DIAGNOSIS OF PROTEIN-ENERGY MALNUTRITION IN CHILDREN

Guidelines for the 5th-6th year English medium students of level 3-4 accreditation universities

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
Харківський національний медичний університет

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ДІАГНОСТИКА БІЛКОВО-ЕНЕРГЕТИЧНОЇ НЕДОСТАТНОСТІ У ДІТЕЙ

Методичні вказівки для студентівV–VI курсів вищих медичних закладів освіти III–IV рівнів акредитації, що навчаються англійською мовою

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INTRODUCTION

Nutrition problems are common in children with neurological impairment [1, 2]. Causes of protein-energy malnutrition (PEM) in them are multifactorial, and malnourishment may be due to motor disorders, digestive problems, medicine use, and the social environment [3].

PEM is one of the most serious medical problems around the world. According to WHO research, in poor families in 22–35 % of children aged 2 to 6 years, the body weight (BW) is below the 5th percentile, the growth of 11 % of children is below the 5th percentile. In hospitalized children, various forms of PEM are still common, which aggravates the course of the disease, worsens their prognosis, and causes a delay in the physical and neurological development of children [4].

In Ukraine, as one of low income and middle-income countries (LMICs), PEM is detected and diagnosed not quite actively especially in children with neurologic impairment. Some recent publications demonstrate actuality and research of this problem in other countries such as Bosnia and Herzegovina, Nigeria and Ghana [3, 5, 6].

The main clinical requirements for the assessment of PEM in children is the rapid process of identifying people from the nutritional risk group, which is carried out using developer questionnaires and using appropriate validated scales [7, 8]. The standard method for detecting PEM is the assessment of physical development in children [9].

DEFINITION, CAUSES, CLASSIFICATION OF PEM

PEM is an alimentary-dependent condition, manifested by the duration and intense protein-energy starvation, which is manifested by a deficit of body weight and/or growth, a complex violation of homeostasis [10].

The assessment of nutritional status according to weight-for-height (or length), height (or length) -for-age and oedema is summarized in Table 1. Also shown are the criteria for classifying severe alnutrition as ‑oedematous‖, ‑severely wasted‖ or ‑severely stunted‖. Reference values for weight-for-height or length are given in *Appendix 1* [11].

Children whose weight-for-height is below -3 SD or less than 70 % of the median NCHS/WHO reference values (termed ―severely wasted‖), or who have symmetrical oedema involving at least the feet (termed ‑oedematous malnutrition‖) are severely malnourished. They should be admitted to hospital where they can be observed, treated and fed day and night [11].

Causes of PEM:

- decreased appetite;
- pain;
- unbalanced;
- diet;
- swallowing disorders;

- anomalies of the gastrointestinal tract;
- unconscious state;
- head injuries;
- tumors of the head, neck or gastrointestinal tract;
- severe pathology;
- oncology;
- cystic fibrosis;
- bullous epidermolysis;
- bedsores;
- restrictions on medical indications (risk of aspiration) [12].

Classifications of PEM:

1. WHO classification (*Table 1*).
2. Gomez classification – the use of body weight by age, the assessment of the degree for prediction (*Table 2*).
3. Wellcome classification – based on 2 criteria – weight loss in% of body weight by age + presence/absence of edema (*Table 3*).
4. Waterlow classification – adapted by the WHO, allows to distinguish between weight deficit by % growth (wasting – atrophy) and growth deficit by age % (stunting-growth arrest) (*Table 4, 5*) [13].

- Is easy to use due to the application of only body weight measurement.
- Disadvantages: 90 % level is veryhigh, 80 % corresponds to -2/3 SD, so the proportion of normal children is estimated as the first degree of nutritional deficiency.
- It is impossible to determine the "chronicity" of the deficit only by weight.
- The Boston Standard, which compiles the classification, is no longer an international reference standard [15].

Table 1

WHO classifications of PEM [11]

Indicator	Classification	
	Moderate malnutrition	Severe malnutrition (type)
Symmetrical oedema	No	Yes (oedematous malnutrition)
Weight-for-height	-3 < SD-score < -2d SD-score <-3 (< 70 %) (70-79 %)	SD-score <-3 (< 70 %) (severe wasting)
Height-for-age	-3 < SD-score <-2 (85-89%)	SD-score <-3 (<85%) (severe stunting)

Table 2

Classification of nutritional insufficiency (Gomez F., 1955) [14]

% of weight than expected	Degree of deficit
91--100	None
60-90	1
61-75	2
< 60	3

Table 3

The concept of weight for age + edema (Wellcome classification) [16]

Degrees of severity:
80-60 % without edema (malnutrition-PEM)
80-60 % with edema (Kwashiorkor)
< 60 % with edema (Marasmus-Kwashiorkor)
< 60 % without edema (insanity)

Table 4

The concept of weight for age and height for age (Waterlow classification) [17]

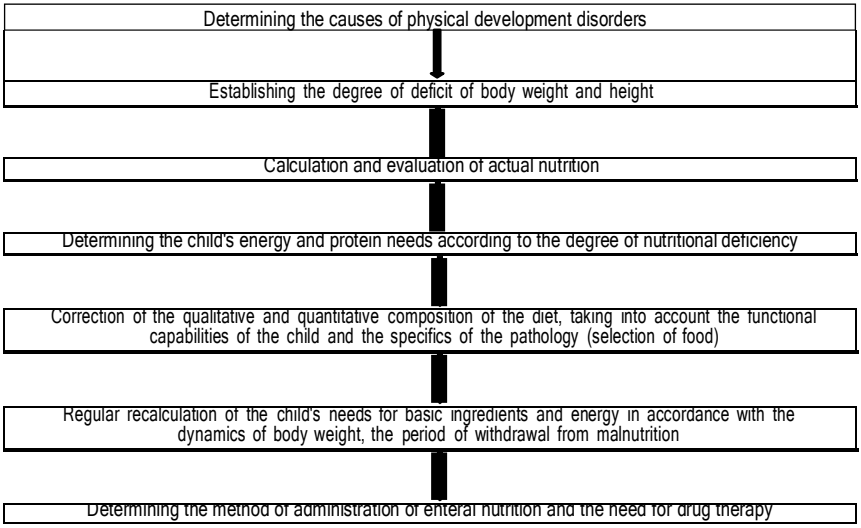
Age growth / Weight gain	Norm (> -2SD HAZ)	Growth retardation Stunted (> -2SD HAZ)
Norm (> -2SD WHZ)	Norm	Growth retardation
Atrophy Wasted (> -2SD WHZ)	Malnutrition/atrophy	Atrophy with growth retardation

Table 5

Waterlow classification [17]

Weight per height, %	Degree (atrophy) of malnutrition
> 110	Hypertrophy
91-110	Norm
81-90	I
71-80	II
< 70	III

NUTRITIONAL SUPPORT ALGORITHM [18]



Eating Disorders Risk Screening is a rapid process for identifying people at risk that is performed using questionnaires and appropriate validated scales.

Screening should be performed within 24–48 hours after the first contact and then performed on a regular basis.

ESPEN recommends using the Nutrition Risk Screening-2002 scale (NRS-2002) and the Malnutrition Universal Screening Tool (MUST) for children (Appendix 2) [19].

For adults, the Mini Nutritional Assessment (MNA) scales with self-assessment forms (MNA-SF), the Malnutrition Screening Tool (MST), and the Short Nutritional Assessment Questionnaire (SNAQ) are used more [20].

METHODOLOGY FOR ASSESSING NUTRITIONAL STATUS IN CLINICAL PRACTICE

First step [21]

Nutrient intake *(comparison of received with needs)*	Clinical signs *(external, internal)*	Anthropometry *(height, body weight, circumference, thickness of skin folds)*
• method of mentioning 24 hours • nutrition schedule (frequency of intake, duration of feeding) • weighing products and estimating food volume • food methods (bottle, siping, etc.)		

The second step

Biochemical and hematological parameters Blood and urine tests for proteins and minerals

The third step

Body composition, distribution of lean and fat mass, water and minerals	Functional tests, neurological functions, developmental tests

The main method of determining the degree of nutritional insufficiency is anthropometry:

- monthly increase in body weight and height;
- method of sigma deviations (Percentiles and Z-scores are two ways to determine how far a child's nutritional status deviates from international averages for a particular gender and age population.);
- modified tables-scales of regression of body weight on growth;
- specific indices (Broca, Pine, Kettle).

The method of sigma deviations allows you to determine how many sigmas the child's index differs from the arithmetic mean of this indicator (body weight, height, chest circumference). Physical development is considered average if the child's performance coincides with an average of up to 1 sigma. Proportional is the structure of the body in which the deviations of the indicators are at the same level or differ by no more than one sigma. Martin's profile can be constructed using the sigma deviation method, but the method is now almost never used.

There is a correspondence between percentiles (quantiles of order q) and z values (*Appendix 3*). This allows you to translate the scale of rankings or scores to the value of the Z-score and vice versa.

WHO PC software-Anthro, for Microsoft Windows operating system designed to monitor the growth and development of children under 5 years. Consists of 3 modules:

- anthropometric calculator (AK);
- individual assessment (IA);
- nutrition survey (nutritional status – NS) [22].

DESCRIPTION OF STAGES OF MEDICAL CARE

Management of the child with severe malnutrition is divided into three phases. These are:

• *Initial treatment*: life-threatening problems are identified and treated in a hospital or a residential care facility, specific deficiencies are corrected, metabolic abnormalities are reversed and feeding is begun.

• *Rehabilitation*: intensive feeding is given to recover most of the lost weight, emotional and physical stimulation are increased, the mother or carer is trained to continue care at home, and preparations are made for discharge of the child.

• *Follow-up*: after discharge, the child and the child's family are followed to prevent relapse and assure the continued physical, mental and emotional development of the child [11].

Initial treatment begins with admission to hospital and lasts until the child's condition is stable and his or her appetite has returned, which is usually after 2–7 days. If the initial phase takes longer than 10 days, the child is failing to respond and additional measures are required (see section 7). The principal tasks during initial treatment are:

— to treat or prevent hypoglycaemia and hypothermia;
— to treat or prevent dehydration and restore electrolyte balance;
— to treat incipient or developed septic shock, if present;
— to start to feed the child;
— to treat infection;
— to identify and treat any other problems, including vitamin deficiency, severe anaemia and heart failure [11].

Approaches to the calculation of nutrients:

Calculation of the basic (basal) metabolism in children (kcal/day) [23]

Sex	Age, years	Equation
Boys	0-3	0.167 × Body weight (kg) +1517.4 × Height - 617.63
	3-10	19.6 × Body weight (kg) + 130.3 × Height + 414.9
	10-18	16.25 × Body weight (kg) + 137.2 × Height + 515.5
Girls	0-3	16.25 × Body weight (kg) + 1023.2 × Height - 413.5
	3-10	16.97 × Body weight (kg) + 161.8 × Height + 371.2
	10-18	8.365 × Body weight (kg) + 465 × Height + 200

Actual energy demand (AED):

$$BM \times AF \times DF \times TF \times BWD$$

where *BM* – basic (basal) metabolism, kcal/day; *AF* – activity factor, *DF* – damage factor, *TF* – thermal factor, *BWD* – body weight deficit [24].

Basic conversion factors:

Growth factor: 1–2 years – 1.02–1.04; > 2 p. – 1.02; growth jump -– 1.2.

Activity factor: bed rest/coma – 1.0, ward – 1.2, total – 1.3; wheelchair – 1.1.

Thermal factor – temperature 38 °C – 1.1, 39 °C – 1.2, 40 °C – 1.3.

Body weight deficit: from 10 to 20 % – 1.1, from 20 to 30 % – 1.2, more than 30 % – 1.3.

Damage factor: small operations – 1.1, fractures – 1.2, large operations – 1.3, peritonitis – 1.4, sepsis – 1.5, numerous injuries – 1.6, burns – 1.7–2.2 [24].

Assessment of protein needs:

High protein intake in children with severe nutritional deficiencies can have a negative effect on the function of the kidneys and organs of the gastrointestinal tract. Therefore, the protein requirements for young children are set at 1.2–1.5 g/kg per day [9].

Periods of nutritional correction:

1. adaptive (determination of tolerance);
2. reparatory;
3. fortified food.

Clinical nutrition is a term that includes oral nutritional supplements, enteral nutrition (tube feeding, etc.), parenteral nutrition. The latter two species have traditionally been called artificial nutrition, but the term has been replaced by clinical nutrition. Foods that enter the gastrointestinal tract orally or enterally are defined by European Union legislation as products for special medical purposes (FSMP) - Directive 2009/39/EC 2013/609/EC (PARNUTS) [25].

Products for clinical nutrition:

Oral nutritional supplements - 2 types (nutritiously complete and incomplete):

- Nutritious – standard products that can be used as the only resource for long-term feeding due to the balanced composition of macro- and micronutrients, including essential amino acids, essential fatty acids, which reflects dietary recommendations for healthy people; can be used as a supplement to a regular diet and only as the only source of food.
- Nutritious incomplete – not used as the only source of nutrients adapted to supply some specific components in increased quantities in conditions of deficiency or insufficiency in their diet.

Disease-specific oral supplements modified according to special nutritional and metabolic needs in diseases (diabetes, ulcers, cirrhosis, cancer, renal failure, lung disease, congenital metabolic diseases, etc.).

Standard enteral formulas – consist of elements that are used for the nutritional needs of the general population (energy, protein and micronutrient needs are covered by 1.5 liters of standard enteral formula). Can be standard or adapted for certain conditions. Most of these formulas contain dietary fiber, free of lactose and gluten. All protein formulas contain intact proteins, long-chain triglycerides, carbohydrates with a dominant composition in the form of polysaccharides (maltodextrin). Enteral formulas are nutritionally complete. Formulas that contain peptides or medium-chain triglycerides improve absorption in cases of malabsorption or short bowel syndrome. Disease-specific enteral formulas that are designed for specific nutritional or metabolic requirements [25].

Types of clinical nutrition:

Elemental (monomeric) – amino acids, carbohydrates, fats: most elemental formulas (Alpha, Progestimil, Peptamine, Neocate advance, Elemental).

- for kids;
- for children;
- adult.

Semi-elemental (oligomeric) – oligopeptides, glucose polymers, a mixture of triglycerides (Pepticate, Nutrizone, Nutrien junior, Nutrizone advance, Peptisorb).

- for kids;
- for children;
- adult.

Polymeric – high content of energy, proteins, polymeric carbohydrates (Infatrini, Nutrin varieties, Nutrizone, Clinutren junior, Resource junior).

- for kids;
- for children up to 6 years;
- for children> 6 years;
- adult.

Formulas for siping – increased content of energy, whole proteins, whole carbohydrates and fats (Infatrin, Nutridrink, Resource optimum, Nutrizone).

- for kids;
- for children under 12;
- for children > 12 years;
- adults [10].

The child is deemed to have entered the rehabilitation phase when his or her appetite has returned. A child who is being fed by NG tube is not considered ready to enter the rehabilitation phase.

Criteria for transfer to a nutrition rehabilitation centre:

- Eating well.
- Mental state has improved: smiles, responds to stimuli, interested in surroundings.
- Sits, crawls, stands or walks (depending on age).

- Normal temperature (36.5–37.5 °C).
- No vomiting or diarrhea.
- No oedema.
- Gaining weight: > 5 g/kg of body weight per day for 3 successive days [11].

Nutritional rehabilitation

The most important determinant of the rate of recovery is the amount of energy consumed. However, at the start of the rehabilitation phase, the child is still deficient in protein and various micronutrients, including potassium, magnesium, iron and zinc. These must also be given in increased amounts. Infants under 24 months can be fed exclusively on liquid or semi-liquid formulas. It is usually appropriate to introduce solid foods for older children [11].

THE LIST OF THEORETICAL QUESTIONS TO BE STUDIED IN PRACTICAL CLASSES:

1. What is protein energy malnutrition?
2. How is protein energy malnutrition diagnosed?
3. What is the cause of protein energy malnutrition?
4. What are the two types of protein energy malnutrition?
5. What is the treatment of protein energy malnutrition?
6. What is the management of protein energy malnutrition?
7. Which disease is caused due to deficiency of protein?
8. Which disease is related to protein energy malnutrition?
9. How does protein energy malnutrition affect the immune system?
10. What is severe protein malnutrition?
11. How can protein malnutrition be prevented?
12. How do you prevent PEM?

TASKS

1. Girl 1 year 3 months, born at 38 weeks of gestation, with a body weight of 2800 g, body length of 51 cm. Now body weight 7000 g, the height is 70 cm. When viewed, facial expressions are monotonous, do not respond to the face of the person who addresses her. Baby talk. Preserved sucking reflex and automatic cervical-tonic reflex, muscle tone is sharply reduced. In the area of the head marked stigma disembriogenesis, umbilical hernia. Grefe's symptom is expressed. The child does not sit independently, tremors of hands, chin. Skills and abilities are missing.

Tasks:

1. Formulate a diagnosis.
2. Assess the neuropsychological development.
3. Evaluate the physical development.

Answers:

1. Protein-energy grade I malnutrition.

2. Encephalopathy with severe delayed psychomotor development.
3. Delay in physical development.

2. A child with grade II malnutrition, body weight 2600 g was admitted to the hospital. The mother states decreased appetite and weight loss. Calculate the child's needs for basic ingredients and energy according to the dynamics of body weight, period of withdrawal from malnutrition.

Answers:

1. Proteins: 2.5 × 2.6 = 6.5 (g), which corresponds to 654 ml of 10 % amino acid solution; energy value 26 kCal.

2. Fat: 2.0 × 2.6 = 5.2 (g), which corresponds to 25 ml of 20 solution of intralipid; energy value 52 kCal.

3. Energy value: 120 kCal x× 2.6 = 312 kCal. The introduction of the specified amount of protein and fat provides 78 kCal. The remaining 224 kCal is provided by the introduction of 56.0 g of glucose, which corresponds to 280 ml of 20 %, or 420 ml of 15 %, or 560 ml of 10 % glucose.

3. A 3-month-old girl was admitted to the hospital with complaints of weight loss. There is a delay in psychomotor development. Before admission to the hospital, the child was fed cow's milk. Child from V pregnancy, childbirth at 38 weeks of gestation. Body weight at birth 2850 g, height 48 cm. Discharged from the hospital for 4 days in satisfactory condition during breastfeeding. Later (at the age of 10 days) the mother fed the child cow's milk. Objectively: a state of moderate severity, the child is lethargic, reduced activity. The skin is clean, the subcutaneous fat layer is present only on the face. Body weight 2650 g, height 53 cm.

Tasks:

1. Assess the nutritional status of the child.
2. Give advice on nutritional support for the child.

Answers:

1. Protein-energy malnutrition, severe (grade III).

2. Evaluation of breastfeeding. In this case, there is an inadequate selection of food that does not meet the physiological needs of the child of this age. Recommendations for nutritional support. Taking into account the malnutrition of III degree, it is recommended to prescribe a combined diet (enteral + parenteral).

4. A boy aged 8 years, body weight 11 kg, height 104 cm. Diagnosis: cerebral palsy, spastic tetraparesis. Concomitant: celiac disease is typical. Atrophy of the optic discs. Gross delay of physical and neuropsychological development. Gastroesophageal reflux disease. The child receives a volume of food of 200 ml. Parents feed every 4 hours. Gets baby formula 4 feedings and rice milk porridge 3 feedings. Over the past few years, the mass does not add. Frequent bronchitis, pneumonia 4–5 times a year.

Tasks:

1. Formulate a diagnosis.
2. Your tactics of managing the child.

Answers:

1. Protein-energy malnutrition, severe (grade III).
2. Given the fact that the child does not gain weight for a long time, this indicates that the resulting products are not digested. Therefore, you need to change the diet using enteral foods. With the replacement of the base mixture with a hypercaloric mixture with a high content of dietary fiber and gluten-free. Deficiency of carbohydrates and calories will be eliminated in the future with the introduction of vegetable and fruit dishes.

5. Boy 1 year 4 months, born at 37 weeks of gestation, with a body weight of 2700 g, body length of 51 cm. Now body weight 7500 g, the height is 70 cm. Baby talk. Preserved sucking reflex and automatic cervical-tonic reflex, muscle tone is sharply reduced. Grefe's symptom is expressed. The child does not sit independently, tremors of hands, chin. Skills and abilities are missing.

Tasks:

1. Formulate a diagnosis.

Answers:

1. Protein-energy grade III malnutrition.

TEST TASKS

1. A 5-month-old childis diagnosed with grade III malnutrition. Which of the following body mass deficit characterizes this degree of malnutrition?

A. 5–10 %. B. 10–20 %. C. 21–30 %. D. 31–50 %. E. 51–70 %.

2. Determine grade II malnutrition in child:

A. 10–15 %. B. 15–20 %. C. 21–30 %. D. 20–25 %. E. 25–31 %.

3. A 4-month-old childis. She was born full-term with a body weight 3300. She is on artificial feeding with an adapted mixture. Develops according to age. There are no complaints from the mother. In order to assess the subcutaneous fat layer, the doctor determined the thickness of the abdomen and regarded it as the norm. What was the thickness of the subcutaneous fat layer?

A. 0.5 cm. B. 1.5 cm. C. 2.5 cm. D. 3.5 cm. E. 4.5 cm.

4. The mother of a 6-month-old childs consulted a doctor for advice on a rational diet for the child. What advice did the doctor give?

A. Feed 5 times a day after 4 hours. D. Feed 8 times a day for 2.5 hours.
B. Feed 6 times a day for 3.5 hours. E. Feed 10 times a day for 2 hours.
C. Feed 7 times a day for 3 hours.

5. A 3-month-old childs diagnosed with grade II malnutrition by a pediatrician. What tactics in this case will be adequate?

A. Hospitalization in the somatic department.
B. Organization of the hospital at the place of residence.
C. Consult an endocrinologist.

D. Outpatient treatment and examination.
E. Referral to the intensive care unit.

6. A 8-month-old childs thinning of a hypodermic and fatty layer on a stomach, a trunk, extremities is observed. The skin is pale, dry, elasticity is sharply reduced. Turgor of fabrics is reduced. What is the most likely diagnosis?

A. Kwashiorkor. *C. Paratrophy.* *E. Grade II malnutrition.*
B. Grade I malnutrition. *D. Hypostasis.*

7. What are the immediate causes of protein-energy malnutrition?

A. Parasitic infection.
B. Lack of knowledge about feeding and cleanliness.
C. Lack of clean and unadulterated food.
D. All of the above.

8. What is the main criterion for the effectiveness of diet therapy for malnutrition?

A. Normal body temperature. *C. Normalization of hematocrit.*
B. Normal blood sodium. *D. Daily weight gain of 25–30 g.*

9. A 3-month-old childs, a body weight 5100 g. How much milk does a newborn need per feed?

A. 469 ml. *B. 1000 ml.* *C. 861 ml.* *D. 782 ml.* *E. 548 ml.*

10. The child in age of 3 months was hospitalized. The weight of the baby is 4400 g, the height is 59 cm. The child was born with weight of 2900 g in term and in gestational age of 39 weeks. Determine grade malnutrition in child:

A. Grade II malnutrition. *D. Paratrophy.*
B. Grade I malnutrition. *E. Body weight is normal.*
C. Grade III malnutrition.

STANDARDS OF ANSWERS TO TEST TASKS

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	*C*	*B*	*A*	*A*	*E*	*B*	*D*	*D*	*A*

NCHS/WHO normalized reference values for weight-for-height and weight-for-length

Boys' weight (kg)						Girls' weight (kg)				
−4 SD	−3 SD	−2 SD	−1 SD	Median	Length[a] (cm)	Median	−1 SD	−2 SD	−3 SD	−4 SD
1.8	2.1	2.5	2.8	3.1	49	3.3	2.9	2.6	2.2	1.8
1.8	2.2	2.5	2.9	3.3	50	3.4	3.0	2.6	2.3	1.9
1.8	2.2	2.6	3.1	3.5	51	3.5	3.1	2.7	2.3	1.9
1.9	2.3	2.8	3.2	3.7	52	3.7	3.3	2.8	2.4	2.0
1.9	2.4	2.9	3.4	3.9	53	3.9	3.4	3.0	2.5	2.1
2.0	2.6	3.1	3.6	4.1	54	4.1	3.6	3.1	2.7	2.2
2.2	2.7	3.3	3.8	4.3	55	4.3	3.8	3.3	2.8	2.3
2.3	2.9	3.5	4.0	4.6	56	4.5	4.0	3.5	3.0	2.4
2.5	3.1	3.7	4.3	4.8	57	4.8	4.2	3.7	3.1	2.6
2.7	3.3	3.9	4.5	5.1	58	5.0	4.4	3.9	3.3	2.7
2.9	3.5	4.1	4.8	5.4	59	5.3	4.7	4.1	3.5	2.9
3.1	3.7	4.4	5.0	5.7	60	5.5	4.9	4.3	3.7	3.1
3.3	4.0	4.6	5.3	5.9	61	5.8	5.2	4.6	3.9	3.3
3.5	4.2	4.9	5.6	6.2	62	6.1	5.4	4.8	4.1	3.5
3.8	4.5	5.2	5.8	6.5	63	6.4	5.7	5.0	4.4	3.7
4.0	4.7	5.4	6.1	6.8	64	6.7	6.0	5.3	4.6	3.9
4.3	5.0	5.7	6.4	7.1	65	7.0	6.3	5.5	4.8	4.1
4.5	5.3	6.0	6.7	7.4	66	7.3	6.5	5.8	5.1	4.3
4.8	5.5	6.2	7.0	7.7	67	7.5	6.8	6.0	5.3	4.5
5.1	5.8	6.5	7.3	8.0	68	7.8	7.1	6.3	5.5	4.8
5.3	6.0	6.8	7.5	8.3	69	8.1	7.3	6.5	5.8	5.0
5.5	6.3	7.0	7.8	8.5	70	8.4	7.6	6.8	6.0	5.2
5.8	6.5	7.3	8.1	8.8	71	8.6	7.8	7.0	6.2	5.4
6.0	6.8	7.5	8.3	9.1	72	8.9	8.1	7.2	6.4	5.6
6.2	7.0	7.8	8.6	9.3	73	9.1	8.3	7.5	6.6	5.8
6.4	7.2	8.0	8.8	9.6	74	9.4	8.5	7.7	6.8	6.0
6.6	7.4	8.2	9.0	9.8	75	9.6	8.7	7.9	7.0	6.2
6.8	7.6	8.4	9.2	10.0	76	9.8	8.9	8.1	7.2	6.4
7.0	7.8	8.6	9.4	10.3	77	10.0	9.1	8.3	7.4	6.6
7.1	8.0	8.8	9.7	10.5	78	10.2	9.3	8.5	7.6	6.7
7.3	8.2	9.0	9.9	10.7	79	10.4	9.5	8.7	7.8	6.9
7.5	8.3	9.2	10.1	10.9	80	10.6	9.7	8.8	8.0	7.1
7.6	8.5	9.4	10.2	11.1	81	10.8	9.9	9.0	8.1	7.2
7.8	8.7	9.6	10.4	11.3	82	11.0	10.1	9.2	8.3	7.4
7.9	8.8	9.7	10.6	11.5	83	11.2	10.3	9.4	8.5	7.6
8.1	9.0	9.9	10.8	11.7	84	11.4	10.5	9.6	8.7	7.7

SD: standard deviation score (or Z-score). Although the interpretation of a fixed percent-of- median value varies across age and height, and generally the two scales cannot be compared, the approximate percent -of- median values for -1 and -2 SD are 90% and 80% of median, respectively (Gorstein J et al. Issues in the assessment of nutritional status using anthropometry. *Bulletin of the World Health Organization*, 1994, 72:273-283).

Length is measured for children below 85 cm. For children 85 cm or more, height is measured. Recu mbent length is on average 0.5 cm greater than standing height; although the differe nce is of no im portance to individual children, a correction may be made by subtracti ng 0.5 cm from all lengths above 84.9 cm if standing height cannot be measured [11].

Boys' weight (kg)						Girls' weight (kg)				
−4 SD	−3 SD	−2 SD	−1 SD	Median	Length[a] (cm)	Median	−1 SD	−2 SD	−3 SD	−4 SD
7.8	8.9	9.9	11.0	12.1	85	11.8	10.8	9.7	8.6	7.6
7.9	9.0	10.1	11.2	12.3	86	12.0	11.0	9.9	8.8	7.7
8.1	9.2	10.3	11.5	12.6	87	12.3	11.2	10.1	9.0	7.9
8.3	9.4	10.5	11.7	12.8	88	12.5	11.4	10.3	9.2	8.1
8.4	9.6	10.7	11.9	13.0	89	12.7	11.6	10.5	9.3	8.2
8.6	9.8	10.9	12.1	13.3	90	12.9	11.8	10.7	9.5	8.4
8.8	9.9	11.1	12.3	13.5	91	13.2	12.0	10.8	9.7	8.5
8.9	10.1	11.3	12.5	13.7	92	13.4	12.2	11.0	9.9	8.7
9.1	10.3	11.5	12.8	14.0	93	13.6	12.4	11.2	10.0	8.8
9.2	10.5	11.7	13.0	14.2	94	13.9	12.6	11.4	10.2	9.0
9.4	10.7	11.9	13.2	14.5	95	14.1	12.9	11.6	10.4	9.1
9.6	10.9	12.1	13.4	14.7	96	14.3	13.1	11.8	10.6	9.3
9.7	11.0	12.4	13.7	15.0	97	14.6	13.3	12.0	10.7	9.5
9.9	11.2	12.6	13.9	15.2	98	14.9	13.5	12.2	10.9	9.6
10.1	11.4	12.8	14.1	15.5	99	15.1	13.8	12.4	11.1	9.8
10.3	11.6	13.0	14.4	15.7	100	15.4	14.0	12.7	11.3	9.9
10.4	11.8	13.2	14.6	16.0	101	15.6	14.3	12.9	11.5	10.1
10.6	12.0	13.4	14.9	16.3	102	15.9	14.5	13.1	11.7	10.3
10.8	12.2	13.7	15.1	16.6	103	16.2	14.7	13.3	11.9	10.5
11.0	12.4	13.9	15.4	16.9	104	16.5	15.0	13.5	12.1	10.6
11.2	12.7	14.2	15.6	17.1	105	16.7	15.3	13.8	12.3	10.8
11.4	12.9	14.4	15.9	17.4	106	17.0	15.5	14.0	12.5	11.0
11.6	13.1	14.7	16.2	17.7	107	17.3	15.8	14.3	12.7	11.2
11.8	13.4	14.9	16.5	18.0	108	17.6	16.1	14.5	13.0	11.4
12.0	13.6	15.2	16.8	18.3	109	17.9	16.4	14.8	13.2	11.6
12.2	13.8	15.4	17.1	18.7	110	18.2	16.6	15.0	13.4	11.9

SD: standard deviation score (or Z-score). Although the interpretation of a fixed percent-of- median value varies across age and height, and generally the two scales cannot be compared, the approximate percent -of-median values for -1 and -2 SD are 90 % and 80 % of median, respectively (Gorstein J et al. Issues in the assessment of nutritional status using anthropometry. *Bulletin of the World Health Organization*, 1994, 72:273-283).

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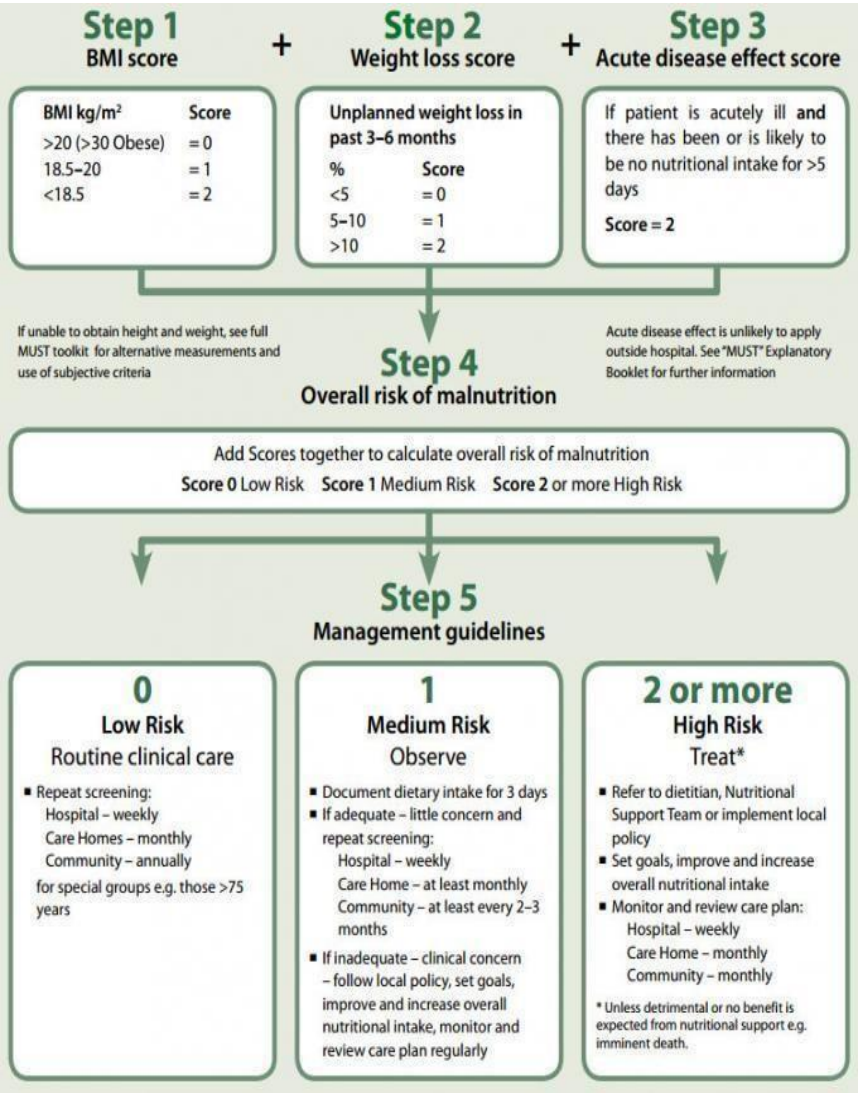
Malnutrition Universal Screening Tool (MUST)



The image is taken from the site nutritional assessment.
Available from: https://nutritionalassessment.mumc.nl/en/screening

Appendix 3

Unification of percentile distribution and standard deviations

Percentiles	Z-score	Percentiles	Z-score
0,2	-3	84	+1
2,3	-2	85	+1,04
2,5	-1,96	95	+1,96
15	-1	97,7	+2
50	0	99	+3

V.R. Preedy (ed.), Handbook of Anthropometry: Physical Measures 29 of Human Form in Health and Disease, DOI 10.1007/978-1-4419-1788-1_2

Appendix 4

Age needs for nutrients (per day) for girls

Age	Proteins, g/kg	Fats, g/kg	Carbohydrates, g/kg	Energy, kcal/kg
0–3	**2.2**	**6.5**	**13**	**115 (120)**
4–6	**2.6**	**6.0**	**13**	**115**
7–12	**2.9**	**5.5**	**13**	**110**

The image is taken from the site parentcircle.
Available from: https://www.parentcircle.com/article/calorie-requirement-for-girls-of-different-age-groups/

Age needs for nutrients (per day) for boys

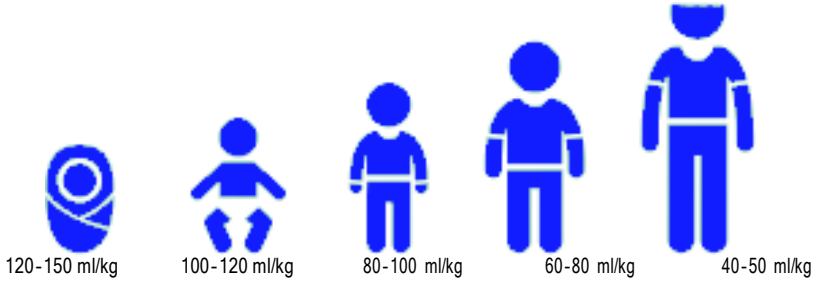
Age	Proteins, g/kg	Fats, g/kg	Carbohydrates, g/kg	Energy, kcal/kg
1–3	**3.5–4**	**3.5–4.0**	**15–16**	**110**
4–6	**3–3.5**	**3–3.5**	**14–14**	**90–95**
7–11	**2.5–3**	**2.5–3**	**10–12**	**70–80**
12–15	**2–2.5**	**2–2.5**	**7–8**	**55–65**

The image is taken from the site parentcircle.

Available from: https://www.parentcircle.com/article/calorie-requirement-for-boys-of-different-age-groups/

Appendix 5

Fluid requirement depending on age (per day)



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Навчальне видання

ДІАГНОСТИКА БІЛКОВО-ЕНЕРГЕТИЧНОЇ НЕДОСТАТНОСТІ У ДІТЕЙ

Методичні вказівки для студентів V–VI курсів вищих мед. закладів освіти III–IV рівнів акредитації, що навчаються англійською мовою

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