POLTAVA STATE MEDICAL UNIVERSITY

Physical development in children of different age groups. Principles and methods of assessing the physical development in children. Semiotics of disorders of physical development of children.

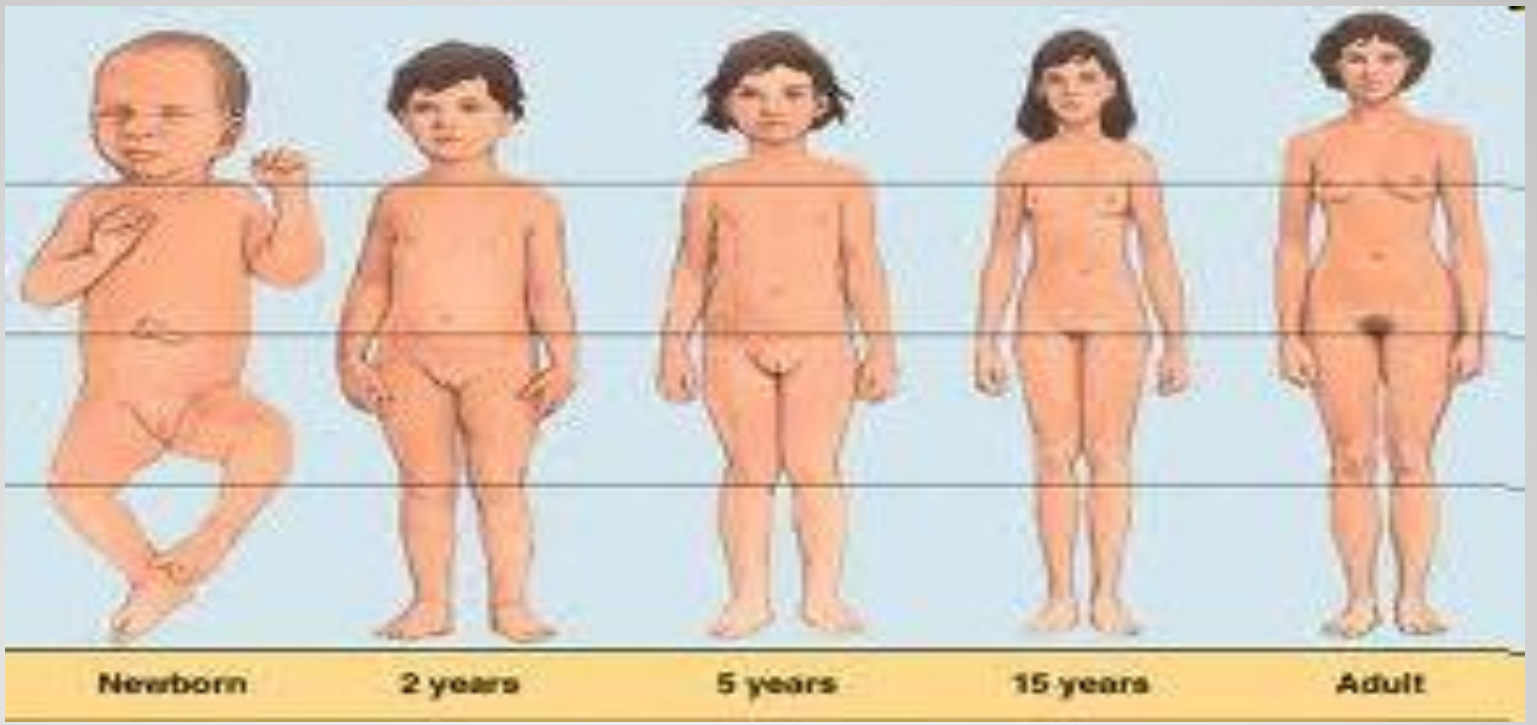
Assoc. prof., MD, PhD
Soloviova Halyna

Plan of the lecture

1. Definition of physical development.
2. The concept of acceleration.
3. Assessment of physical development of the fetus and newborns.
4. Calculation of basic indicators of physical development of children older than one year.
5. Anthropometric indexes
6. Semiotics of disorders of physical development of children.

Physical development. What is this?

Change in the child that occurs over time. Changes follow an orderly pattern that moves toward greater complexity and enhances survival.



Terminology

- Growth
- Length (lengs)/ height (hait)
- Weight (weit)
- Head circumference
- Chest circumference
- Proportionality of these measurements

Measurements should be taken at regular intervals in order to observe reliable trends.

Recommendations for measurement intervals include:

- Infants (0-12 months): every month
- Young Children: at 15, 18, 24 and 30 months
- Ages 3+: every year

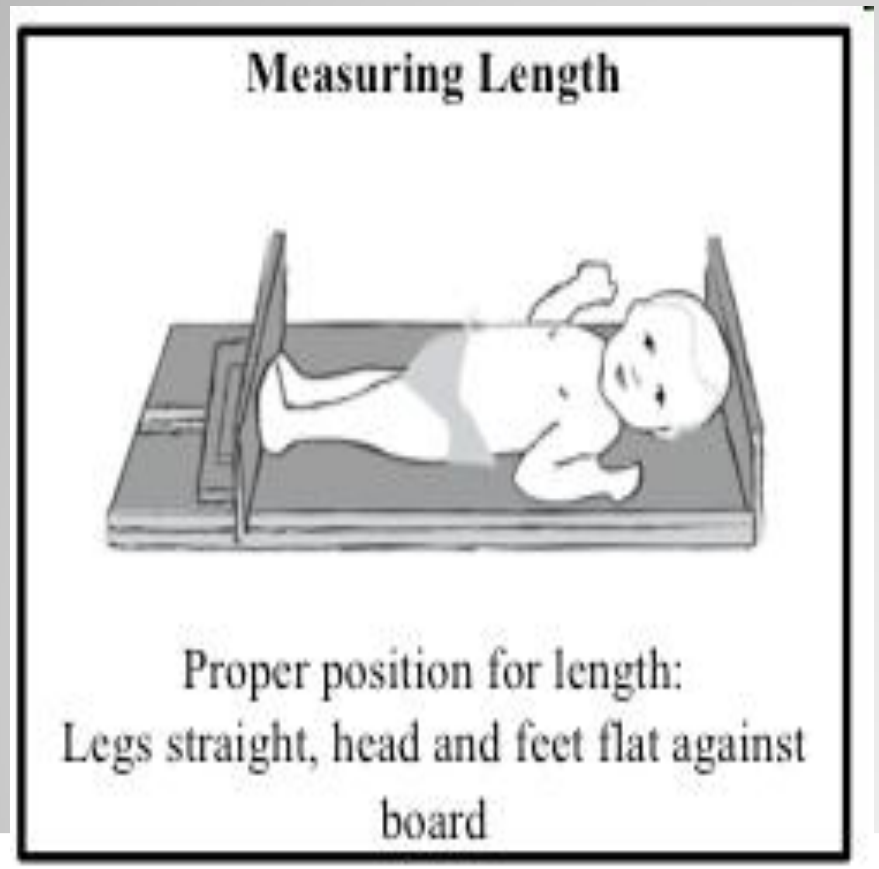
Growth

Is a complex dynamic process by which the body and various structures within the body increase in size.

Its results from the careful coordination of three cellular processes:

- **Increase in the number of cells or cell hyperplasia**
- **Increase in the size or cell hypertrophy**
- **Programmed cell death or apoptosis**

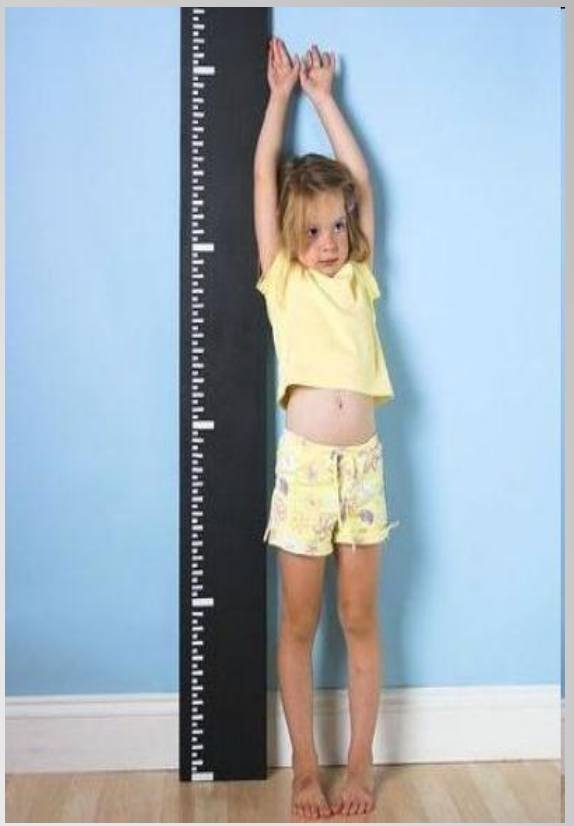
Length is the linear measurement for infants up to 24 months.



Height for child elder 2 years

A

B



C

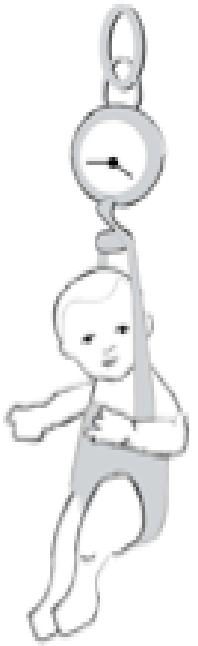
Child and adolescent

Weight of a body

Measuring Weight

Infant being weighed in a pan scale.

Measuring Weight



Infant being weighed in a hanging scale.

Weight of a body

On a pan scale up to 2 years in laying or sitting position and in standing position after 2 years

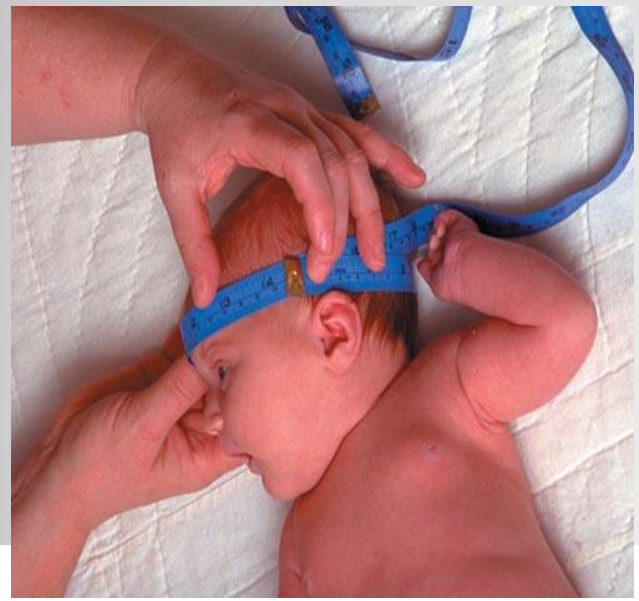
A

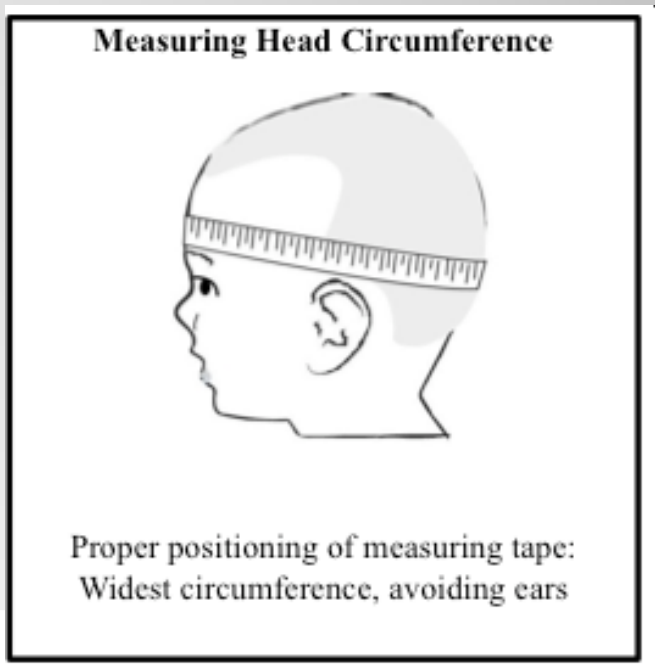
B

C

Head circumference

- is a measurement taken around the largest part of a child's head above the eyebrow and occipital tuberculars.
- Take the measurement three times and select the largest measurement to the nearest 0.1cm.





Head is measured with a flexible tape over the most prominent part of the occiput and just above the supraorbital ridges

Chest circumference

- **Measure chest circumference with paper or steel tape around chest at nipple line and under tips of scapules at back**

Chest circumference in infant is measured in supine position at rest

FEATURES of PHYSICAL DEVELOPMENT of a NEWBORN:

- - Weight of a body at birth 2500-4200 gram;
- - Length of a body - 50-52 cm.;
- - Head circumference - 34-36 cm;
- - Chest circumference - 32-34 cm.

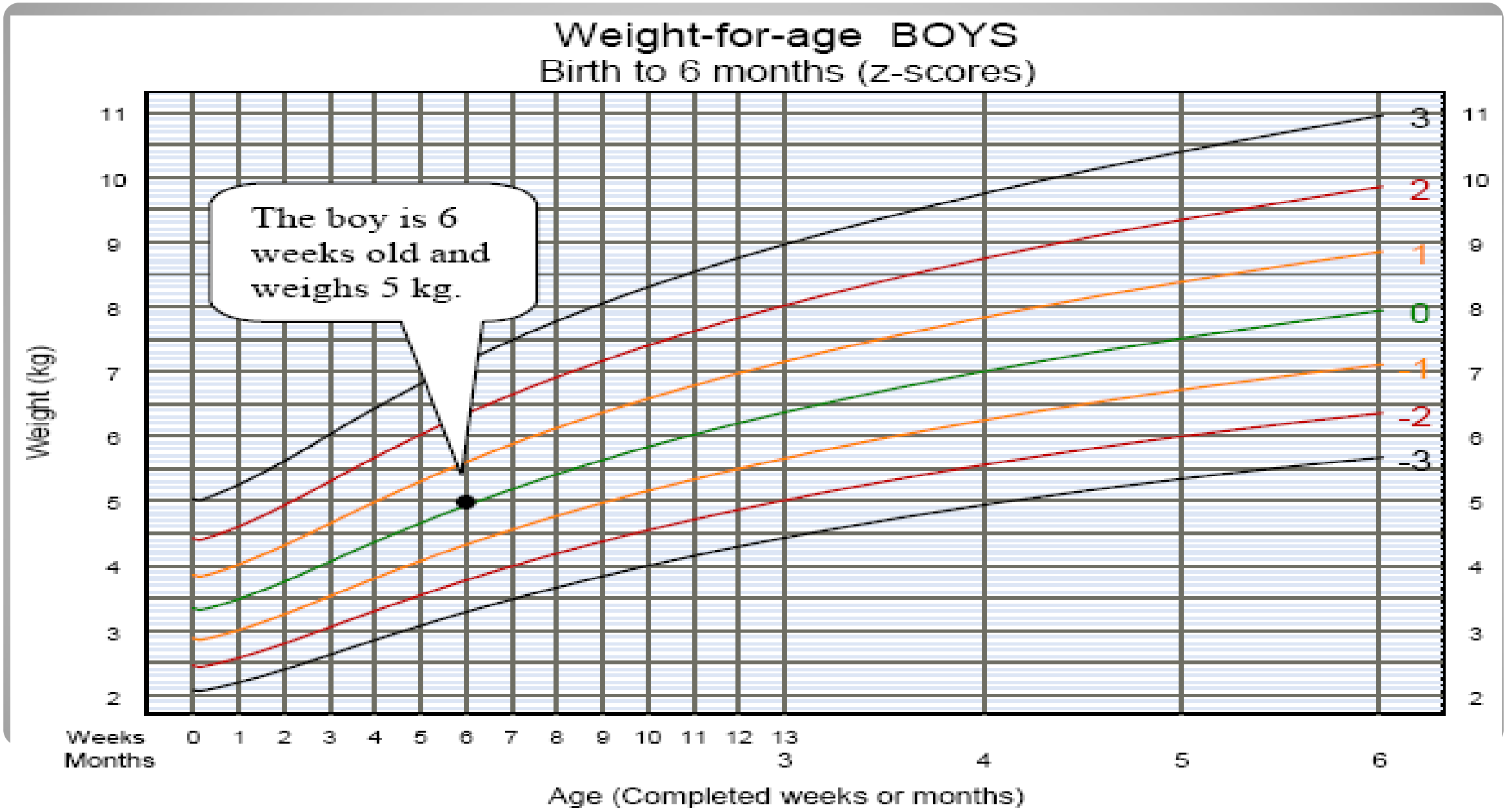
Methods of estimation of physical development of children

- Method of empirical formulas

- Method of anthropometrical standards:
  - centile chart (tables)
  - standard deviation score (SD) or Z-score charts

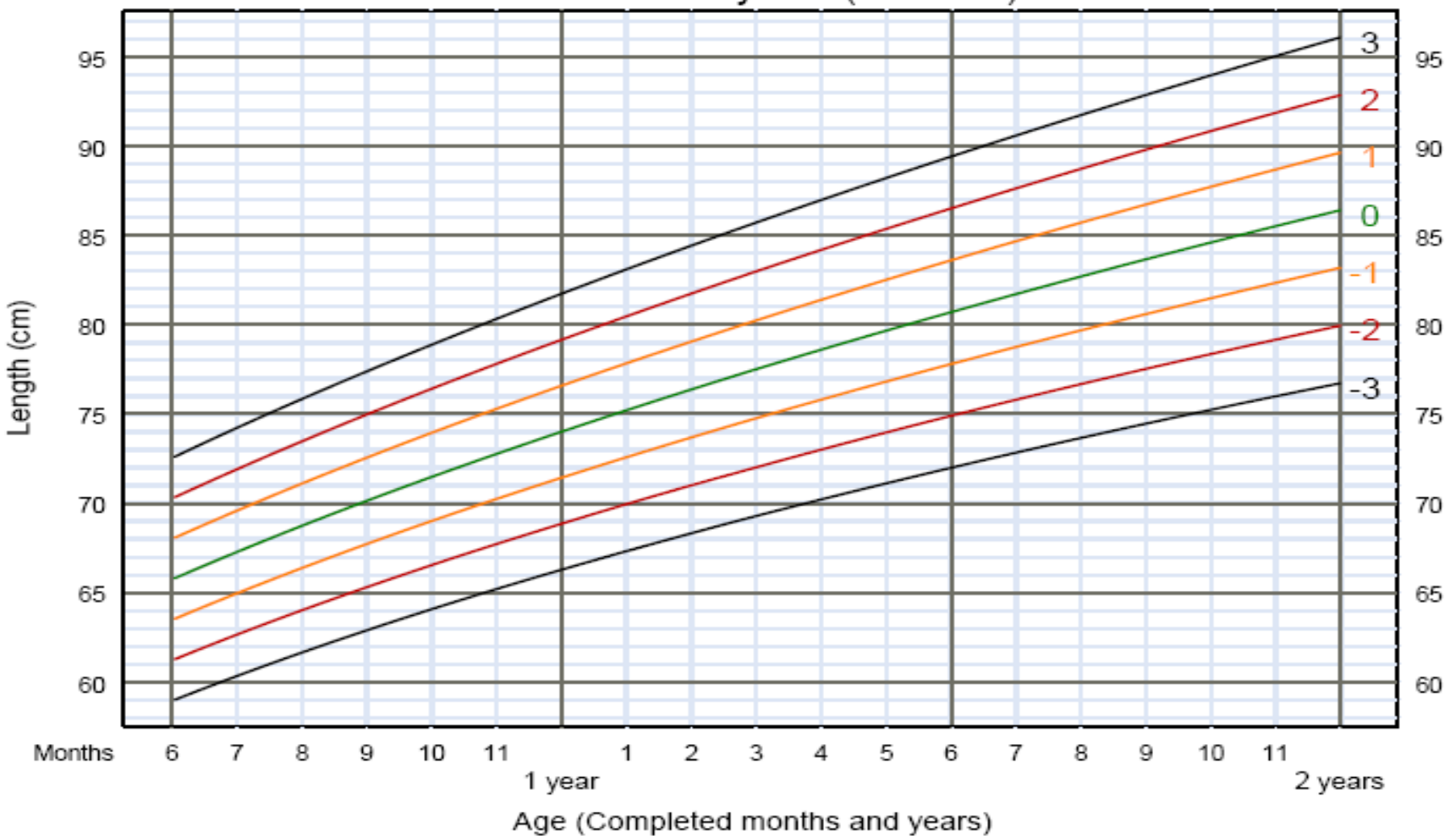
Growth Grids

- Height, weight, circumferences are plotted against the child's chronologic age on standardized growth charts.
- **Normal growth** - measurement between the 25^{th} and 75^{th} percentiles or ±1 SD indicate
- **Either normal growth or a deviation** measurements between the 10^{th} - 25^{th}, 75^{th} - 90^{th} percentiles or ± 2 SD
- Measurements less then 10^{th} , above 90^{th} percentiles or ± 3 SD are **pathological.**


Weight-for-age BOYS
Birth to 6 months (z-scores)
The boy is 6 weeks old and weighs 5 kg.
Weight (kg)
11
10
9
8
7
6
5
4
3
2
3
2
1
0
-1
-2
-3
Weeks 0 1 2 3 4 5 6 7 8 9 10 11 12 13
Months 3 4 5 6
Age (Completed weeks or months)

Length-for-age GIRLS

6 months to 2 years (z-scores)



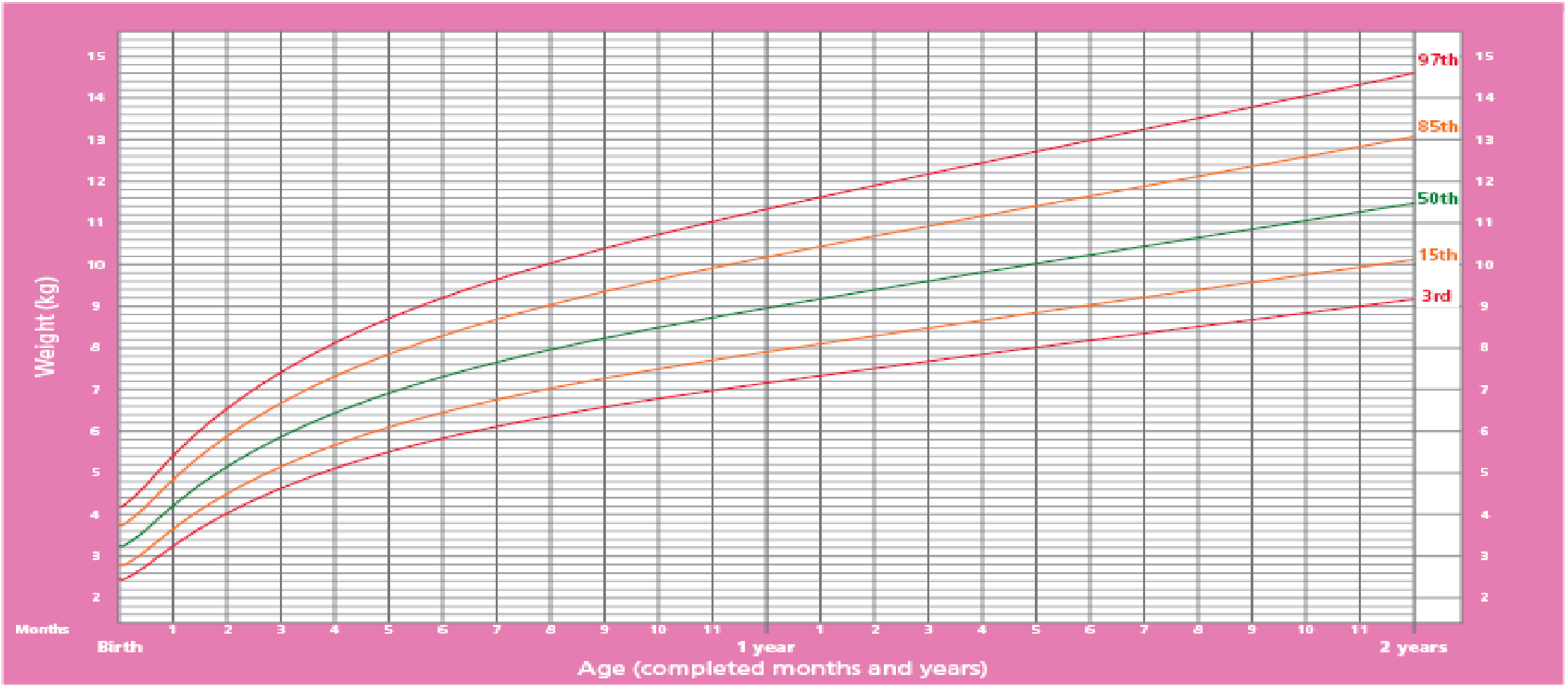
This **Length-for-age** chart shows growth in length relative to age in comparison to the median (0 line).

- A child whose length-for-age is below the line –2 is **stunted.**
- Below –3 is **severely stunted.**

Weight-for-age GIRLS

Birth to 2 years (percentiles)

World Health Organization



WHO Child Growth Standards

Weight of a body up to 1 year

- Up to 6 months: **m = m0 + 600+800×(n-1)**

  n – months after 1 (because 1 is 600g always)

- body mass in the second half year (from 6 till 12 months) is:
- **m = m0 + (800 x 6) + 400 (n - 6),**
- where m0 is initial mass, n is age of the child (months);

Body weight after 1 year:

- From 2 to 10 years

  M = 10 + 2n,

  where n is the age of the child in years.

- Older than 10 years:

  M = 30 + 4 (n-10),

  where n is the age of the child in years.

Length of the body

- **for the I st quarter. - 3 cm per month**
  (for a quarter of 9 cm);
- **for the II nd quarter. - 2.5 cm per month**
  (for the quarter of 7.5 cm);
- **for the III quarter. - 1,5 cm per month**
  (4.5 centimeter for the quarter);
- **for the IV quarter. - 1.0 cm per month**
  (for a quarter of 3 cm).

You can use this formula for the Growth up to 1 year but it is not very accurate

- Up to 6 months = **L in 6 months - 2.5 (n-1)**
- After 6 months = **L in 6 months + 1.5 (n-6)**
- In 6 months the length of the child's body is 66 cm

Growth after 1 year

- Up to 4 years:

  L = 100 - 8 (4-n);

- Older than 4 years:

  L = 100 + 6 (n-4),

  where n is the age of the child in years.

- In 4 years, height = 100 cm

Circumference of the chest up to 1 year

- Monthly increases by 1.3 cm;
- Up to 6 months = **45 - 2 (6-n)**,
- after 6 months = **45 + 0.5 (n-6),**

where n - the age of the child in months

- In 4 months Circumference of the chest=Circumference of the head
- At 6 months = 45 cm.

Circumference of the chest after 1 year

- from 1 to 10 years = **63 - 1.5 (10-n);**
- older than 10 years = **63 + 3 (n-10),**

where n is the age of the child in years.

Head circumference

- Monthly increases by 1.5 cm to 6 months,
- After 6 months per 0.5 cm monthly;

- At 6 months Head circumference = 43 cm.

- Up to 6 months head circumference = **43-1.5 (6-n);**
- After 6 months = **43 + 0.5 (n-6),**

where n is the age in months.

Head circumference after 1 year

- from 1 to 5 years = 50-1 (5-n);

- after 5 years = 50 + 0.6 (n-5), where n is the age of the child in years.

Anthropometric indexes

- **Mass-length (weight-height) parameter** is calculated only in newborn:

mass of body (g) : length of body (cm)

In norm this parameter is 60-70.
55-60 – prenatal hypotrophy of I degree.
50-55 – II d.
<50 – III d.

- **Index of trophism** is calculated only till 1.5 years:

(mass present : mass ideal) x100 %.

In norm it is 100±10 %
80-90% – acquired (postnatal) hypotrophy of I d.,
70-80% – hypotrophy of II d.,
<70% – hypotrophy of III d.

Somatotype

- The region of intervals N1, 2, 3 is region of slowed physical development – microsome
- The regions of 6, 7, 8 intervals is reg. of accelerated physical development - macrosome
- region of 4 and 5 intervals is reg. of normal rate of physical development – mesosome

Deviation from normal physical development at childhood

- Stunting (growth failure)
- Shot stature
- Small stature
- Nanism (dwarfism)
- Gigantism

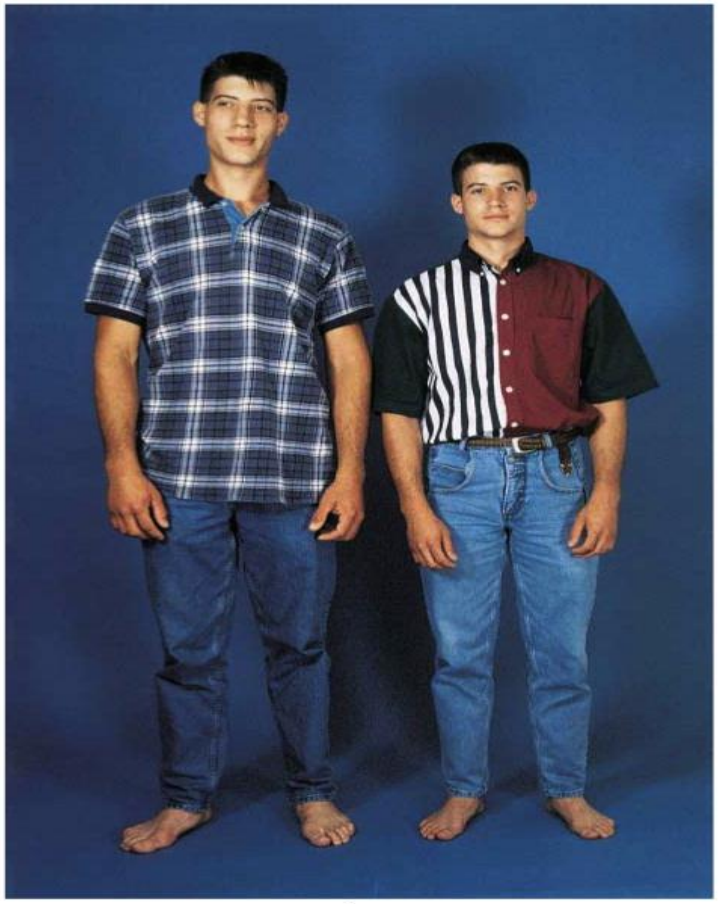
- Failure to gain weight
- Malnutrition (hypotrophy)
- Underweight
- Overweight
- Obesity

- Growth failure – failure to maintain a normal height velocity that is appropriate for age and maturity
- Short stature - height less than 2 SD for age below the mean for age and gender
- Height less than 3 SD for age below the mean for age and gender is called Nanism (dwarfism)

Dwarfism due to growth hormone deficiency

Pituitary nanism

Gigantism



A

B

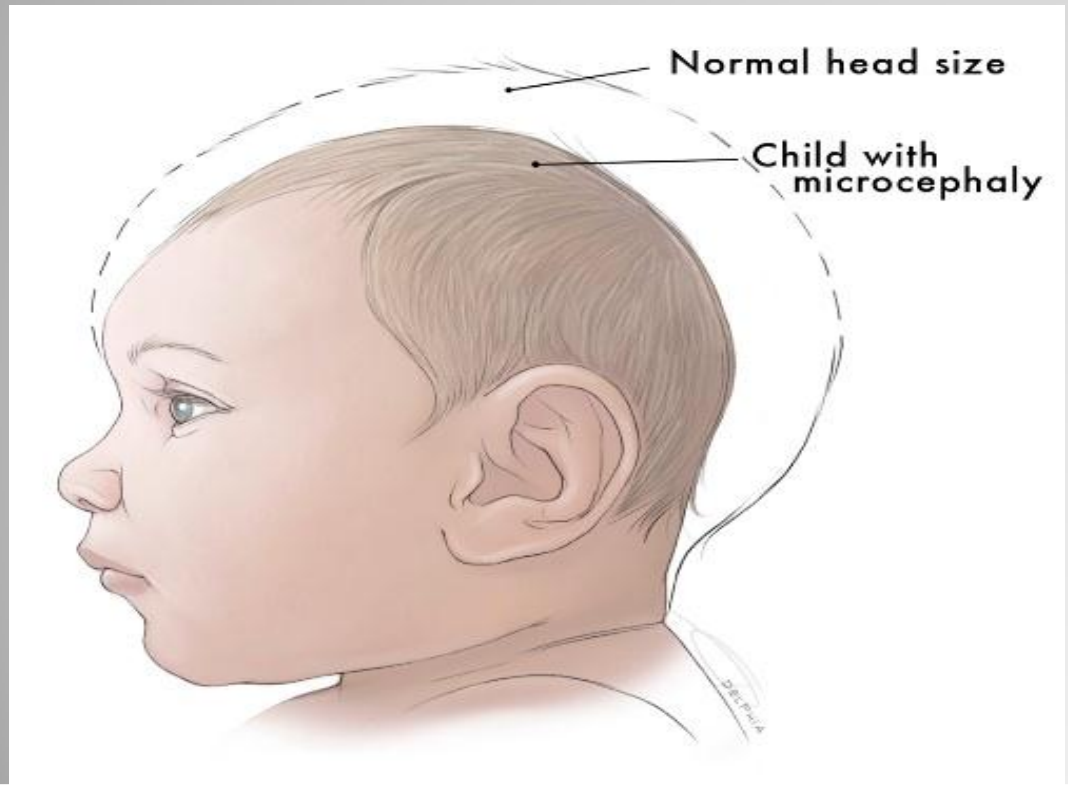
C

Causes of tall stature

- Constitutional
- Endocrine: Pituitary adenoma,
  Cerebral Giagantism
  Thyreotoxicosis
- Genetic diseases:
  Klinefelter ‘s syndrome,
  Marfan syndrome

Microcephaly

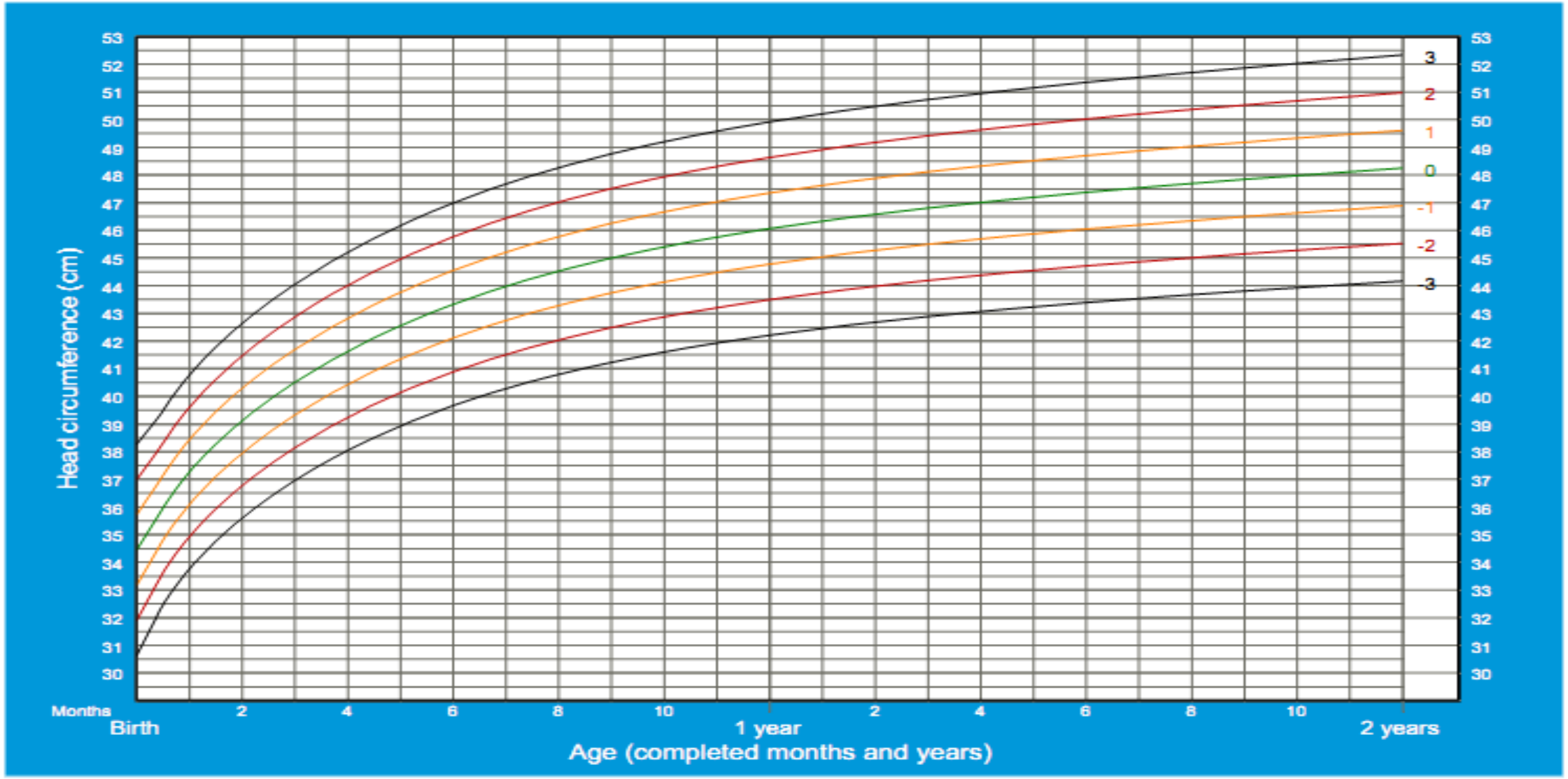
- A head circumference is less then 3 SD below the mean for sex and age



Head circumference-for-age BOYS

World Health Organization

Birth to 2 years (z-scores)



WHO Child Growth Standards

BMI in kg/m^2 =

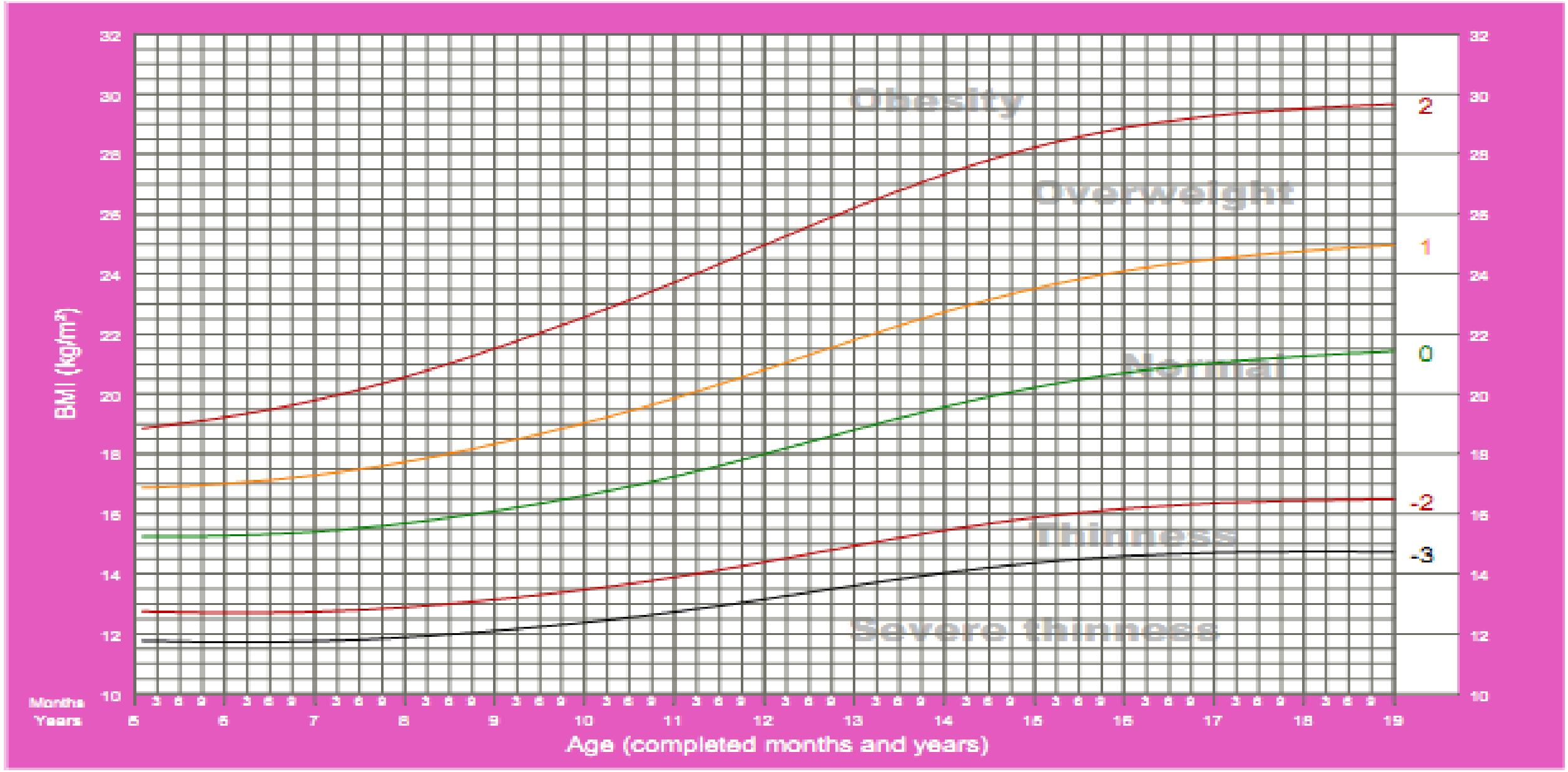
weight in kg / height in m^2

Body mass index

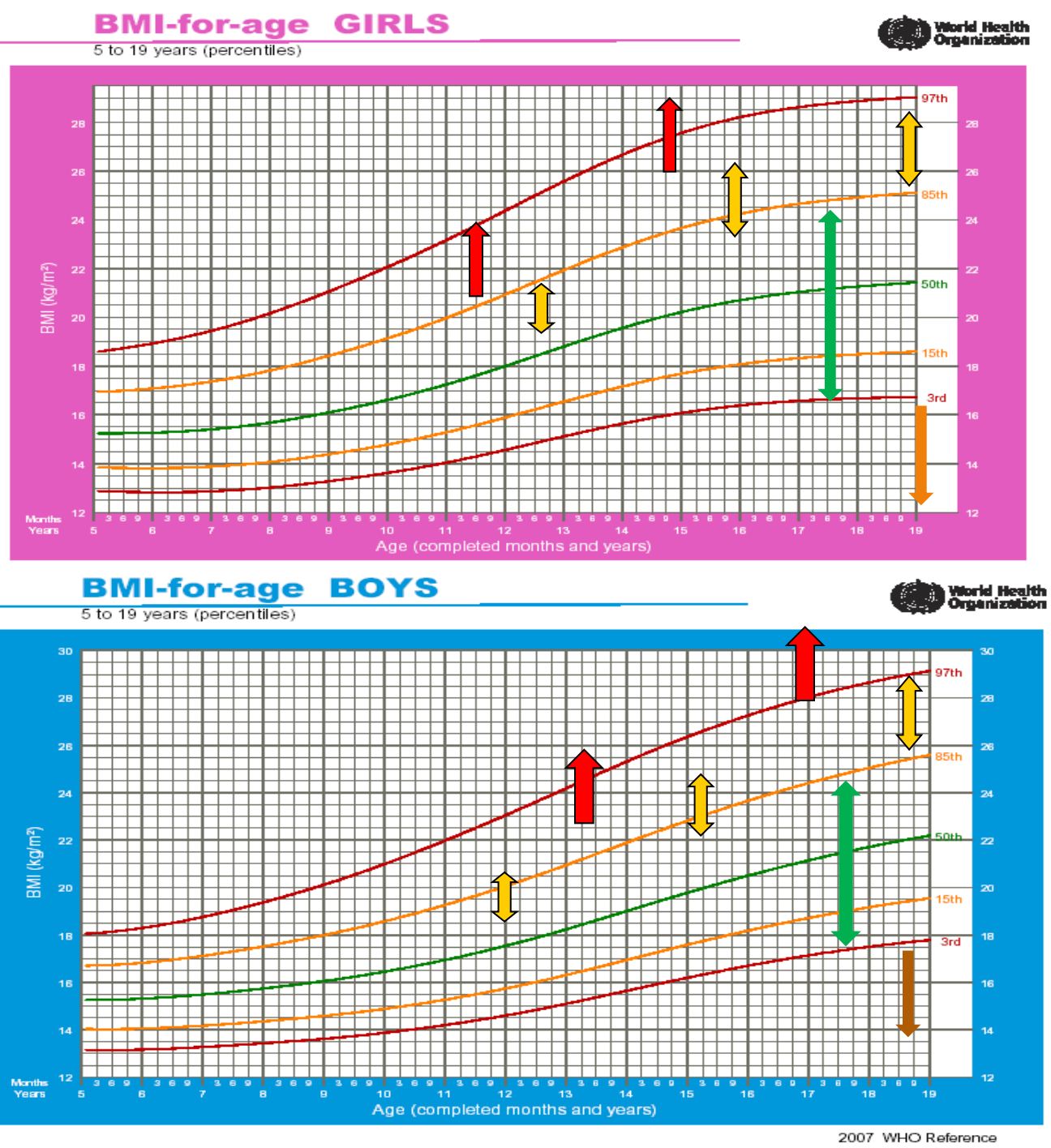
BMI-for-age GIRLS

5 to 19 years (z-scores)

World Health Organization



2007 WHO Reference



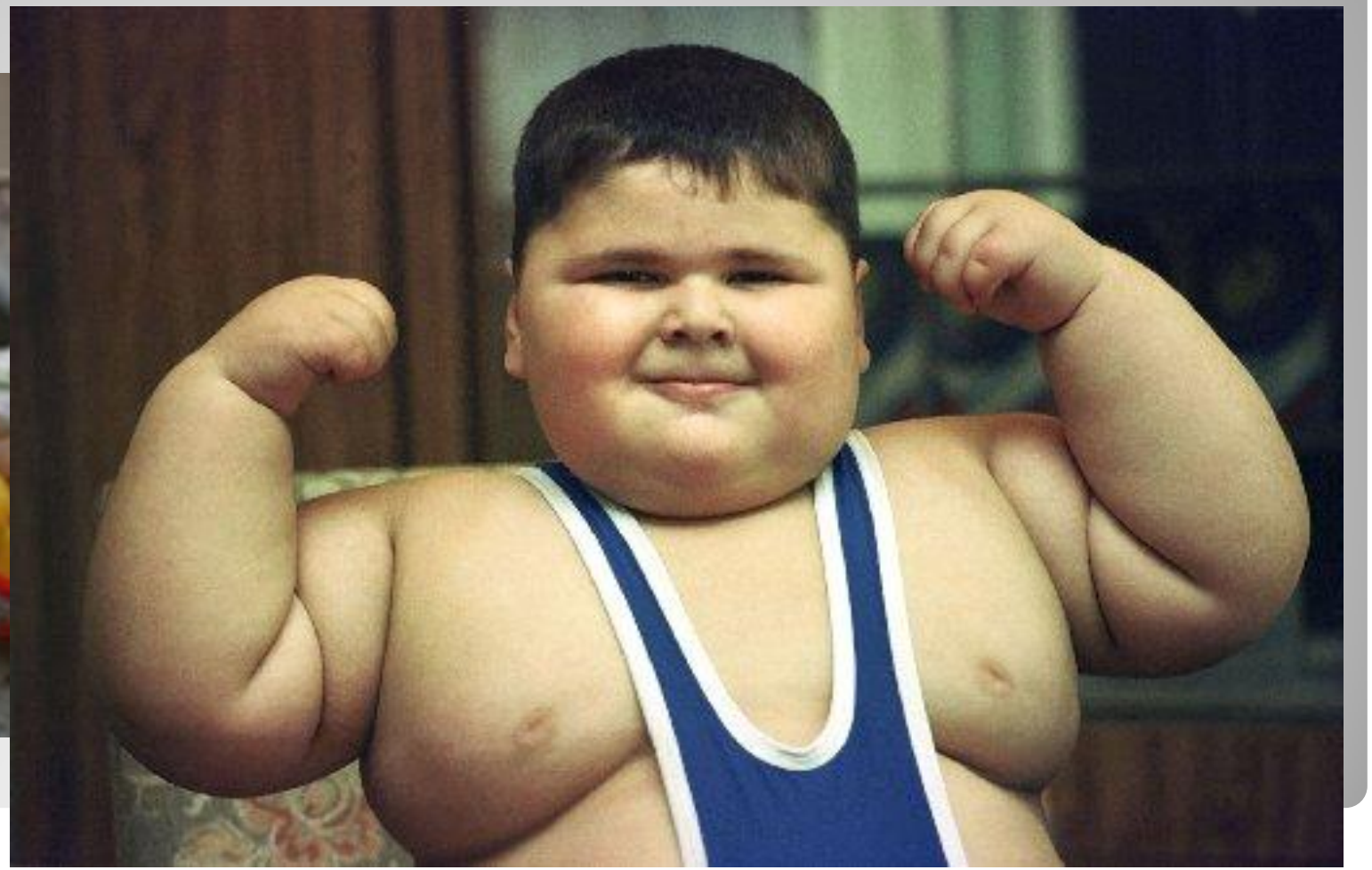
BMI> 95- centile
obesity

BMI= 85-95 centile
overweight

BMI= 5-85 centile
normal weight

BMI < 5 centile
underweight

Paratrophy and obesity



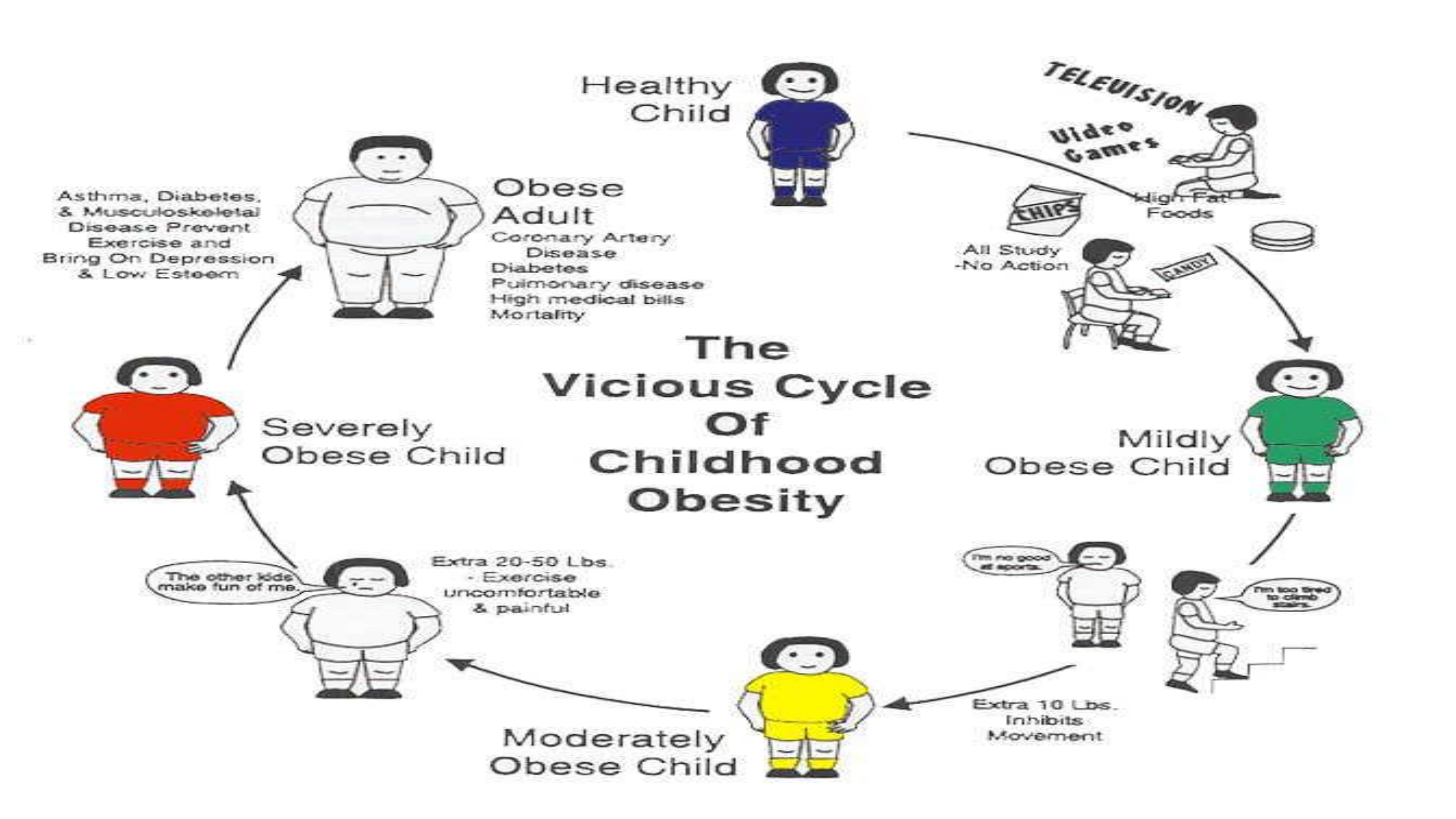
Paratrophy

- I d. – 10-20%
- II d. – 20-30%
- III d. - > 30% of excessive mass

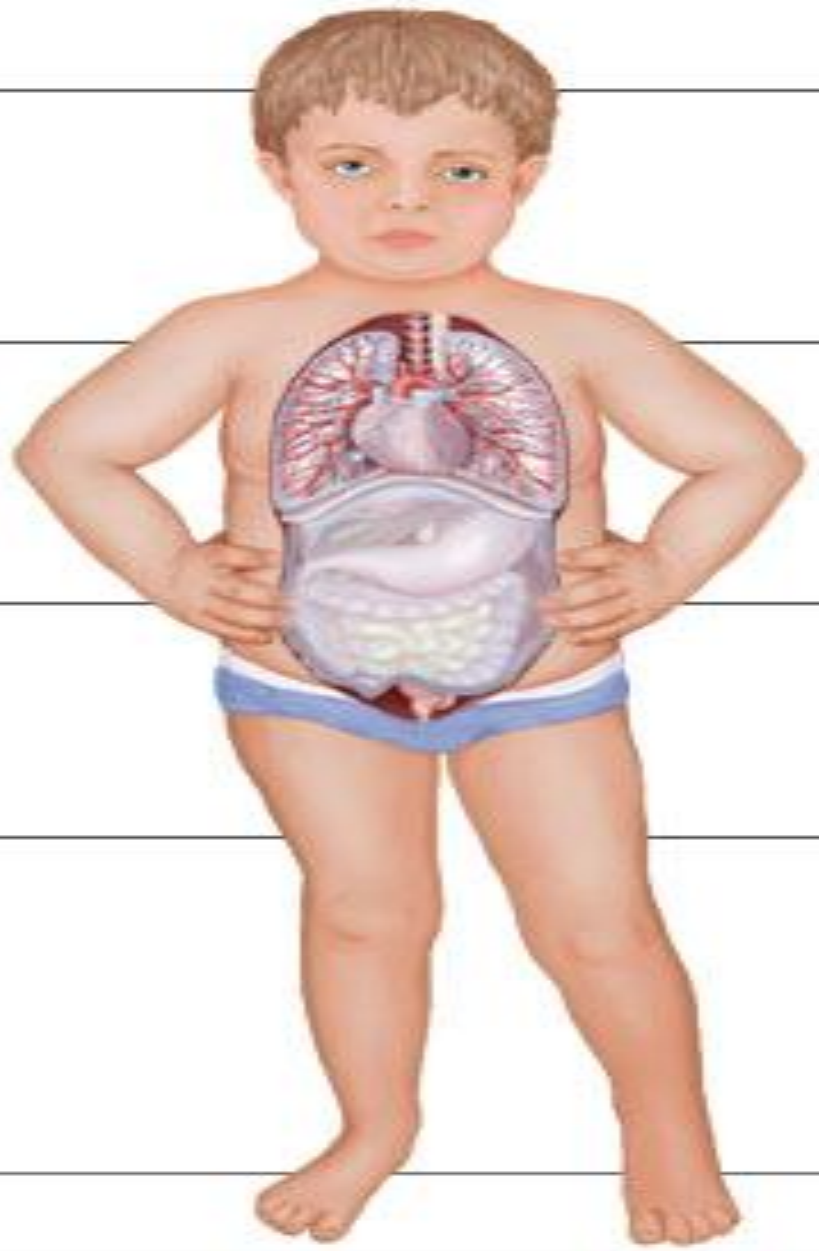
Obesity

- I d. – 10-30%
- II d. – 30-50%
- III d. – 50-100%
- IV d. - >100% of excessive mass

The Vicious Cycle Of Childhood Obesity



Childhood Obesity Complications



Psychological
Stress and Anxiety
Eating Disorder Risk
Poor Self-esteem
Poor Social Skills
Social Isolation

Pulmonary
Asthma
Exercise Intolerance
Sleep Disorders
Sleep Apnea

Gastrointestinal
Fatty liver
Gallstone
Acid Reflux

Musculoskeletal
Bone and Joint Disorders
Flat Feet
Blout's Disease
Femoral Epiphysis

Central
Fatique
Skin Infections
Skin Rashes

Cardiovascular
Hypertension
Heart Disease
Blood Clots
High Cholesterol
Endothelial Dysfunction

Renal
Kidney Disease
Glomerulosclerosis
Kidney Failure

Endocrine
Diabetes
Early Puberty
Polycystic Ovary (Girls)
Hypogonadism (Boys)

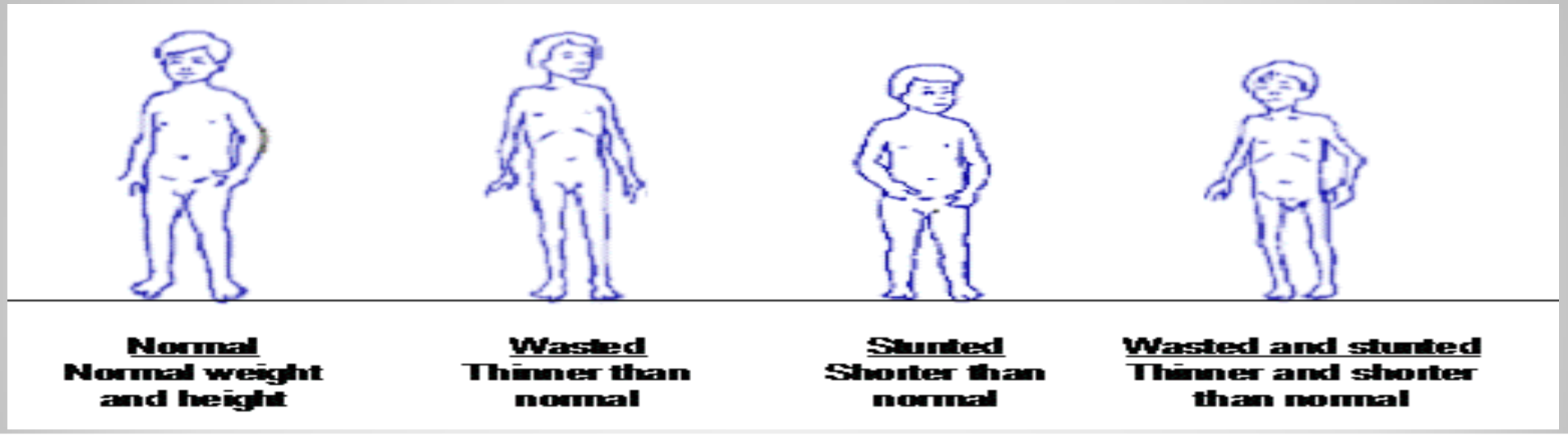
Malnutrition (hypotrophy)

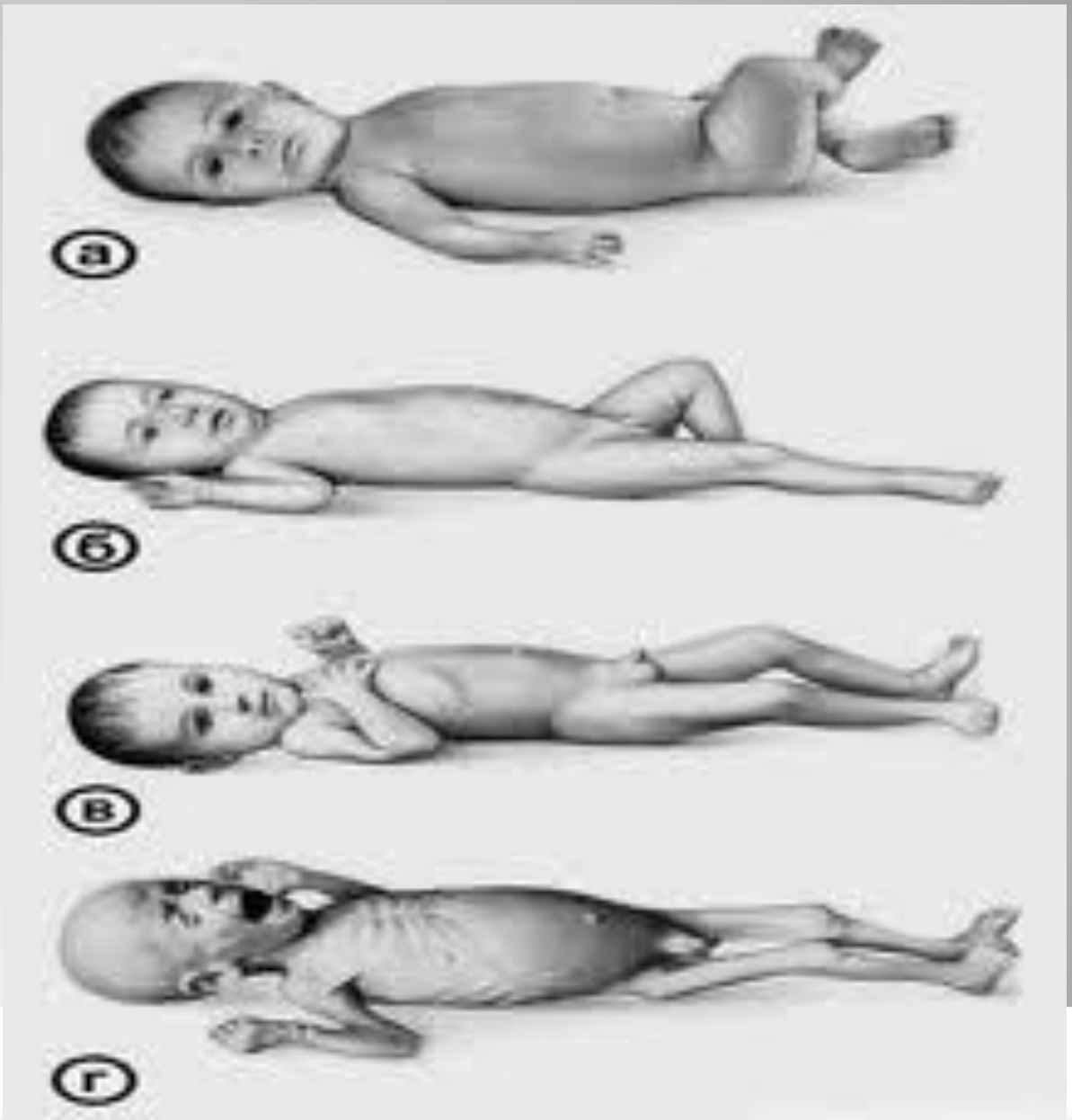
- the result of a lack of essential nutrients, resulting in poorer health, may be caused by a number of conditions or circumstances.

- In many developing countries long-term (chronic) malnutrition is widespread - simply because people do not have enough food to eat.

Malnutrition

STAGE	WEIGHT DEFICITE	LENTH DEFICITE
I	10-20%	0
II	20-30%	2-4 cm
III	More than 30%	7-10 cm




а
б
в
г

Thank you for your attention!

Literature, was used in the lecture

- 1.Nelson Textbook of Pediatrics: 21th edition / Klegman S, Geme ST, Tasker W, 2021. – 1078 p. 2. Основи педіатрії за Нельсоном: переклад 8-го англ. видання : у 2 томах. Том 1 / Карен Дж. Маркданте, Роберт М. Клігман. – К.: ВСВ «Медицина», 2019. – XIV, 378 с. 3.Пропедевтична педіатрія : підручник для студентів вищих медичних навчальних закладів IV рівня акредитації / В. Г. Майданник [та ін.]. - 2-ге вид., випр. та допов. - Вінниця : Нова кн., 2018. - 871 с. : табл., іл. . 4.Педіатрія : підручник для студентів вищих медичних навчальних закладів IV рівня акредитації / О. В. Тяжка [та ін.] ; за ред. О. В. Тяжкої ; Нац. мед. ун-т ім. О. О. Богомольця МОЗ України. - 5-те вид., випр. та допов., оновлене. - Вінниця : Нова кн., 2018. - 1150 с. : табл., іл. 5.Педіатрія : національний підручник : у 2 т. / Д.Д. Іванов, С.В. Кушніренко, Д.А. Сеймівський [та ін.] ; за ред. В.В. Бережного; Асоціація педіатрів України. – К. : Сторожук О.В., 2013. – Т. 2. – 1021 с. 6. Henderson G, Anthony M, Quigley M. Formula milk versus term human milk for feeding preterm or low birth weight infants. Cochrane Database of Systemic Reviews . 2020; 77(6):1537S-43. 7. Elwyn DH, Askanazi J, Kinney JM, Gump FE. Kinetics of energy substrates. Ada Chir Scand Suppl 2019;507:209-19. 8. Talpers SS, Romberger DJ, Bunce SB, Pingleton SK. Nutritionally associated increased carbon dioxide production. Excess total calories vs high proportion of carbohydrate calories. Chest 2019;102(2):551-5.9. Askanazi J, Weissman C, LaSala PA, Milic-Emili J, Kinney JM. Effect of protein intake on ventilatory drive. Anesthesiology 2019;60(2):106—10. 10. Klein CJ, Stanek GS, Wiles 3rd CE. Overfeeding macronutrients to critically ill adults: metabolic complications. J Am Diet Assoc 2019;98(7):795-806. 11. Pineault M, Chessex P, Bisaillon S, Brisson G. Total parenteral nutrition in the newborn: impact of the quality of infused energy on nitrogen metabolism. Am J Clin Nutr 2019;47(2):298-304. 12. Koletzko B, Goulet O, Hunt J, Krohn К Shamir R, Parenteral Nutrition Guide¬lines Working G, et al. Guidelines on Paediatric Parenteral Nutrition of the European Society of Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) and the European Society for Clinical Nutrition and Metabolism (ESPEN), supported by the European Society of Paediatric Research (ESPR). J Pediatr Gastroenterol Nutr 2020;41(Suppl. 2):Sl-87. 13. Rodriguez JL, Askanazi J, Weissman C, Hensle TW, Rosenbaum SH, Kinney JM. Ventilatory and metabolic effects of glucose infusions. Chest 2118;88(4): 512-8. 14. Extracorporeal Life Support Organization (ELSO). ELSO Guidelines for Neonatal Respiratory Failure Supplement to the ELSO General Guidelines. 2018 Dec [cited 2018 Jun 22]; 15. The Neonatal Inhaled Nitric Oxide Study Group. Inhaled nitric oxide in full-term and nearly full-term infants with hypoxic respiratory failure. N Engl J Med. 2018;336(9):597–604. 16. Robertson C, Sokol GM, Solimano A, Singer J, et al. Early Inhaled Nitric Oxide Therapy for Term and Near Term Newborn Infants with Hypoxic Respiratory Failure: Neurodevelopmental Follow-Up. J Pediatr. 2017 Mar;150(3):235–240.e1.
- **Інтернет – ресурси:**
- Сайти МОЗ України: https://moz.gov.ua/protokoli Онлайн-платформа з протоколами на засадах доказової медицини Джерела клінічних настанов Інформаційні ресурси http://www.booksmed.com/pediatriya http://pediatriya.info http://health-ua.com/parts/pediatrics http://www.med-edu.ru/pediatr. http://www.medport.info/index.php?option=com_content&view=section&id=48&Itemid=73 http://youalib.com/медицина/педіатрія