Mal – Nutrition screening in paediatrics

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Nutrition is the provision of adequate energy and nutrients (in terms of amount and mix and timeliness) to the cells to enable them to perform their physiological function (of growth, reproduction, defense, repair, etc).

Malnutrition is the result of a lack or an excess in the provision of energy and/or nutrients to the body (undernutrition or overweight/obesity)

Undernutrition:

- Protein-energy malnutrition
- Micronutrient deficiencies

Overnutrition:

- Overweight and obesity
- Health consequences (diabetes, cardiovascular diseases)

Co-existence of under and overnutrition: “double burden of malnutrition”

- Obesity and PEM in the same family
- Obesity and micronutrient deficiencies in the same individual

Chronic and acute malnutrition

Malnutrition refers to poor nutritional status

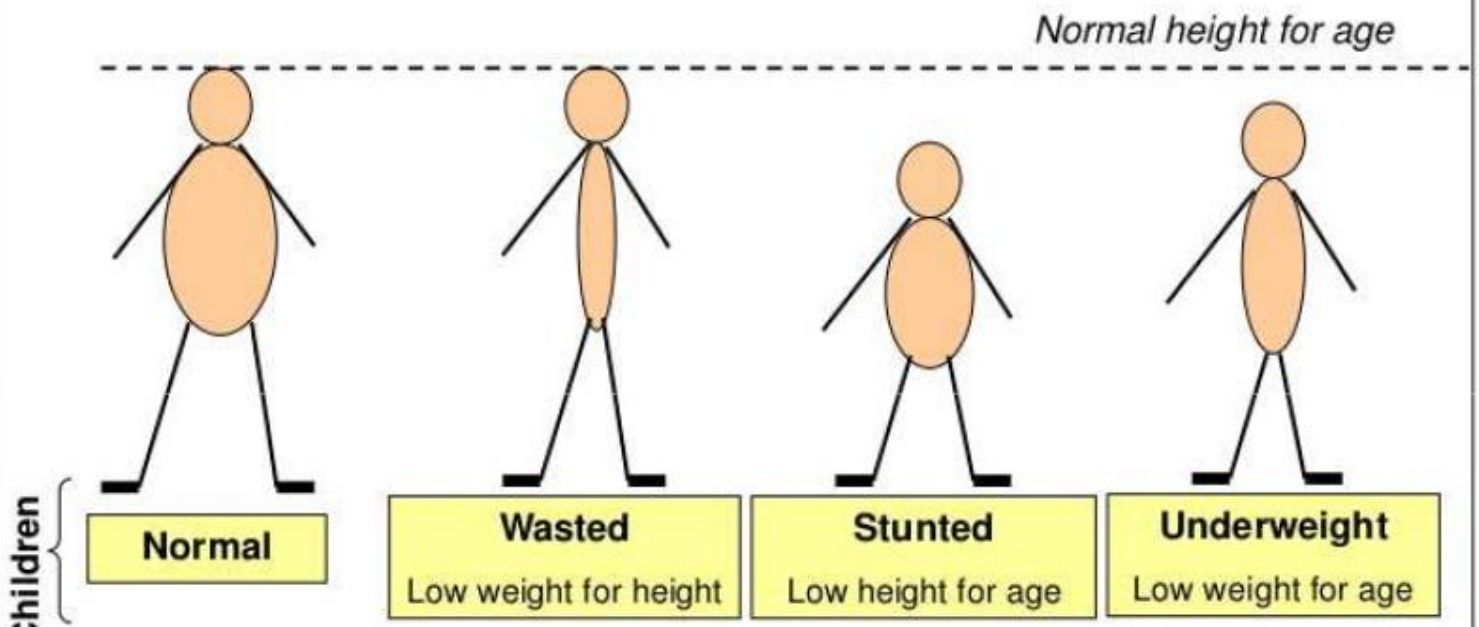
Undernourishment* is an FAO concept : it is the number or proportion of persons whose energy consumption is less than their minimum energy needs

“Malnourished” can refer to the state of malnutrition or to inadequate food intakes

Hunger is defined as “a feeling of discomfort or weakness caused by lack of food, coupled with the desire to eat”

* Also designated as “chronic hunger”

Different Types of Childhood Malnutrition



Wasting means that the infant/child is thin: she/he has lost fat and muscle mass

Stunting means that the infant/child is short in stature: she/he did not grow in length/height has he/she should have

Underweight means that she/he weighs less than she/he should

A child can be both wasted and stunted

Wasting is usually due to a recent lack of food or illness (infections) that prevents the child from eating or absorbing nutrients of foods

Stunting is a long term process, often starting in utero which is due to the mother's malnutrition, to food intake lacking quality (insufficient intake of essential micronutrients) and the repetition of episodes of common infections

Overweight and obesity are due to excessive energy intake and lack of physical activity

Remarks on the difference between wasting and stunting

Wasting is more easily detectable than stunting

Wasting is the result of recent lack of food and illness while stunting develops over time, often starting during pregnancy

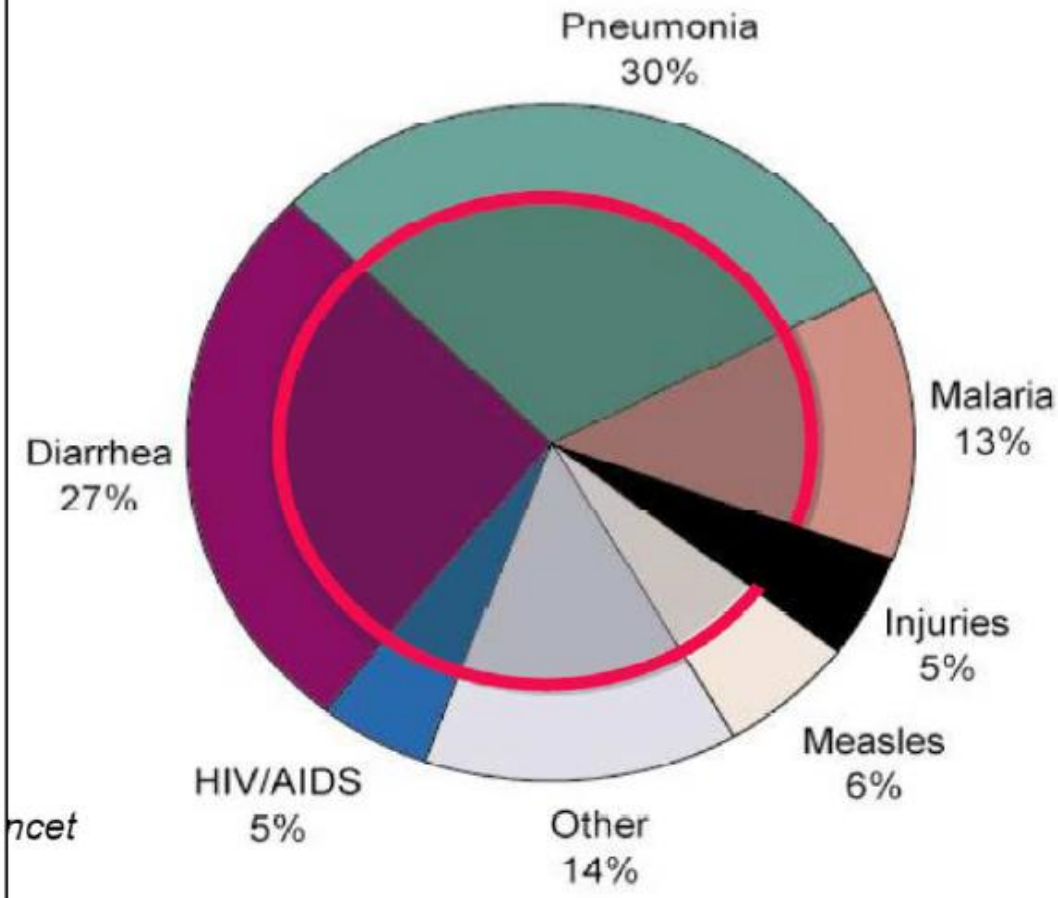
Stunted mothers produce stunted babies

Stunting has long term and permanent consequences on health and cognitive development

Stunting is a cause and a consequence of poor human development

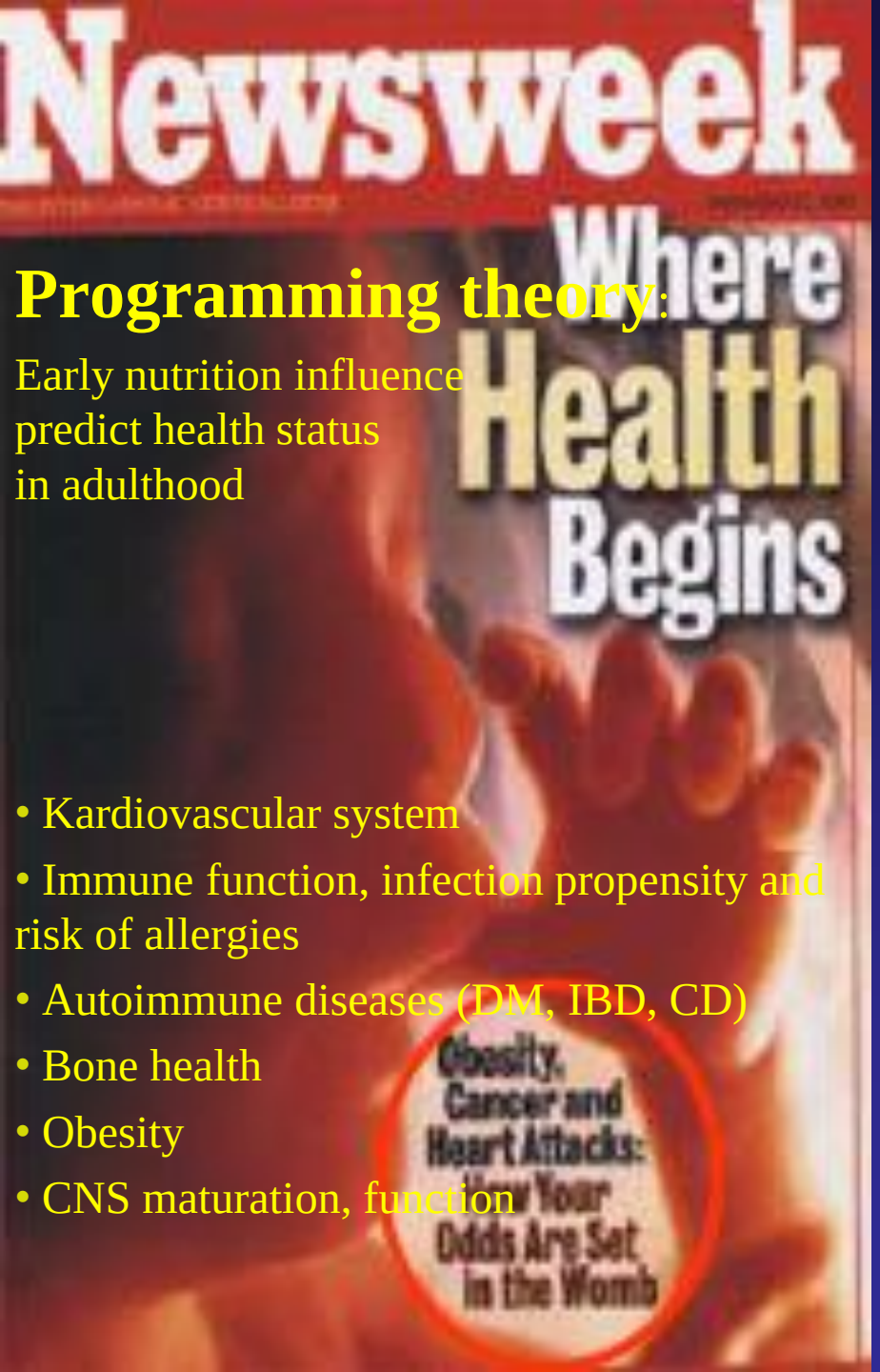
Impact of undernutrition on child mortality*

Undernutrition is rarely a direct cause of death.
It is most often an underlying cause of death from common illnesses of which it increases the occurrence and severity: approx. 45% of mortality due to common illnesses is attributed to malnutrition.
Most deaths occur in moderately malnourished children



ncet

* Among infants and children under five years, excluding neo-natal mortality



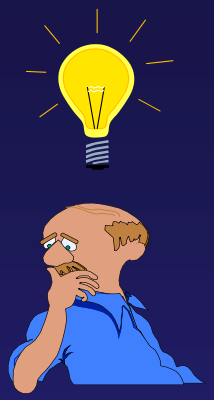
Programming theory:

Early nutrition influence predict health status in adulthood

- Kardiovascular system
- Immune function, infection propensity and risk of allergies
- Autoimmune diseases (DM, IBD, CD)
- Bone health
- Obesity
- CNS maturation, function

- Programming of human adult function and diseases by hormones, metabolites and neurotransmitters during critical development periods
  G. Dörner, Berlin, Germany 1974
- Programming by early nutrition in man
  A. Lucas, Cambridge, UK 1991
- Fetal programming of adult disease by poor fetal nutrition and low birth weight
  D.Barker, Southampton, UK 1992

„Barker hypothesis“



- fetal undernutrition leads to the disproporcional growth of featus and programmes later development of diseases in adulthood

Barker theory

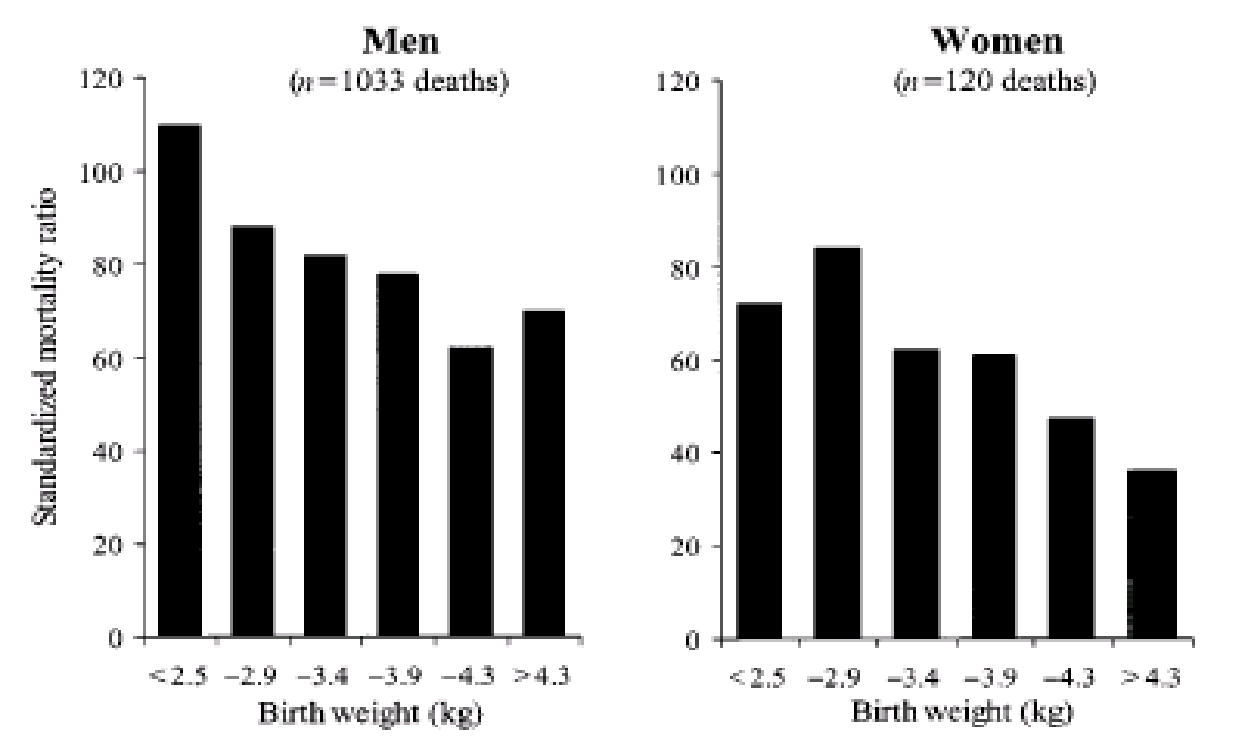
Hertfordshire
Preston
Sheffield

analysis of incidence CV morbidity in Great Britain

I. World War — 80th

perinatal data → mortality on CVD

risk factors CVD
- hypertention, DM, cholesterol



Osmond C et al. Early growth and death from cardiovascular disease in women.

BMJ 1993;307:1519-1524

Human tissues ans systems with already prooved programming influence

Tissue or system	Examples of programming
Cardiovascular system	Vascular compliance
	Endothelial function
Respiratory system	Lung volume
Endocrine system	Hypothalamic-pituitary-adrenal axis
	Glucose-insulin metabolism
	Growth hormone–IGF-I axis
Reproductive system	Age at menarche
	Polycystic ovary syndrome
Central nervous system	Schizophrenia
Skeletal muscle	Insulin resistance
	Glycolysis during exercise
Bone	Bone mineral content
Kidney	Renin-angiotensin system
Liver	Cholesterol metabolism
	Fibrinogen and factor VII synthesis
Immune system	Thyroid autoantibodies
	IgE concentrations

[f] IGF-I, insulin-like growth factor I; Ig, immunoglobulin.

The concept of the « 1000 days » window of opportunity

Undernutrition often starts in utero when mothers are malnourished and /or stunted : intra-uterine growth retardation

Undernutrition impairs physical growth and cognitive development

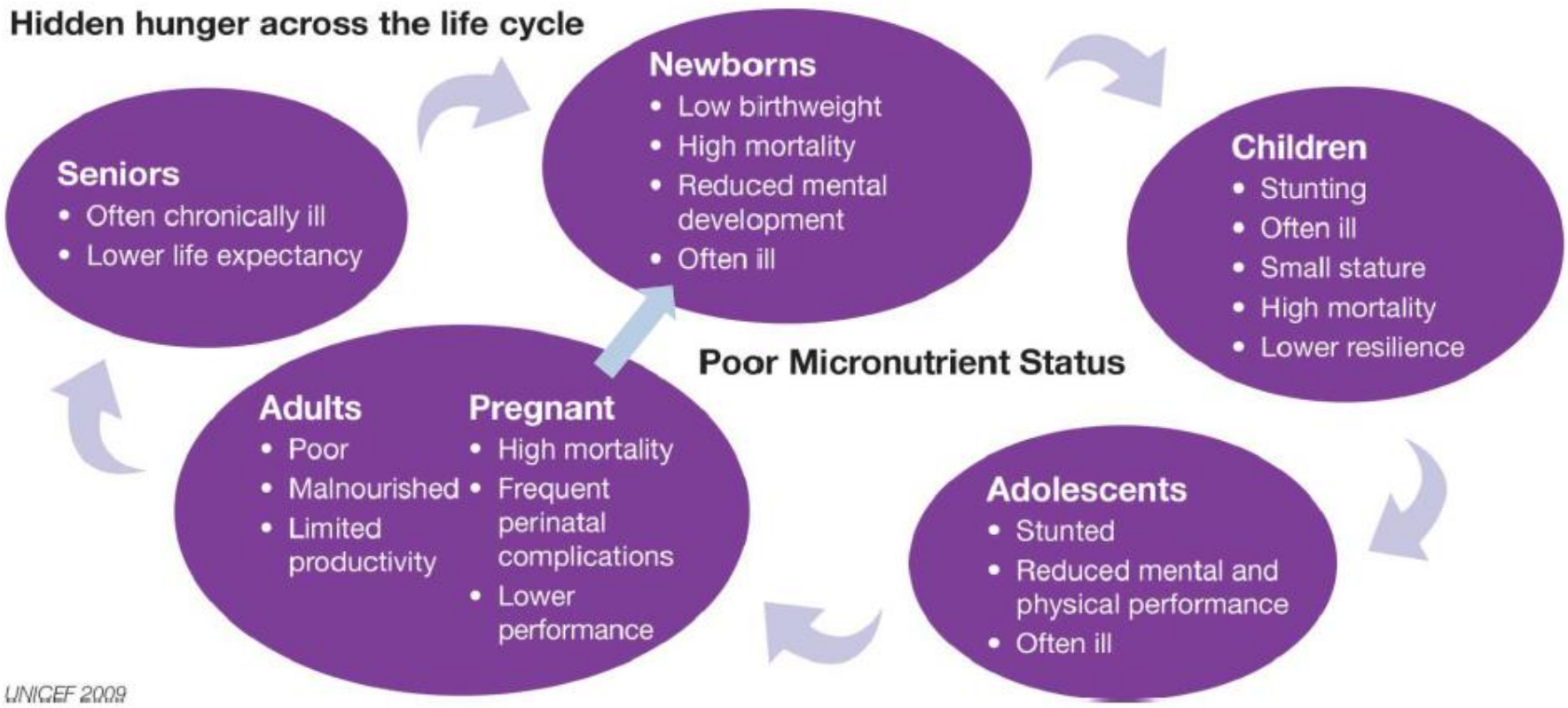
After the age of 2 years damage is usually irreversible

Therefore it is crucial to fight malnutrition during pregnancy and the first 2 years of the child, i.e. the 1000 days between conception and the child's second birthday

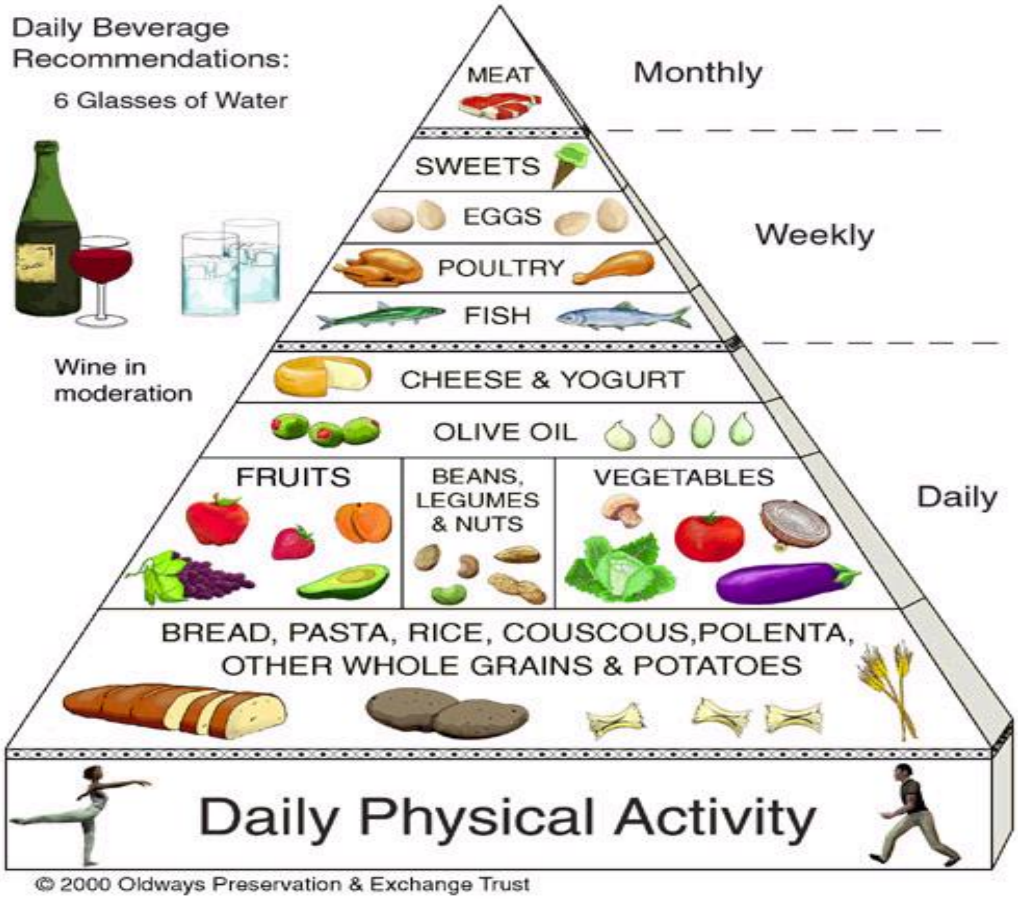
Changes in nutrition behavioral

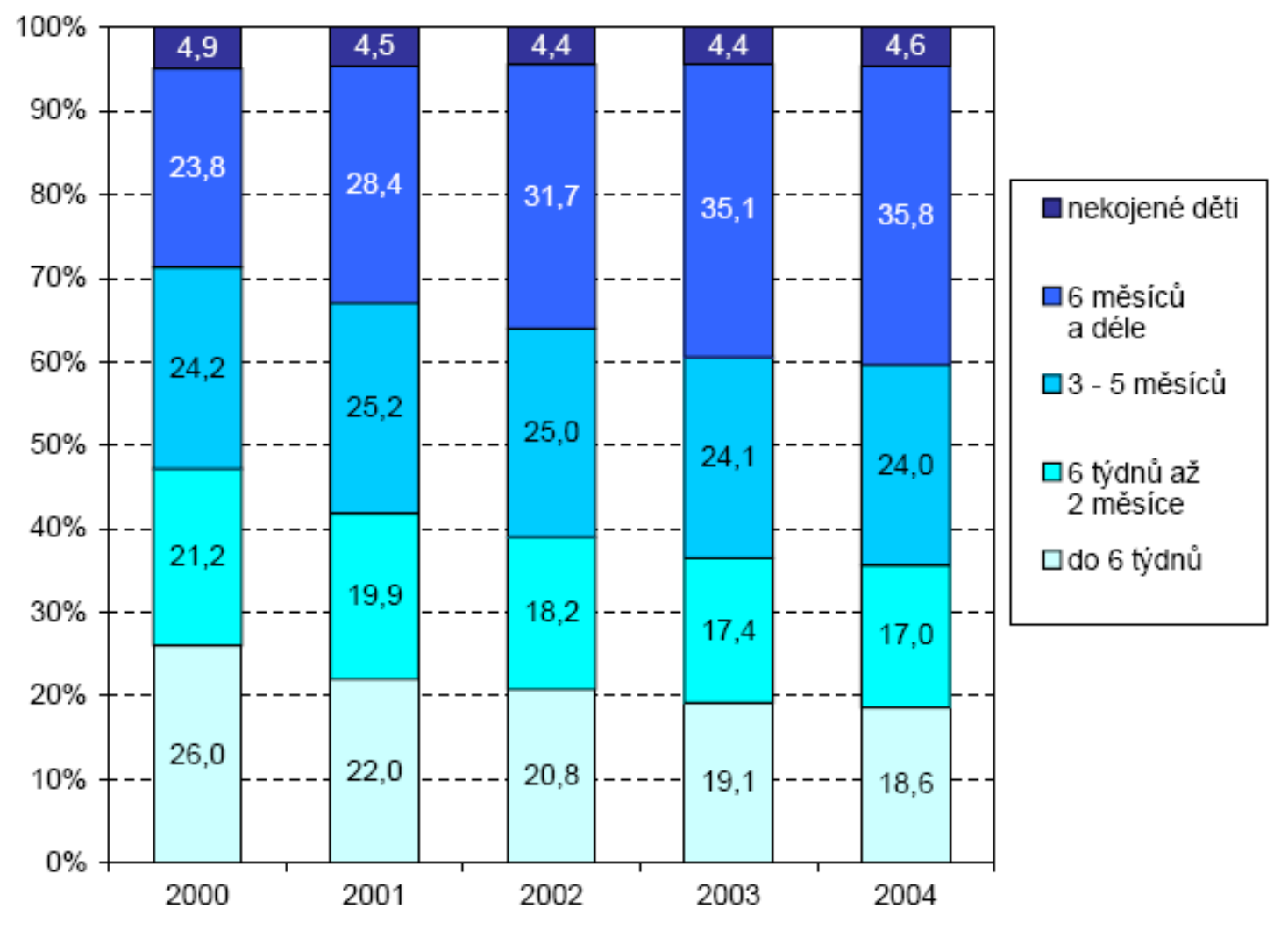
- Changes in structure of family (less members, two generation, mothers at work).
- Technological advances in food processing.
- Urbanisation
- Access to the health service and informations.
- Lower age of children in kindergardens and schools.
- Higher amounts of money in younger children.
- Advertising (junk foods) consequently presure on:
  1) consumption 2) food restriction 3) slim statures models

Nutrition throughout the life-cycle



The Traditional Healthy Mediterranean Diet Pyramid




100%
90%
80%
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50%
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23,8
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24,0
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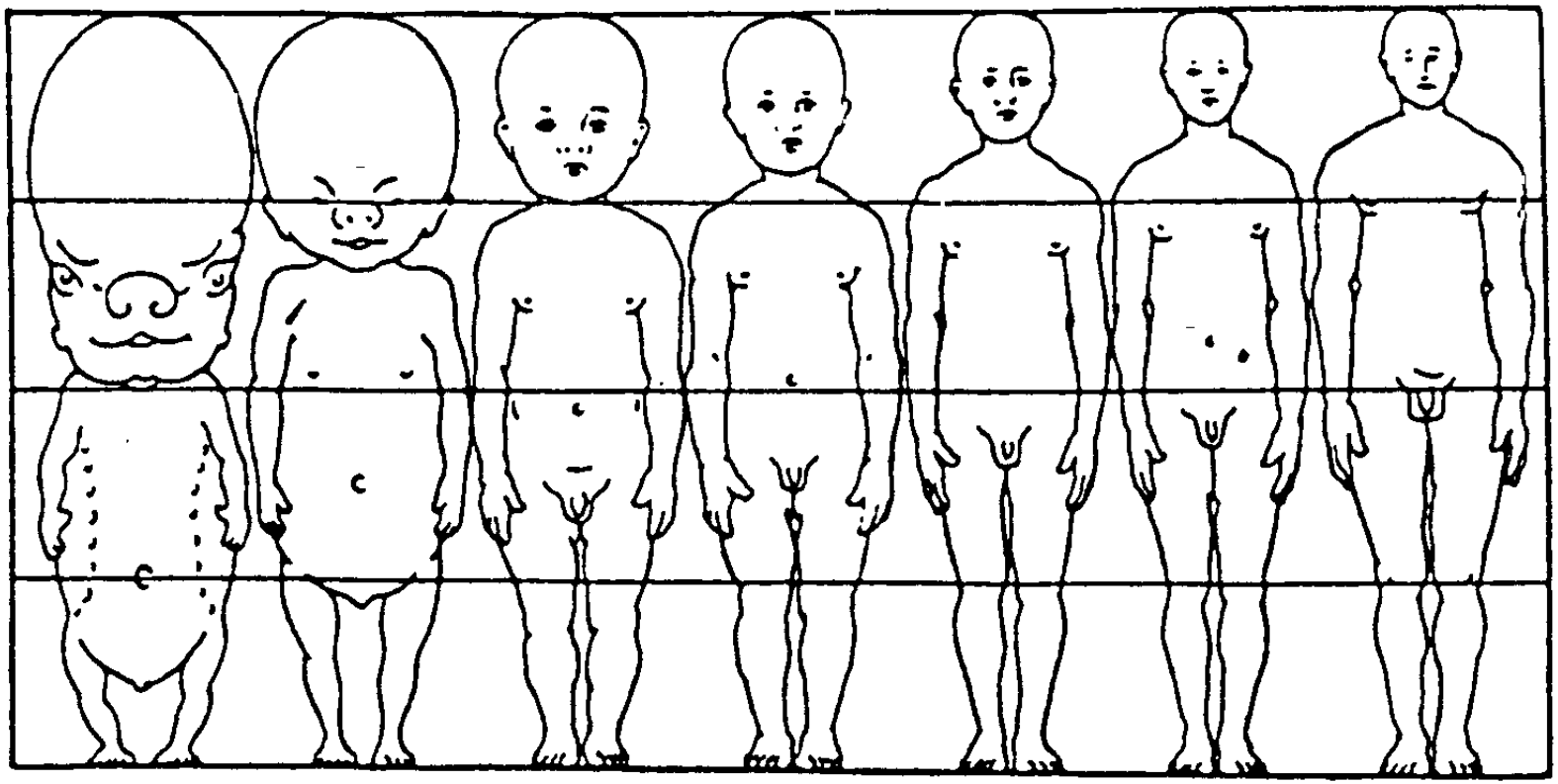
18,6
2000
2001
2002
2003
2004
nekojené děti
6 měsíců a déle
3 - 5 měsíců
6 týdnů až 2 měsíce
do 6 týdnů

Goals of optimal nutrition

- **Adequate growth** with minimal morbidity
- cognitive, mental and motoric **development** ensuring life prosperity
- Induction of optimal sleep activity needed for rytmic **activity of CNS**, mental development and neuroendocrinne regulation
- Support of **immunity** and minimalisation of infection morbidity
- **prevention** and minimalisation of alergic symptoms
- Influence , prevention and decrease of risk factors for **chronic diseases** associated with food intake disorders (anorexia nervosa, bulimia and obezity)

Body changes during life periods



Stratzedt et Robbins

Changes in body composition

Age	Birth	1 y	3 y	12 y	Adulthood
BW	3.250 kg	10 kg	14 kg	36 kg	65 kg
BL/H	50 cm	75 cm	95 cm	145 cm	175 cm
Lipids	0.5 kg	x 4.0	x 4.5	x 13	x 22
Proteins	0.4 kg	x 4.5	x 5.5	x 18	x 30

Measurements of body dimensions cannot be interpreted directly

Indices have a biological interpretation :

- e.g. height for age
- they can be expressed in comparison to a reference population (standard deviation from the median of a reference population = standard)

Indicators :

- a cut-point for the index is defined, differentiating normal and at risk individuals
- the indicator is the % of individuals below (or above) the cut-point

The most commonly used body measurements and indices derived

Weight:

- birth weight
- weight for age

Height:

- height for age
- weight for height
- body mass index

Mid upper arm circumference (MUAC)

Waist circumference

Infant and young child anthropometric indices and indicators of *undernutrition*

Wasting: low weight-for-height is a sign of *acute malnutrition :*

Indicator = prevalence of wasting

Stunting: low height-for-age is a sign of *chronic malnutrition :*

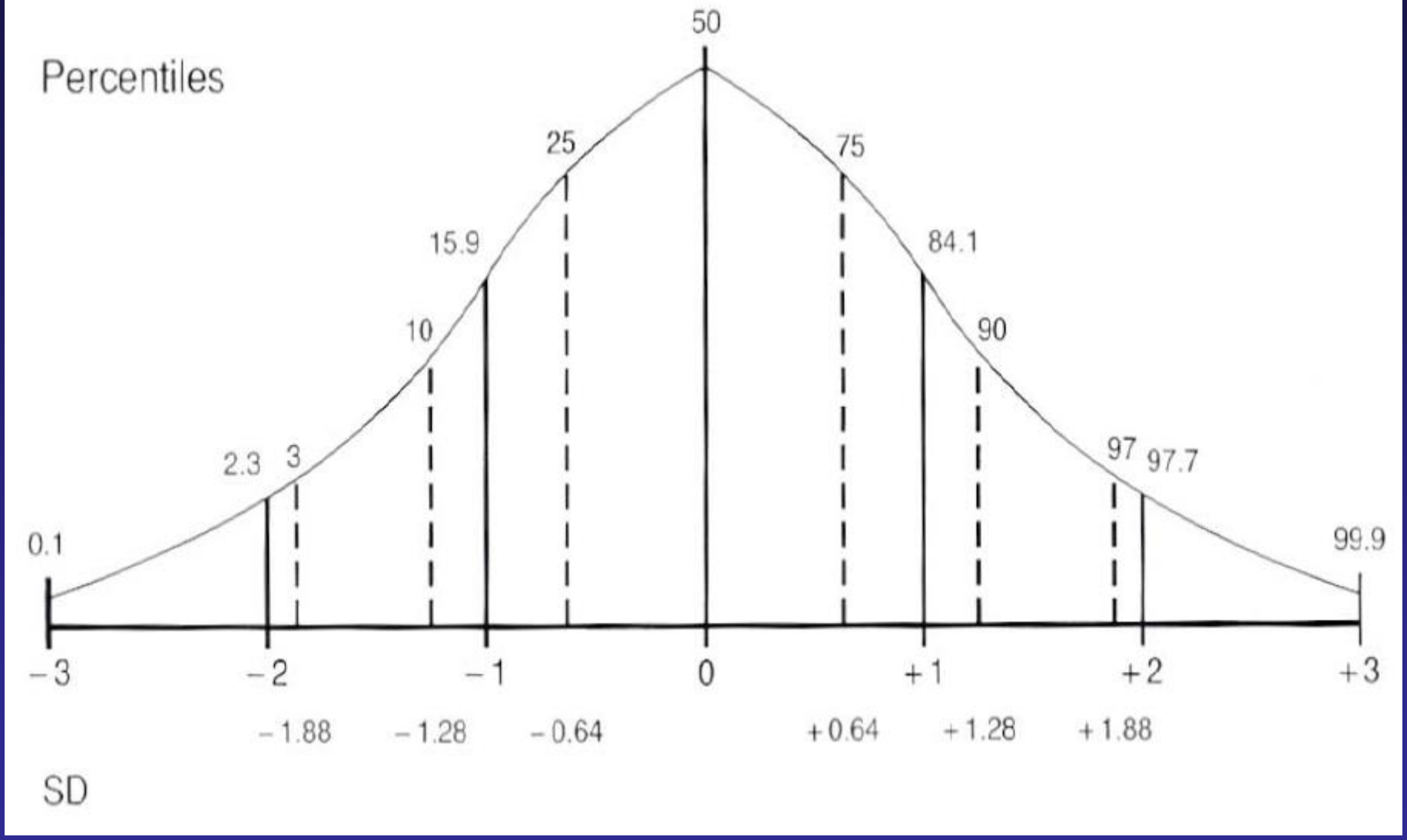
Indicator = prevalence of stunting

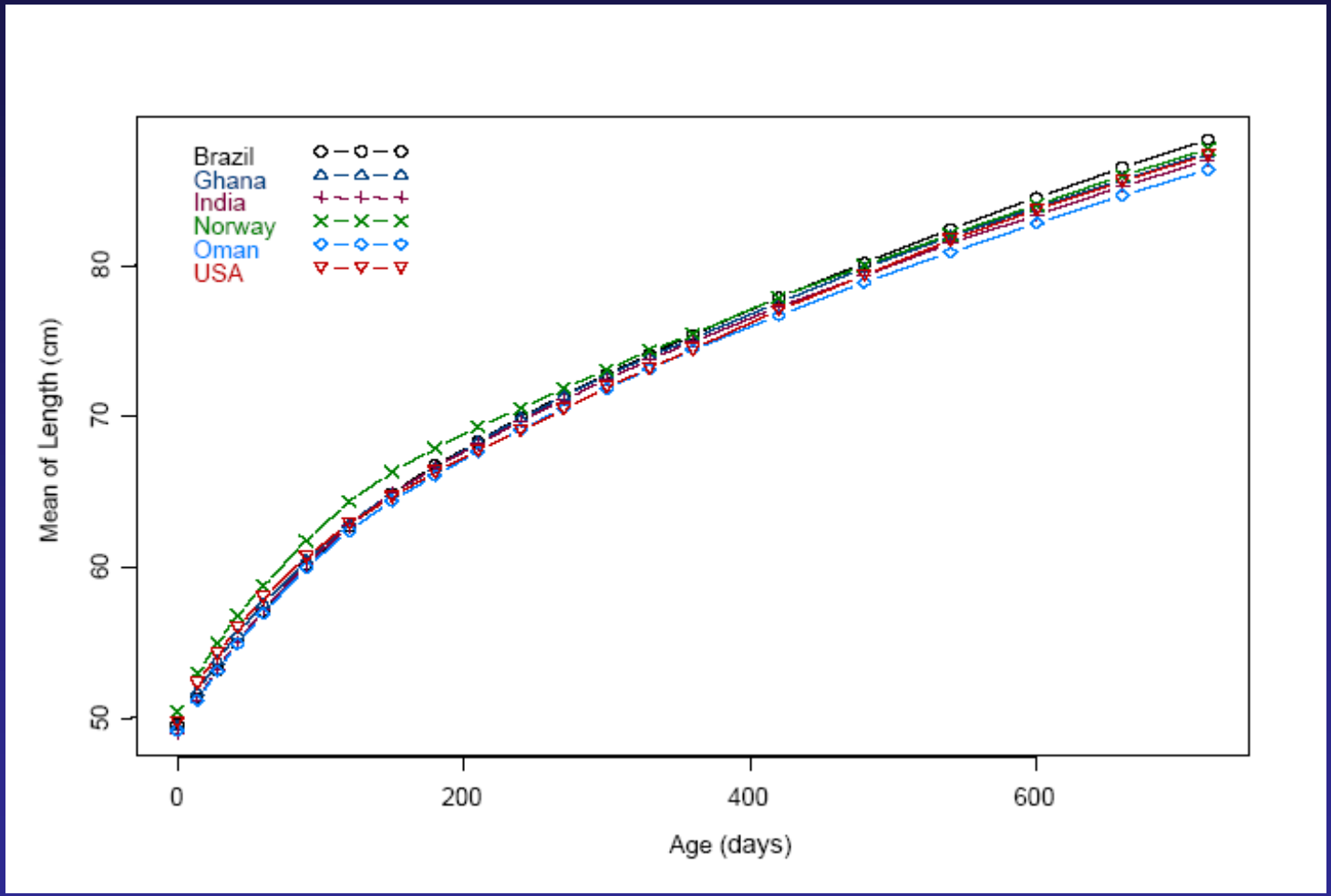
Underweight: low weight-for-age is a sign of *acute or chronic malnutrition or both :*

Indicator = prevalence of underweight

Underweight is an internationally recognized public health indicator for monitoring nutritional status and health in populations

MUAC is also used to assess acute malnutrition, especially in situations where it is difficult to weigh children


Percentiles
50
25
75
15.9
84.1
10
90
2.3
3
97
97.7
0.1
99.9
−3
−2
−1
0
+1
+2
+3
−1.88
−1.28
−0.64
+0.64
+1.28
+1.88
SD



- 1) *WHO Multicentre Growth Reference study group. Assessment of linear growth differences amoung populations in the WHO Multicentre Growth reference Study Acta Paediatr Suppl 2006: 450:56-65*

Interpretation of anthropometric indices

- WHO has developed growth standards based on the growth of healthy adequately fed* infants and young children from several countries (2006)
- Normal growth is defined as the interval around the median and +/- 2 standard deviations of these children
- Weight and height of a child can be interpreted by comparison to the age/sex standard (i.e. calculation of the deviation from the median in standard deviations or z-scores)

*Exclusively breastfed until 6 months, *inter alia*

See: http://www.who.int/childgrowth/standards/en/

Consequences of malnutrition

- Muscle weakness
- Decreased wound healing
- Worsening of organ and systems function immune, cardiovascular, GIT, haemopoetic, lungs, kidney
- electrolyte dysbalance
- Growth and development retardation!

Types of malnutrition

- Marasmus – lack of proteins and E
- Kwashiorkor - proteins
- combination

Marasmus

- easy diagnostic
- Gradual decrease of BW, muscle and fat mass decrease
- Longterm process $\rightarrow$ cachexia

kwashiorkor

- Caused by insuficient protein content in nutrition/food
- Decreased stores of body proteins. Lipids almost intact
- Dominant hypolbuminemia
- hepatomegaly, retention of extracelular fluids, oedemas.

Nutritional screening

If any of following symptoms is present, the complete nutritional examination is indicated:

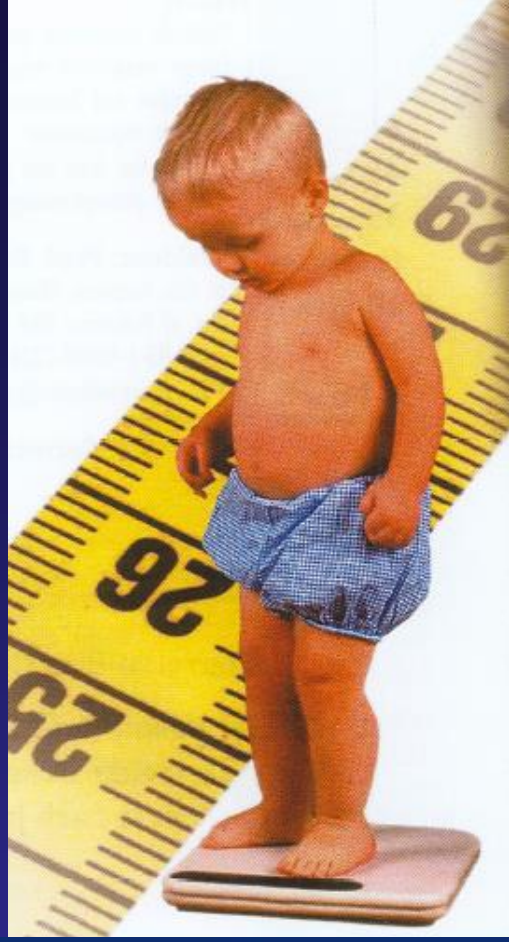
1) Loss of 5 and more % weight
2) Diagnosis compatible with PCM
3) Weight : Height = under 3rd percentile, under 90 % of standard
4) albumin <3,5 g%

Complete nutritional examination

- Anamnesis, stress evaluation
- Anamnesis of weight losses
- diet
- somatometry: Height for age, Weight/Height, skinfold, arm circumference,
- lab: index kreatinin / height, albumin, transferin, number of lymfocytes
- TBC skin test (MxII)

Evaluation of nutritional status

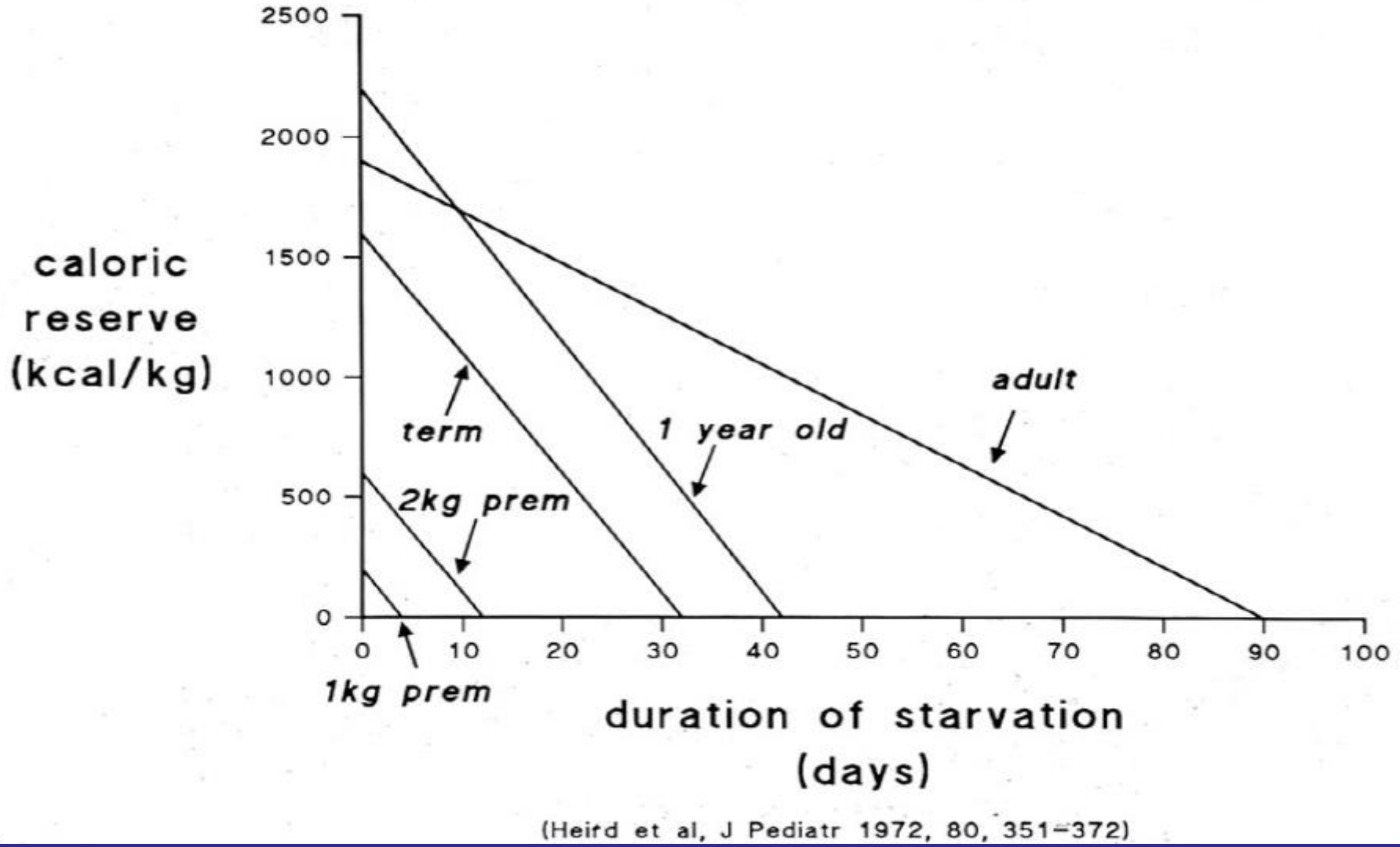
- Clinical parameters
- Antropometric parameters
- Imunological
- Hematological
- biochemical



Criteria of malnutrition

- Albumin 30 g/l
- Prealbumin 0,20 g/l
- Abs. Number of lymfocytes 1200
- Weight loss of 10% in 3 month
- Transferin, kreatinin, CHE, N-bilance
- BMI: BW/height in m^2 < 16 severe malnutrition

ABILITY TO WITHSTAND STARVATION
EFFECTS OF AGE AND SIZE



(Heird et al, J Pediatr 1972, 80, 351-372)

Differences

parameter	Simple fasting	Stress - malnutrition
development	weeks, months	days
examples	MA	sepsis, burns, polytrauma
BW	↓	N/↑
Lipid stores	↓	↓/N
proteins	↓ autokanibalism	↓↓↓
muscles	↓	↓↓↓
Total protein	N/↓	↓↓↓
albumin	N/↓	↓↓↓
prealbumin, transferin	↓	↓↓↓
CRP	N	↑
Energy needs	↓	↑

Hypothetical comparison: i.v. substrates LBW neonate vs Adult

	LBW Neonate	Adult
2x BW in 6 weeks	1,5→3 kg	75→150 kg
110 kcal/kg BW	165 kcal/day	8250 kcal/d
3-3,5 g AA/kg	50 ml 10% AA/d	2,5 litre 10% AA/d
2,5 g lipids/kg	20 ml L 20%/d	1 litre of fat 20%
12,5 g glucose/kg	250 ml 10% Glu/d	14 litres 10% Glu/d

Huge substrate requirement & outstanding metabolic performance

Basic algoritm in introduction of arteficial feeding

- Indication- present or increased risk of malnutrition
- GIT does not works- <u>parenteral nutrition</u>

  works - enteral nutrition
- Possible and most frequent is <u>combination</u>

Types EN

- Home made EN – anachronism!,
- non EBM

- **Oligomeric diet**
- **Polymeric diet**

- **Modular dieteticas:** Fantomalt, Protifar, MCT

Oligomeric EN

- chemicaly defined, lowmolecular, single molecules – dont need digestive enzymes, oligopeptids, maltodextrin, MCT
- hyperosmolaric – bad tolerance- taste
- SBS, malabsorption sy

Polymeric EN

- basic substrates same as in classical foods
- nonhydrolyzed protein, polysacharides, LCT
- osmolarity- less than 400 mosmol/l- gastric feeding

EN formulations

- Energy: 1-2 kcal/ml
- vitamins, minerals, trace elements
  - 100% RDD
- Lactose and gluten free
- fibre, diferrent taste

Indication of EN

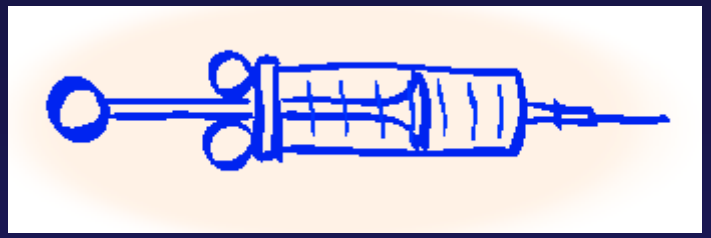
- EN – pacients with malnutrion (at risk) with functioning GIT

- In pediatrics: gastroenterology, neurology, stomatology, ORL, onkology, psychiatry, chirurgy, acute situations…

Contraindication EN

- Absolute: shock sever hypoxy, acute abdomen, instable patient, acutní GIT bleeding, mechanical ileus
- Relative: acute pancreatitis, severe diarrhoe, vomiting, enterocutanneus fistel, etical aspects

Practical feeding

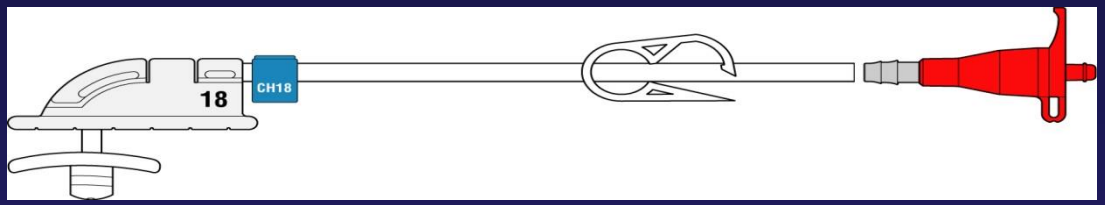


- **Sipping** - drinking, mostly inj addition to classical/any diet
- **Boluse** - Janettova syringe (250 ml)
  - NG tube and stomy, dose ~ tolerance - from minimal stepwise increase
  - Aspiration of gastric residuum
- Aplication sets (bag, bottles)
- Enteral **pumps** – continual feeding, cyclic

NG-TUBE vs PEG

- PEG- less complications (mechanical, removing, replacing with aspiration)
- Easier service – replacement a 3 month (longterm EN)
- cosmetic effect
- PEG for EN longer than 6 weeks

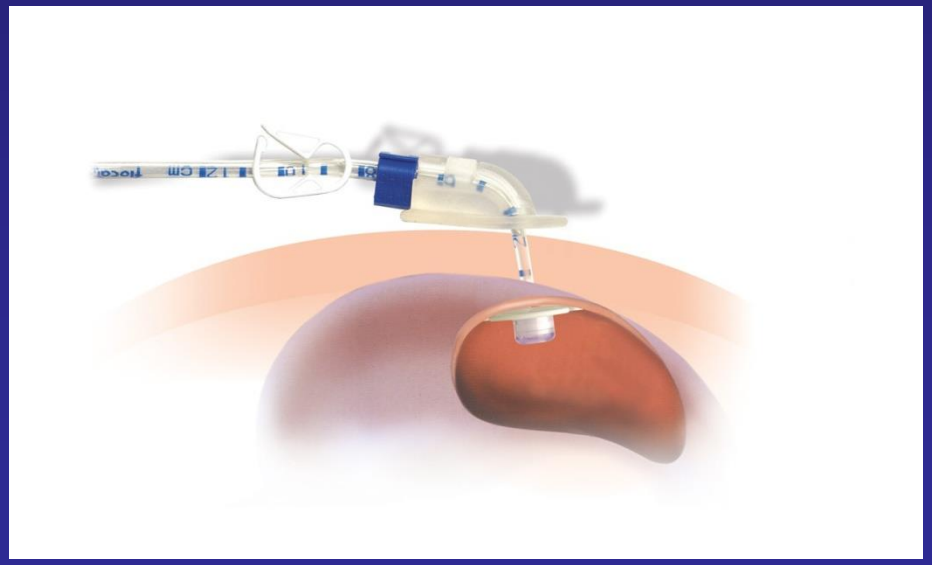
Indication of PEG in pediatric



- Neurological patients, severe epilepsy, disorders with swalloving problems
- Cystic fibrosis – infections, anorexia, E needs
- gastroenterological - GER, m. Crohn,
- Oncological
- Longterm EN - HEN

Gastro-PEG (CH 9-10, CH 14-15)

- Children up 2 years CH 9-10
- Children from 2 years CH 14-15



Absolute contraindication of PEG

Anatomic abnormalities (sever scoliosis), bleeding

Relative or currently obsolent KI

Low age

Previeus abdominal surgery

peritoneal dialysis

ventriculoperitoneal shunt

Advantages - PEG

- Improvement of total status, consequently QoL (patient and family)
- Simplification of feeding – fluids, nutirnts, medication, better compliance
- Improvement of nutritional parameters, status and growth
- More time for RHB and education
- Saveing of peroral feedenig if needed

Fiber in EN

- solubile- hemicelulose, guar, inulin, laktulose
- unsoluble- celulose, lignin
- Source for anaerobic bacteria (SCFA, lactate, propionate, butyrate- colonocytes nutrition)
- Prevention of constipation, diarrhoe
- Dosis: 5-15 g/day
- KI- bowell stenosis, stp. colectomy, SBS

Imunomodulation in EN

- Glutamin- stimulation of imunne reaction in gut, enterocyte nutrition
- n-3- FA, arginin, nucleotides-imunonutrition
- Indication – improvement of imunne reaction in acute situations, preventive before surgery

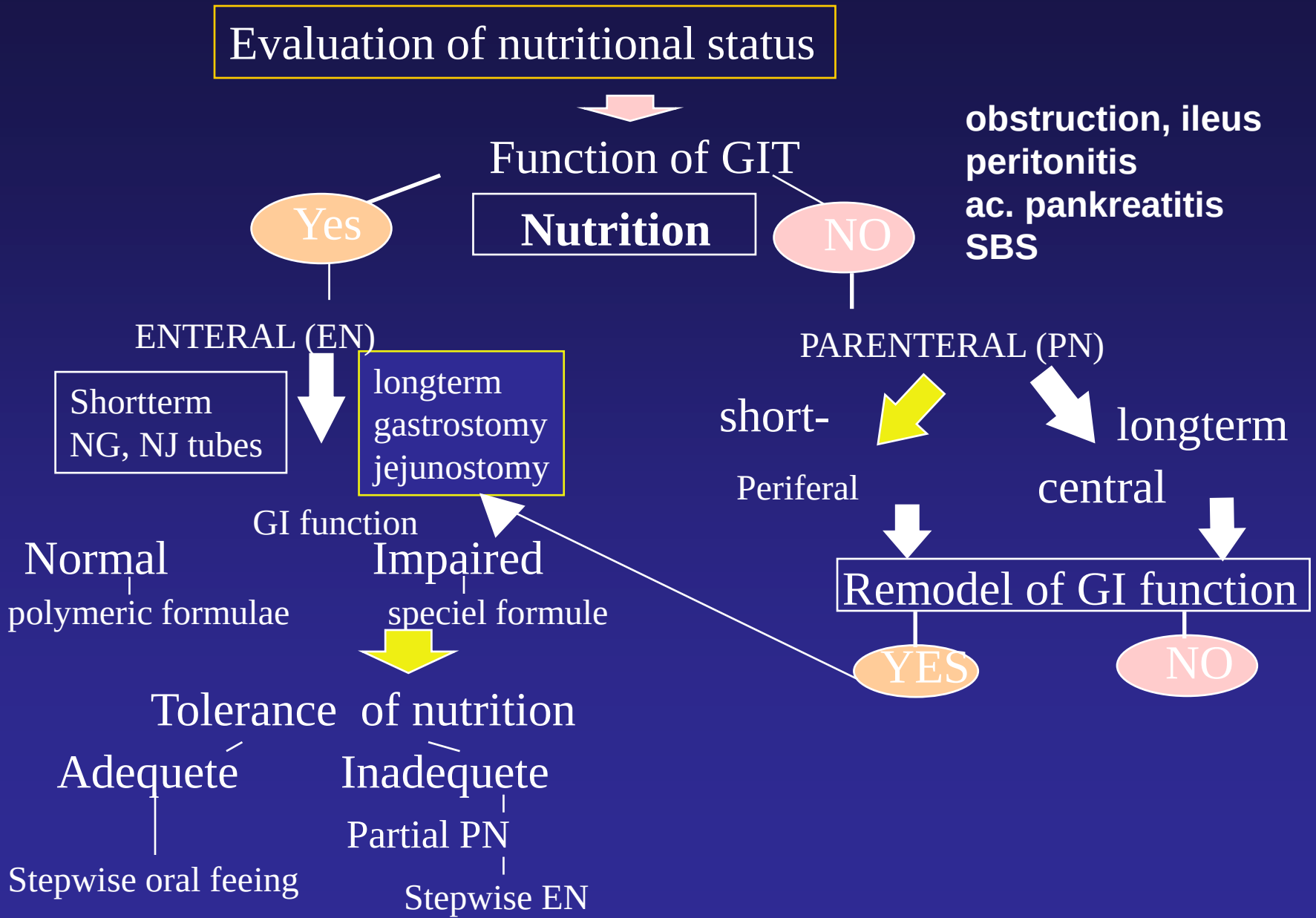
Complications of EN

- **Gastroenterological:** reflux, nauzea, vomiting, diarrhoe, meteorismus, abdominal pain…
- **Infectious:** diarrhoe, sepsis, infection on PEG site
- **Metabolic:** hypo-hyperhydratation, hypo-hypernatremia, kalemia, fosfatemia, hypo-hyperglykemia, edemas.
- **Mechanical:** tube removement, obturation, ulcers

Advantages EN

- Physiological way of nutrition
- Nutrition of the gut, prevention of mucose atrophy, improvment of perfusion, less infectious complications
- Stimulation of gut motility
- Stabilisation of hepatobiliary circulation, stimulation of production of GIT hormons
- Economical aspect

Decision tree



PN- venous access

Periferal! Only for partial PN - duration max 5-7 days, exosting of periferal venous system (changing of veins)).

- Osmolarity of solutions 600-700 mosm/l.
- For longterm PN, including HPN, necesserity of central line

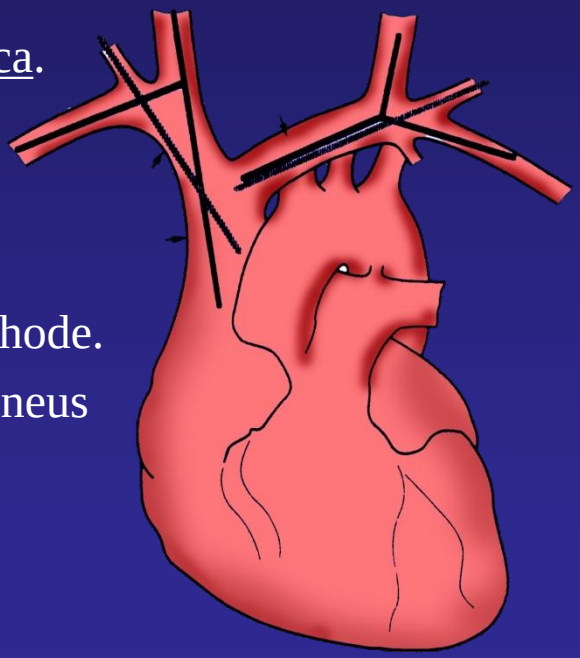
Mostly used accesses vena jugularis, vena subclavia, vena basilica.

Tip of catheter shoud be located in *vena cava superior/inferior*, close before right atrium.

Higher risk of infection in inguinal location.

Different catheters with implantation according to Sendliger methode.

Prevention of infectious complication is dakron cuff and subcutaneus tunel (Hickmann-Broviac).



- Unlimited physical activity
- Cosmetic effect
- Need of further punction Hubers needle
- Complicated treatment of complication- infections, obturation of system

Intravenous port

- More limitations in activities
- cosmeticaly unoptimal- young people
- **No additional punctation**
- **Successfull treatment of infections**

Permanent catétr

Nutrients and Energy

Daily need of nutrients (g) and energy (kcal) for kg of BW

Age	Aminoacids	Glucose	Lipid	Energy
1. year	1,5-2,5	8-15	2-3	90-110
2.	1,5	12-16	2-3	80-100
3.-5.	1,5	12	1-2	60-80
6.-10.	1,0	10	1-2	50-70
10.-14.	1,0	8	1	50-60

PN - carbohydrates

- Fast mobilisation of E in body
- In childhood solutions of glukose. Utilisation in all tissues of man, majority with inzulin (except CNS)
- 3,8 kcal/g glukose
- tolerance decreased in patients in critical status (sepsis, surgery, trauma).
- High intake of GLU leeds to increased lipidogenesis and consequently liver steatosis

PN - lipids

- In clinical praxis is almost inpossible cover energetic needs on PN with lipidless solutions
- 9 kcal/g lipid
- Essencial FA
- In pediatrics – emulsions with decreased ratio lecithin/triacylglycerols, (20% emulsions)

PN- vitamines and trace elements

- Even short PN duration requires supply with vitamines (Water/lipids solubile).
- In longterm PN suplementation of trace elements zink, copper, iron, chrom, iodin, cobalt, selen, mangan and molybden.

Administration of infusions/solutions

- ! Only using infusin pumps !
- AIO bag, tailored, industrial prepared bags (ready to use, 3 chamber bags
- continual infusion, cyclic, night infusion, ~ metabolic tolerance

- most frequent 8-12 hours/day, time to play, physical activity, school

Home parenteral nutrition

- **Indication:**

  every situation requiring longterm PN

- **Goal:**

  Secure for patients survival, growth, psychomotoric development and QoL (P and family)

Criteria of HPN:

- Chronic intestinal failure,
- Safe venous access
- Functional NT
- Family able to secure HPN

HPN

- Easier family and social integration
- ”normal” daily activity in kindergarden, school
- Positive influence on self-confidence, psychological stability and QoL
- Less of infectious complications compared to hospitalized patients
- Less costs for treatment and PN