Others: B12, folic acid are less common but you have to remember them .Others are uncommon

Assessment of nutritional status:

History:

- dietary history for quantity and quality of nutrition.
- Your objective: determine whether children are taking adequate calories and nutrients:

Physical examination:

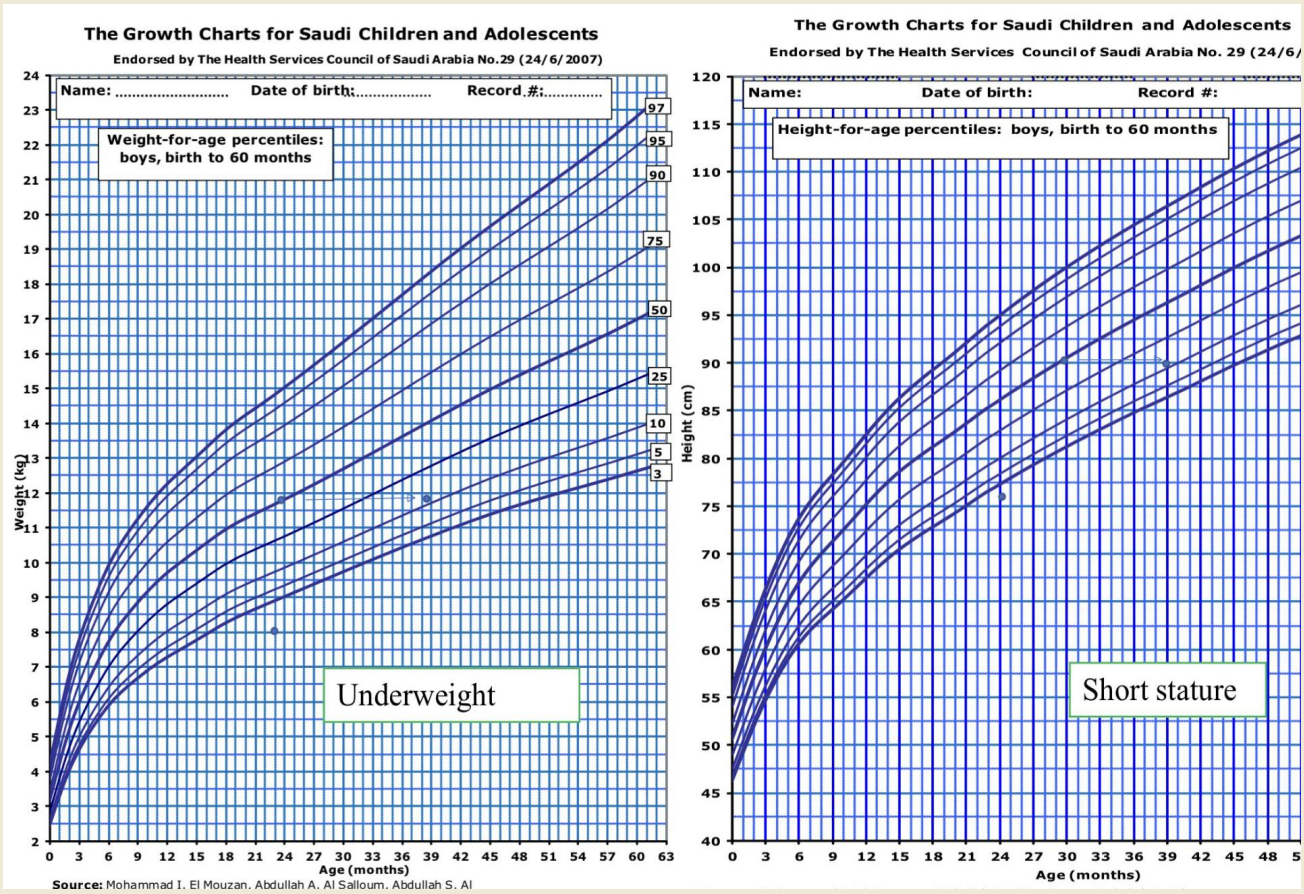
- is the most imp.
- General signs of malnutrition: Pallor (suspect Fe deficiency anemia), signs of vitamin and mineral deficiencies: skin and mucosal lesions (zinc), eye lesions (vit A) are rare and need a long time to develop, or skeletal (softness, frequent fractures) (vit D).

Growth charts:

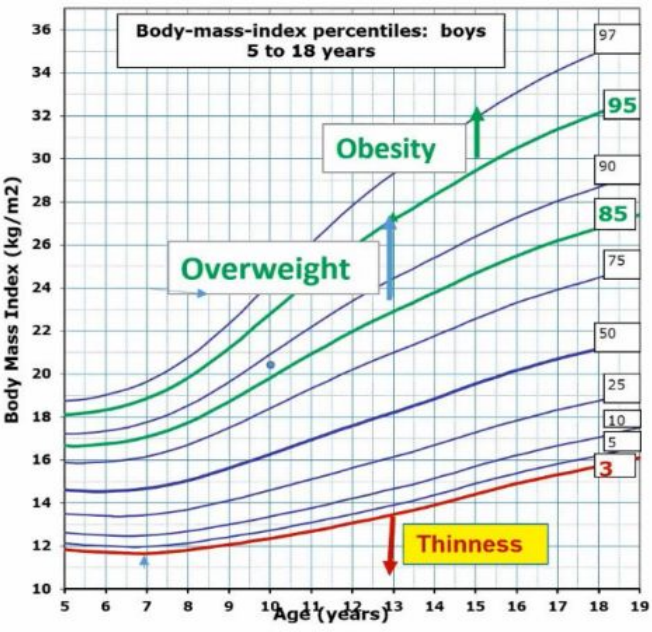
- The weight is affected very early in malnutrition.
- Underweight: weight for age < 3 rd percentile. If child has underweight but the others are ok so this medical expression of calories deficiency.
- Thinness: BMI for age < 3rd percentile.
- Overweight: BMI for age > 85th and < 95th percentile.
- Obesity: BMI for age > 95th percentile.
- Short stature: length/height for age < 3 rd percentile.
- The growth charts is the main source for evaluating the nutritions

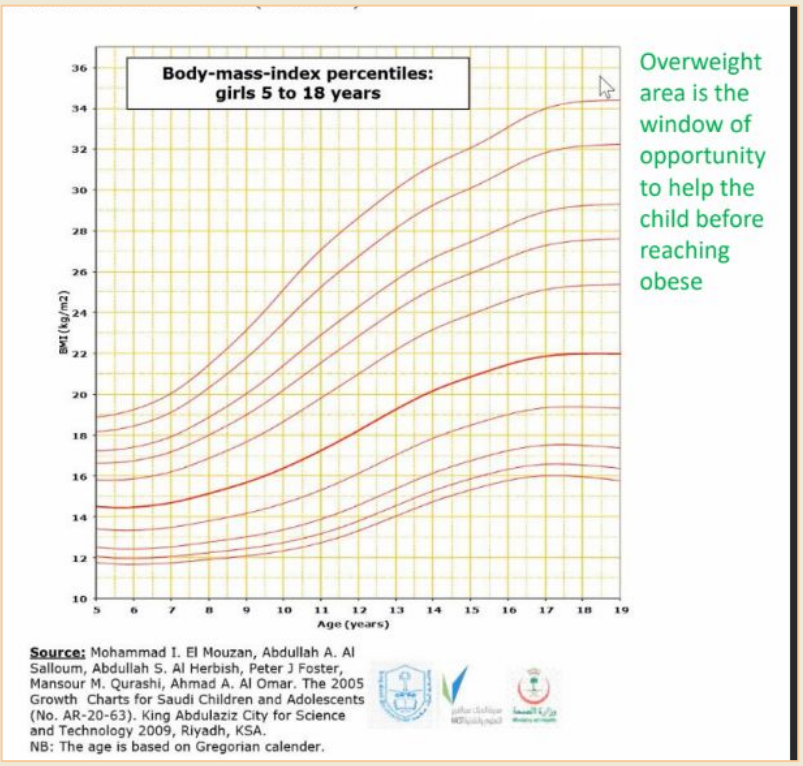
Assessment of nutritional status:

Growth charts:



This child didn't grow(underweight), he was on 50 percentile when his age was 24m then he is on 10th percentile. He crossed two lines → FTT.
10 percentile is normal but he was before in 50 and then in 10 and this is not normal.





Overweight area is the window of opportunity to help the child before reaching obese

Extra

Rickets

Rickets signifies a failure in mineralization of bone tissue and characteristic changes in the growth plates within growing bones. Failure of mature bone to mineralize is osteomalacia.

Clinical manifestations

Children with vitamin D deficiency and/or calcipenia rickets are often miserable.
The costochondral junctions may be palpable (rachitic rosary), wrists (especially in crawling infants) and ankles (especially in walking infants) may be widened, and there may be a horizontal depression on the lower chest corresponding to attachment of the softened ribs with the diaphragm (Harrison sulcus; Fig. 13.15). Once the child has started weight-bearing, the legs may become bowed (Fig. 13.16). One of the earliest clinical signs of rickets is softening of the skull vault (craniotabes), elicited by careful application of pressure over the occipital or posterior parietal bones producing a sensation similar to pressing a ping-pong ball. A comprehensive list of clinical features are listed in Box 13.4

Diagnosis:

This is made from:
- **dietary history** (prolonged breastfeeding)
- **blood tests** – biochemical findings depend on the stage of vitamin D deficiency, i.e. degree of decompensation of serum mineral homeostasis. In most cases of established vitamin D deficiency / calcipenia rickets, blood tests reveal a low or normal calcium, low phosphate, high alkaline phosphatase activity, low 25-hydroxyvitamin D, and high parathyroid hormone
- **X-ray of the wrist or knee** – shows cupping and fraying of the metaphyses and a widened growth plate.

Management:

Nutritional rickets is **managed with vitamin D** and **ensuring adequate dietary calcium**. If compliance is an issue, a single high dose (oral or intramuscular) of vitamin **D3 can be given**, followed by the daily maintenance dose. Bone healing starts within 2–4 weeks but may take several years for all bony deformities to resolve. In order to prevent recurrence and maintain optimal bone health, advice on safe sunlight exposure, balanced diet, and correction of predisposing risk factors should be given.

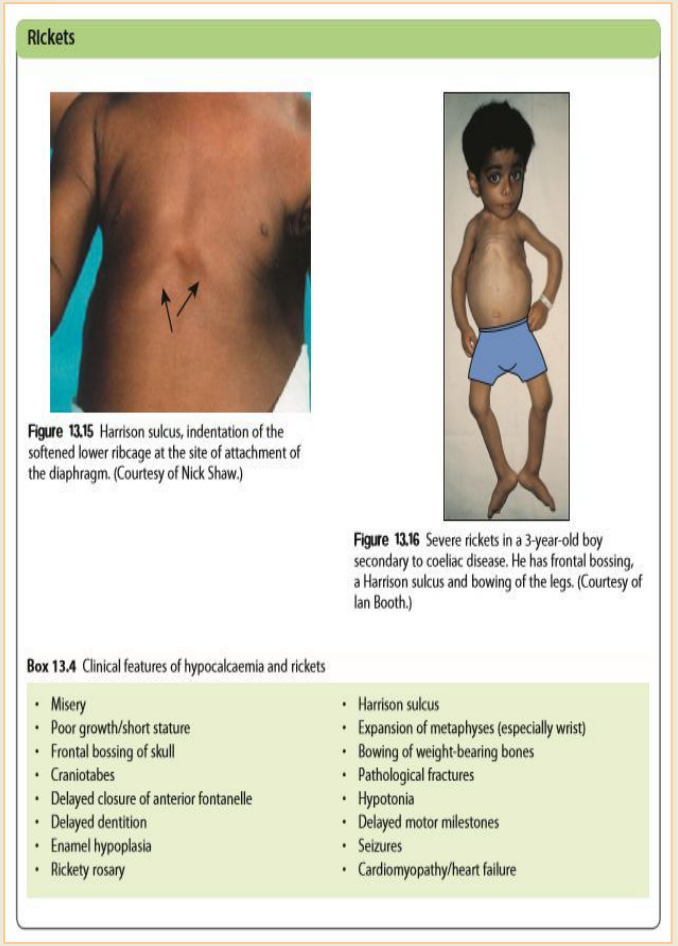


Figure 13.15 Harrison sulcus, indentation of the softened lower ribcage at the site of attachment of the diaphragm. (Courtesy of Nick Shaw.)

Figure 13.16 Severe rickets in a 3-year-old boy secondary to coeliac disease. He has frontal bossing, a Harrison sulcus and bowing of the legs. (Courtesy of Ian Booth.)

Box 13.4 Clinical features of hypocalcaemia and rickets

- Misery
- Poor growth/short stature
- Frontal bossing of skull
- Craniotabes
- Delayed closure of anterior fontanelle
- Delayed dentition
- Enamel hypoplasia
- Rickety rosary
- Harrison sulcus
- Expansion of metaphyses (especially wrist)
- Bowing of weight-bearing bones
- Pathological fractures
- Hypotonia
- Delayed motor milestones
- Seizures
- Cardiomyopathy/heart failure

Extra

Rickets

Box 13.3 Causes of rickets

Nutritional (primary) rickets – risk factors

- Living in northern latitudes
- Dark skin
- Decreased exposure to sunlight
- Diets low in calcium, and vitamin D, e.g. exclusive breastfeeding into late infancy or, rarely, toddlers on unsupervised 'dairy-free' diets
- Extreme prematurity – inadequate phosphate intake in breast milk and parenteral nutrition
- Macrobiotic, strict vegan diets
- Prolonged parenteral nutrition in infancy

Intestinal malabsorption

- Small bowel enteropathy (e.g. coeliac disease)
- Pancreatic insufficiency (e.g. cystic fibrosis)
- Cholestatic liver disease
- High phytic acids in diet (e.g. chapattis)

Defective production of 25-hydroxyvitamin D

- Chronic liver disease

Increased breakdown of 25-hydroxyvitamin D

- Enzyme induction by anticonvulsants (e.g. phenobarbital)

Defective production of 1,25-dihydroxyvitamin D

- Chronic kidney disease
- Fanconi syndrome (renal loss of phosphate)
- Inherited disorders (rare) e.g. vitamin D-dependent rickets type 1

Resistance to effect of 1,25-dihydroxyvitamin D

- Vitamin D-dependent rickets type 2

Hypophosphataemic rickets

- X-linked hypophosphataemic rickets
- Other inherited types of hypophosphataemic rickets
- Hypophosphataemia due to primary or secondary tubulopathy
- Lack of bioavailable dietary phosphate (rare)

Summary:

• Nutritional rickets is an important cause of rickets in the UK. Darker skin colour and prolonged breastfeeding in late infancy without complementary feeding are risk factors.

• Diagnosis – serum calcium is low or normal, phosphorus low, plasma alkaline phosphatase markedly raised, 25-hydroxyvitamin D low and parathyroid hormone raised.

• X-ray features – cupping and fraying of the metaphyses and widened growth plate.

Extra

- Protein and energy requirements: The energy requirements of infants relative to body weight is approximately double that of adults due to rapid growth (makes them vulnerable to nutritional deficiencies). A small reduction in the milk volume or quality can significantly impact infant growth, hydration and nutrition.

Table 13.1 Reference values for energy and protein requirements

Age	Energy (kcal/kg per 24 h)	Protein (g/kg per 24 h)
0–6 months	115	2.2
6–12 months	95	2.0
1–3 years	95	1.8
4–6 years	90	1.5
7–10 years	75	1.2
Adolescence	(male/female)	
11–14 years	65/55	1.0
15–18 years	60/40	0.8

- **Body composition:** newborn infants, preterm and those with IUGR have lower fat and protein stores than other age groups, and the lower the caloric reserves the less likely a person can tolerate starvation:

- **Brain growth:** brain accounts for approximately two-thirds of basal metabolic rate in a baby at term, and for about 50% at 1 year of age. This rapid growth happens in the last trimester of pregnancy and the first 2 years of life so any deprivation of energy at this rapid phase of growth can increase risk of **neurodevelopmental impairment.**

- Following complicated surgery or severe acute illness in an infant, the energy deficit may be so large that they may require an energy intake as high as 150–200 kcal/kg per day. Parenteral nutrition (not simply fluids containing dextrose) must be considered early in these children.

- **Poor feeding can become a 'vicious cycle'** that is hard to break, as it can lead to lethargy, hypoglycemia and ketosis; and a lethargic or hypoglycemic infant lacks the energy to feed.

- During acute illness children can lose weight but this is **transient**.

- Nasal congestion in infant can impair breathing during feeding!

- Which of the following adult diseases can be related to **poor feeding in childhood (particularly first 2 years of life)?** Coronary heart disease, non-insulin dependent diabetes, and hypertension.

Extra

Nutritional deficiencies

Table 13.3 Vitamin deficiencies affecting children

Vitamin	Dietary/environmental sources	When deficiency is encountered	Clinical consequences
Fat-soluble vitamins			
A	Retinol: Liver, fish liver oils, dairy products Carotenoids: in spinach, carrots, mango, papaya	Fat malabsorption conditions e.g. cystic fibrosis Children in low-income countries who do not receive supplements	Increased susceptibility to infection, especially measles Xerophthalmia (dryness of the conjunctiva and cornea) Night blindness
D	90% from ultraviolet B exposure Eggs Fortified foods including margarine, certain yoghurts and breakfast cereals	Children who live further from the Equator, as ultraviolet B levels are low outside summer months Children with darker skin or when exposure to sunlight is limited	Rickets
E	Vegetable oils	Fat malabsorption conditions Preterm infants	Haemolytic anaemia, retinopathy, progressive neuropathy
K	Green leafy vegetables – the richest sources Other vegetables, fruits, dairy produce, vegetable oils, meats and cereals Synthesized by intestinal bacteria Given intramuscularly (occasionally orally) at birth (see Ch. 10, Perinatal medicine)	Newborn infants are vitamin K deficient Seen in children with fat malabsorption	Coagulation abnormalities - lead to bruising/bleeding from vitamin K deficient bleeding (haemorrhagic disease of the newborn)
Water-soluble vitamins			
Thiamine (B_1)	Yeast, brown rice, wheatgerm, nuts, pork, pulses	Deficiency is beri-beri Children from South East Asia with a 'polished rice diet' or those with malnutrition	Cardiomyopathy in infants, also hoarseness, aphonia, encephalopathy, apathy, drowsiness, seizures
Riboflavin (B_2)	Yeast, organ meats (such as liver and kidney), lean meat, milk and milk products, eggs, vegetables, fortified breakfast cereals	Malnutrition	Angular stomatitis, fissuring of lips
Niacin (B_3)	Liver, meat, oily fish, soya, nuts, seeds, pulses, eggs, dairy products, grains	Deficiency is pellagra Malnutrition Regions where maize a major part of the diet	Thick, scaly skin, swollen mouth, fatigue, vomiting and diarrhoea
Pantothenic acid (B_5)	Found in animal and plant products	Very rare as found in almost all foods Can occur in starvation	Fatigue, apathy, paraesthesia, muscle cramps, hypoglycaemia
Pyridoxine (B_6)	Found in a wide variety of foods Also synthesized by intestinal bacteria	Isolated deficiency is rare. Can be found together with B_{12} and folic acid deficiency	Microcytic anaemia, glossitis, cheilosis, confusion, increased susceptibility to infection
B_{12}	All animal products, yeast extract	Children on a vegan diet, not receiving supplementation Resection of small intestine where B_{12} is absorbed Pernicious anaemia	Megaloblastic anaemia, weakness and fatigue, paraesthesia

Summary

Malnutrition

- Worldwide – contributes to about one-third of all childhood deaths.
- Can be identified by measuring weight for height, mid-upper-arm circumference (MUAC), and height for age.
- Marasmus – wasted, wizened appearance, apathetic.
- Kwashiorkor – generalized oedema, sparse and depigmented hair, skin rash, angular stomatitis, distended abdomen, enlarged liver, and diarrhoea.

- There is an increased risk of developing diarrhoea, pneumonia and sepsis.
- Malnutrition worsens the outcome of illness, e.g. respiratory muscle weakness may delay a child being weaned from mechanical ventilation.
- Proper feeding can reverse some behavioral abnormalities caused by malnutrition but a prolonged malnutrition can cause permanent cognitive impairment.

Extra

- Management of severe malnutrition:

- if the child has appetite and alert >> community with ready-to-use therapeutic food (RUTF).
- Children with no appetite, has edema, medical complication or are less than 6 months >> hospitalization and follow the acute management (10 steps, stabilization):

Acute management comprises the WHO's 10 essential steps. Stabilization is to:

- treat or prevent hypoglycaemia urgently
- treat or prevent hypothermia
- treat or prevent dehydration – but avoid fluid overload as it may lead to heart failure. The standard WHO oral rehydration solution contains too much sodium (Na^+ 75 mmol/l) and too little potassium for severe acute malnutrition; they should be given a special rehydration solution (ReSoMal). Rehydration should be provided orally, by nasogastric tube if necessary. Intravenous fluids are given only for shock
- correct electrolyte imbalance – especially potassium and magnesium. Although plasma sodium may be low, they have excess body sodium
- treat infection – give broad-spectrum antibiotics; fever and other signs may be absent. Treat oral *Candida* if present
- correct micronutrient deficiency – vitamin A and other vitamins; contained in specialized feeds. Introduction of iron is delayed to 2nd week
- initiate feeding – small volumes, frequently, including through the night. Too rapid feeding may result in diarrhoea. Specialized feeds are widely available: initially Formula 75 (75 kcal/100 ml) which is low in protein and sodium and high in carbohydrate is used, subsequently Formula 100 (100 kcal/100 ml) or ready-to-use therapeutic food.

The remaining three steps are provided during rehabilitation:

- achieve catch-up growth
- provide sensory stimulation and emotional support
- provide for follow-up after recovery.

Extra

Weight faltering

- **definition:** a suboptimal weight gain in infants/children

- Complications:
◦if prolonged, results in reduced height (or length) = stunting
◦Reduced head growth +\- delayed development

- Determined by growth chart: a sustained drop down two centile spaces —> the lower the more likely it is weight faltering

- When to measure weight in infants? During the first week (to assess feeding), then At 8,12, and 16 weeks, and 1 year

causes:

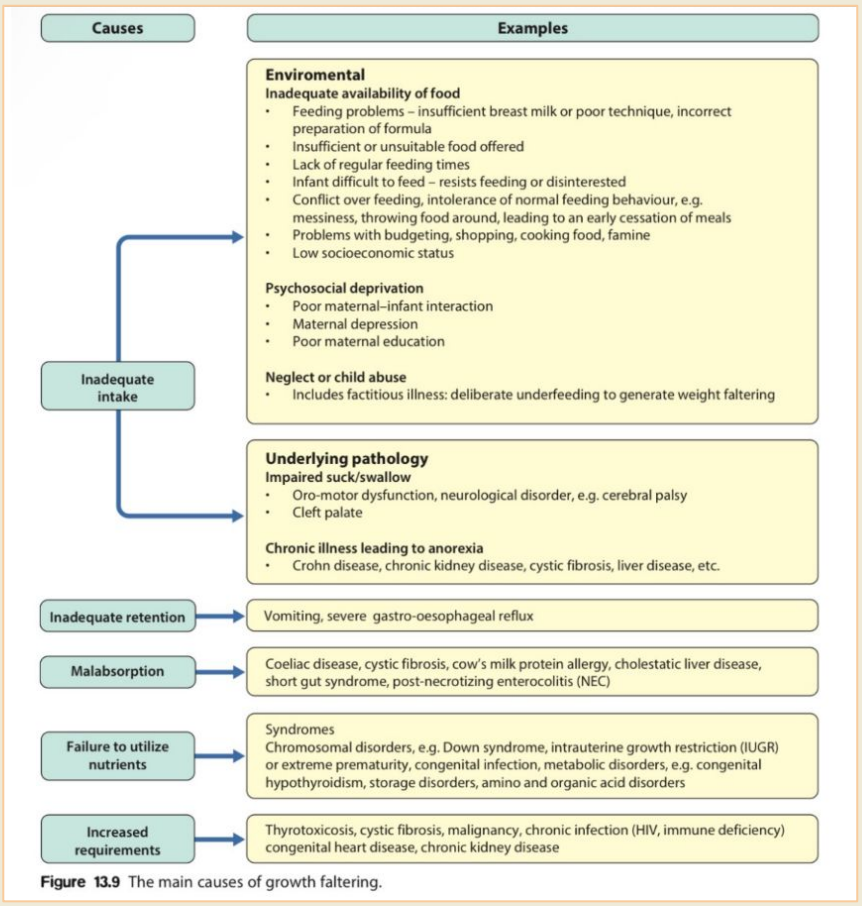


Figure 13.9 The main causes of growth faltering.

investigation:

Investigation	Interpreting result
Full blood count and differential white cell count	Anaemia, neutropenia, lymphopenia (immune deficiency)
Serum creatinine, urea, electrolytes, acid–base status, calcium, phosphate	Renal failure, renal tubular acidosis, metabolic disorders, William syndrome
Liver function tests	Liver disease, malabsorption, metabolic disorders
Thyroid function tests	Hypothyroidism or hyperthyroidism
Acute phase reactant, e.g. CRP (C-reactive protein)	Inflammation
Ferritin	Iron-deficiency anaemia
Immunoglobulins	Immune deficiency
IgA tTG (IgA tissue transglutaminase antibodies)	Coeliac disease
Urine microscopy, culture, and dipsticks	Urinary tract infection, renal disease
Stool microscopy, culture, and elastase	Intestinal infection, parasites, elastase decreased in pancreatic insufficiency
Karyotype in girls	Turner syndrome
Sweat test, chest X-ray	Cystic fibrosis, other respiratory disorders

Management:

- By primary care

◦Meal time observation, food diary
◦Pediatrics dietitian: assess quantity and composition of food
◦Clinical psychologist and social services might be involved

- Long term outcome:

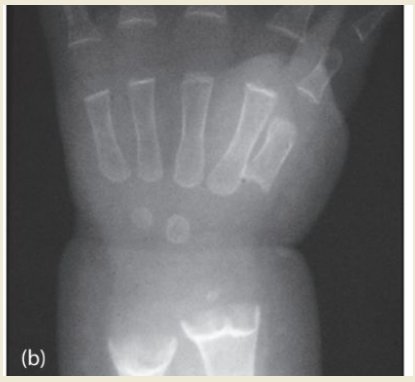
◦Children may remain on a low centile
◦May affect cognition

Questions

1- Sunit, a 13-month-old boy, presents with faltering growth. He is still entirely breastfed. On examination, he is miserable and his wrist is shown in Fig. 13.1a. An X-ray is taken of his wrist is shown in Fig. 13.1b.

What is the most likely diagnosis?

A. Vitamin A deficiency
B. Vitamin B1 deficiency
C. Vitamin D deficiency
D. Vitamin E deficiency
E. Vitamin K deficiency



2- Sarah, a 9-year-old girl, is referred by the school nurse to the paediatric clinic because of her weight. She weighs 43 kg (98th centile) and is 141 cm tall (91st centile). She has followed her height centiles for the last 9 months but her
weight centile has increased. Her body mass index is on the 97th centile. Her mother reports that she hardly eats at all and when she does she has a very healthy diet.

Which of the following statements is most likely to be correct?

A. A calorie-restricted diet is the treatment of choice
B. Sarah's adrenocortical axis should be checked to exclude Cushing syndrome
C. Sarah has a higher risk of an abnormal lipid profile and raised blood pressure in adult life
D. Sarah is obese
E. Sarah's main problem is that she has a low metabolic rate

3- **Which of the following term newborns has the lowest risk of cardiovascular disease in later life?**

A. 1.8 kg
B. 2.1 kg
C. 2.4 kg
D. 3.9 kg
E. 4.6 kg

4- A mother asks you whether there are any disadvantages to breastfeeding. Although you would prefer to inform her about the many advantages of breastfeeding, you wish to answer her question honestly. **Which of the following is most likely to be a true potential disadvantage?**

A. Breastfeeding will reduce her chance of having more children
B. The absence of cow's milk protein in breast milk increases the risk that the child will develop milk allergy at weaning
C. The higher interferon level in breast milk increases the risk of severe bronchiolitis in children who develop respiratory syncytial virus infection
D. The lower vitamin K concentration in breast milk can result in life-threatening bleeding
E. The strong bond developed during breastfeeding will prevent paternal bonding

5- Anil is a 21/2-year-old boy who lives in India and attends the local health clinic near their village for a routine check. Both his parents are subsistence farmers. He is asymptomatic. On examination, he is very thin but his hair and skin appear normal and there is no oedema or other clinical abnormalities. His height is on the 5th centile but his weight is well below the 0.4th centile (z-score between −2 and −3 below the median).

What is the most likely diagnosis?

A. Kwashiorkor
B. Marasmus
C. Normal child
D. Rickets
E. Severe gastro-oesophageal reflux

Answers

1- **C.** Vitamin D deficiency
He has vitamin D deficiency resulting in rickets. This classically causes bowing of the legs but now more often presents with poor growth.
The ends of the radius and ulna, as shown on the x-ray of the wrists, (and the tibia and fibula at the ankles) are expanded and rarefied and cup shaped. At 13 months of age, breast milk alone does not provide adequate intake of vitamin D.

2- **C.** Sarah has an increased risk of an abnormal lipid profile and raised blood pressure in adult life.
Sarah is overweight [body mass index (BMI) > 91st centile] rather than obese (BMI > 98th centile). It places her at increased risk of an abnormal lipid profile and raised blood pressure in adult life unless action is taken.

3- **D.** Birth Weight 3.9 kg
The lowest risk of cardiovascular disease, almost half that of babies born weighing less than 2.5 kg. This is the Barker hypothesis.

4- **D.** The lower vitamin K concentration in breast milk can result in life-threatening bleeding.
The vitamin K concentration in breast milk is lower. There is insufficient vitamin K in breast milk to reliably prevent hemorrhagic disease of the newborn. This risk is minimized by giving prophylactic vitamin K.

5- **B.** Marasmus
In marasmus there is severe protein– energy malnutrition. Oedema is absent.