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# Child's growth and development – characteristics, peculiarities.

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- The knowledge of regularities in the physical development is necessary for correct estimation of the physical development of children of different age; this estimation should be used for characterizing the condition of children's health.
- Evaluation of the physical development is important for assessment of a child's health. It is necessary to understand the causes of all types of variability in the physical development.

**Mechanism of growth and development:**

The process of growth and development is a dynamic action starting from the moment of creation of human body until maturity. The growth presents two parts: qualitative and quantitative.

**Quantitative part** is equal to accumulation of organic substance and is manifested through the process of replacing of the organic mass through life with increase in weight and height.

Two mechanisms participate: cellular proliferation (epithelium, lymphatic organs), cellular hypertrophy with cellular volume growth.

**Qualitative** includes functional and structural differentiations.

# Factors which influence growth and development:

**Exogenic factors influenced in the intrauterine and extrauterine life:**

- Nutrition – the deficiency in mother diet will have an impact on the nutritional state of the fetus. Mother's under nutrition will determine the birth to some children with low weight in 24-45% and smaller height in 10%.

# Factors which influence growth and development:

- Intrauterine malnutrition is reflected to the CNS of the child during pregnancy first 6 months. Mothers undernutrition develops fetus with severe protein deficiency, determine different enzymopathies, hormonal disturbances, and coagulation disturbances.
- Deficiency of minerals salts influence the mineralization of the skeleton. Over nutrition will favor obesity.

# Factors which influence growth and development:

- Geographical- influence the growth from climate conditions (sun, humidity, temperature, UV) which are more important before 5 years of life.
- Socio-economical – sanitary conditions, infections, parasite, stress, place of living, conditions of life, professional activity of parents.

# Factors which influence growth and development:

- ✓ Education – abuse of child in the family has a consequence in growth and development. The calm family supports the child for development.
- ✓ Physical exercise – from the first year of life will stimulate growth and development.
- ✓ Chemical factors – radiation, different rheumatism will influence negatively the growth and development.
- ✓ Political and cultural factors will also influence but with limited effects.

# Factors which influence growth and development:

**Endogenic factors:**

- ✓ Genetic- is multifactorial condition partially influence the determination the height and child dimension at different ages. Decrease growth determined by genetic factors inherited by both parents.
- ✓ Pathological factors- can be present in intrauterine and after that (viral infection HIV, TBC) intoxication with drugs, chronic visceral diseases, renal diseases, chromosomal anomalies.

# Factors which influence growth and development:

- ✓ **Hormonal factors-** are involved in the prenatal and postnatal periods. Fetal hormones play a minor role in development.
- ✓ Hypophysal somatotropin is secreted beginning with the 8th week of gestation.
- ✓ Mother's hormones originate from placental hormones produces by mother's organism, which penetrate the placental barrier have effect of somatotropin hormone on fetal growth

# Factors which influence growth and development:

- After birth the somatotropin take the main role. It influences different periods of age. For example, hypophysis hormone of growth which influence anabolic and growth regulation, thyroid gland has an influence in the first year of life with (T3, T4,), parathyroid hormones – skeletal mineralization.

# Factors which influence growth and development:

- ✓ Sexual glands, sex differentiation, influence on muscles, bones.
- ✓ Adrenal glands (glubocorticoids), growth influence, mineral metabolism.
- ✓ The regulation of somatotropin secretion depends on 2 neuropeptides (releasing hormone of somatotropin and inhibitor somatostatin) but the regulation of neuropeptide depends on neurotransmission.

# Factors which influence growth and development:

- ✓ The insufficient secretion of somatotropin generates nanism and excess secretion generates gigantism.
- ✓ Thymus has synergic action with somatotropin it has a regulatory role in metabolism of nucleic acids and minerals (CA) it is primary organ of immunity for cellular immunity.

Development proceeds from the head downward. This is called the cephalocaudal principle.

According to this principle, the child gains control of the head first, then the arms, and then the legs.

Infants develop control of the head and face movements within the first two months after birth. In the next few months, they are able to lift themselves up by using their arms.

By 6 to 12 months of age, infants start to gain leg control and may be able to crawl, stand, or walk. Coordination of arms always precedes coordination of legs.

- Development proceeds from the centre of the body outward.
- This is the principle of proximodistal development that also describes the direction of development.
- This means that the spinal cord develops before outer parts of the body.

- The child’s arms develop before the hands and the hands and feet develop before the fingers and toes. Finger and toe muscles (used in fine motor dexterity) are the last to develop in physical development.
- Development depends on maturation and learning. Maturation refers to the sequential characteristic of biological growth and development.
- The biological changes occur in sequential order and give children new abilities. Changes in the brain and nervous system account largely for maturation.

- These changes in the brain and nervous system help children to improve in thinking (cognitive) and motor (physical) skills.
- Also, children must mature to a certain point before they can progress to new skills (readiness).
- The child's environment and the learning that occurs as a result of the child's experiences largely determine whether the child will reach optimal development.
- A stimulating environment and varied experiences allow a child to develop to his or her potential.

- Growth and development is a continuous process. As a child develops, he or she adds to the skills already acquired and the new skills become the basis for further achievement and mastery of skills. Most children follow a similar pattern.
- Also, one stage of development lays the foundation for the next stage of development. For example, in motor development, there is a predictable sequence of developments that occur before walking.

- The infant lifts and turns the head before he or she can turn over. Infants can move their limbs (arms and legs) before grasping an object.
- Mastery of climbing stairs involves increasing skills from holding on to walking alone.
- By the age of four, most children can walk up and down stairs with alternating feet.
- As in maturation, in order for children to write or draw, they must have developed the manual (hand) control to hold a pencil.

- There are individual rates of growth and development.
- Each child is different and the rates at which individual children grow are different.
- Although the patterns and sequences for growth and development are usually the same for all children, the rates at which individual children reach developmental stages will be different.

- Understanding this fact of individual differences in rates of development should cause us to be careful about using and relying on age and stage characteristics to describe or label children.
- An understanding of the principles of development helps us to plan appropriate activities and stimulating and enriching experiences for children, and provides a basis for understanding how to encourage and support young children's learning.

- The basic criteria of the physical development of the child are as follows: his/her body weight, length, head circumference, chest circumference, proportionality of these parameters.
- The anthropometry of children must be done with the special medical equipment: electric balance, medical balance for infants, medical level weight, measuring table, tape-measure, nomograms.

**1-4 months**

The average length is 50 cm to 70 cm, the infant grows approximately 2.5 cm per month.

The infant weighs an average of 4 kg to 8 kg.

The infant gains approximately 100 g to 200 g per week.

Respiration rate is approximately 30-40 breaths per minute.

**1-4 months**

The head and chest circumferences are nearly equal.

The head circumference increases approximately 2 cm per month until two months, then increases 1.5 cm per month until four months. Increases are an important indication of continued brain growth.

**1-4 months**

The infant continues to breathe using abdominal muscles.

The posterior fontanelle closes by the second month.

The anterior fontanelle closes to approximately 1.3 cm.

The skin remains sensitive and easily irritated.

The legs may appear slightly bowed.

The infant cries with tears.

Eyes begin moving together in unison (binocular vision).

## 4-8 months

The infant puts on 500 g per month in weight, doubling birth weight.

The infant grows about 1.3 cm in length per month; the average length is 70 cm to 75 cm.

The head and chest circumferences are basically equal.

The head circumference increases approximately 1 cm per month until six to seven months, then 0.5 cm per month; the head circumference should continue to increase steadily, indicating healthy, ongoing brain growth.

## 4-8 months

Breathing is abdominal; it ranges from twenty-five to fifty breaths per minute, depending on activity; its rate and patterns vary from infant to infant.

Teeth begin to appear, with upper and lower incisors coming in first. The gums may become red and swollen, accompanied by increased drooling, chewing, biting, and mouthing of objects.

## 4-8 months

- The legs may appear bowed; bowing gradually disappears as the infant grows older.
- Fat rolls (“baby fat”) appear on the thighs, upper arms and neck.
- True eye colour is established.

## 8-12 months

- Infants reach approximately 1.5 times their birth length by the first birthday.
- Weight increases by approximately 500 g per month; birth weight nearly triples by one year of age: infants weigh an average of 9.6 kg.
- Respiration rates vary with activity: typically, twenty to forty-five breaths per minute.

## 8-12 months

- The head and chest circumferences remain equal.
- The infant continues to use abdominal muscles for breathing.
- The anterior fontanelle begins to close.
- Approximately four upper and four lower incisors and two lower molars erupt.
- The arms and hands are more developed than the feet and legs (cephalocaudal development); the hands appear large in proportion to other body parts.

## 8-12 months

- The legs may continue to appear bowed.

"Baby fat" continues to appear on the thighs, upper arms and neck.

- The feet appear flat as their arch has not yet fully developed.
- Visual acuity is approximately 20/100.
- Both eyes work in unison (true binocular coordination).
- The infant can see distant objects (4 m to 6 m (15 to 20 feet) away) and points at them.

## Toddlers (12-24 months)

- The rate of growth slows.
- Height increases approximately 5 cm to 8 cm with an average height of 80 cm to 90 cm.
- Weighs 9 kg 13 kg; gains 130 g to 250 g per month; the weight is now approximately 3 times the child's birth weight.
- Respiration rate is typically twenty-two to thirty breaths per minute; it varies depending upon emotional state and activity.

## Toddlers (12-24 months)

- Heart rate (pulse) is approximately 80 to 110 per minute.
- The head size increases slowly; it grows approximately 1.3 cm every six months; the anterior fontanelle is nearly closed at eighteen months as bones of the skull thicken.
- The chest circumference is larger than the head one.
- Rapid eruption of teeth; six to ten new teeth will appear.
- The legs may still appear bowed.

## Toddlers (12-24 months)

- Toddlers will begin to lose the “baby fat” once he/she begins walking.
- The body shape changes; it takes on more adult-like appearance; it still appears top-heavy; the abdomen protrudes, the back is swayed.
- Visual acuity is approximately 20/60.

## Two-year-olds

- Weight gain averages 1 kg per year; weighs approximately 12 kg to 15 kg or about 4 times the weight at birth.
- Grows approximately 7 cm to 13 cm per year; the average height is 85 cm to 95 cm.
- The posture is more erect; the abdomen is still large and protruding; the back is swayed, because abdominal muscles are not yet fully developed.

## Two-year-olds

- Respirations are slow and regular (approximately twenty to thirty-five breaths per minute).
- Body temperature continues to fluctuate with activity, emotional state, and environment.
- The brain reaches about 80 percent of its adult size.
- 20 baby teeth have almost finished growing out.

## Three-year-olds

- Growth is steady, though slower than in the first two years.
- Height increases 5 cm to 8 cm per year; the average height is 95 cm to 100 cm, nearly double the child's birth length.
- The adult height can be predicted from measurements of height at three years of age; males are approximately 53 % of their adult height, and females 57 %.
- Weight gains 1.4 kg to 2.3 kg per year; the body weight is 13 kg to 17 kg.

## Three-year-olds

- Heart rate is 90 to 110 beats per minute.
- Respiratory rate is twenty to thirty breaths per minute.
- The legs grow faster than the arms.
- Circumferences of the head and chest are equal; head size is in a better proportion to the body.
- "Baby fat" disappears as the neck appears.
- The posture is more erect; the abdomen no longer protrudes.

## Three-year-olds

- The child is slightly knock-kneed.
- The “baby” teeth stage is over.
- The child needs to consume approximately 6,300 J (1,500 calories) daily.
- Visual sight is about 20/40.

## Four-year-olds

- The child gains approximately 1.8-2.3 kg per year, weighs an average of 14.5 kg to 114cm.
- The child grows 5-6.5 cm in height per year; is approximately 101.6-114cm tall.
- Heart rate averages 90 to 110 beats per minute.
- Respiratory rate ranges from twenty to thirty, varying with activity and emotional state.

## Four-year-olds

- The head circumference is usually not measured after 3 years.
- The child requires approximately 1,700 calories daily.
- Hearing acuity can be assessed by child's correct usage of sounds and language also, by the child's appropriate responses to questions and instructions.
- Visual acuity is 20/30 as measured on the Snellen E chart.

## Five-year-olds

- The child gains 1.8 kg to 2.3 kg per year; weighs an average of 17 kg to 21 kg.
- The child grows an average of 5 cm to 6.5 cm per year; is approximately 105 cm to 115 cm tall.
- Heart rate is 90 to 110 beats per minute.
- Respiratory rate ranges from 20 to 30 per minute.

## Five-year-olds

- Head size is approximately that of an adult's.
- The child may begin to lose "baby" (deciduous) teeth.
- The body is adult-like in proportion.
- The child requires approximately 7,500 J (1,800 calories) daily.
- Visual acuity is 20/20 using the Snellen E chart.
- Visual tracking and binocular vision are well developed.

## 5 years or more

- Height increases 5 cm to 7 cm a year to a height of 105-120 cm.
- Weight increases by 2 kg/year; the body weighs about 17-22 kg.
- Weight gains reflect significant increases in muscle mass.
- Heart rate and respiratory rates are close to those of adults.
- The body may appear lanky as through the period of rapid growth.

**5 years or more**

- Baby teeth begin to be replaced by permanent ones, starting with the two upper front teeth.
- 20/20 eyesight; if below 20/40 should see a professional.
- It is not uncommon for the children to be farsighted.
- Uses 6,700 J to 7,100 J (1,600 to 1,700 calories) a day.

# The methods of assessment, techniques of examination

- There are some methods for assessing the physical development of children. The assessment of the physical development can be done according to formulae, tables, charts, graphs.
- The formulae for approximate determination of the foetus length:
- 1) Gaase's formula: the length of the foetus body during the first 5 months is equal to the month of pregnancy in the second degree. After 5 months the length is equal to the number of month of gestation multiplied by 5.

2) The length of the fetus body in the age from 25 to 42 weeks of gestation is equal to the term of gestation in weeks plus 10 cm.
The formula for determination of the fetus body mass:

- In the term of gestation of 25-42 weeks: the body mass at 30 weeks of gestation is equal to 1300 g, for every next week – plus 200 g, for every week before 30 weeks – minus 100 g.

- There are other, more accurate, methods of assessment of the physical development: special tables with percentiles, charts, graphs of data of children's physical development in different age periods.
- Information includes data of the weight, length, head and chest circumferences in girls and boys separately. These standards are various in different countries; they can change with time (once in 5 years).

In the age of late adolescence (14 to 16 years in boys and 14 to 17 years in girls) the body approximates a young adult size and proportions.
The formula for estimating the head circumference in the first year.

Normal range of the head circumference ($5^{th}$ – $95^{th}$ percentile) =

$$= \left[ \frac{length(cm)}{2} + 9.5 \right] \pm 2.5.$$

Formulae for calculating the approximate weight and height for normal infants of the first year.
The weight of infant before 6 months = birth weight + + 600–800 n (n – month number).
The weight of infant after 6 months = BW + 800 6+400 (n-6) (n – age in months).
The weight after 1 year = 10 kg + 2 kg  n (n – number of years).

Till the age of 24-36 months the height of a child will be measured with pediometer or centimeters.

- The child is placed in clinostatic position (horizontal) and measurement of the height. Head is maintained in a correct position by a person who accompanies the child or the nurse.
- Knees are in extension position by the doctor soles have to form a straight angle. After the age 2-3 years the child is standing straight to the anthropometry's cursor.

Head is fixed and the height is determined. It is necessary to determine the height of sitting baby.

Another measurement is the chest and head circumference, for head the diameters which appreciate anterior posterior diameter and transversal.

For chest circumference the baby sit down or is placed in horizontal position. And the meter is put above the trunk on the mammary glands to determine the chest circumference.

# Methods of physical development in children and teenagers:

- **Somatometria-** anthropometric dates when the child is standing, sitting, horizontal position. This is the method of measurement of height, head and chest.
- **Somatoscopy-** shape of the thorax, back, sole, muscle development, fat development, skin elasticity, biological maturation.

- Functional- spiromety, stretch ability power, dynamometry. All the parameters are analyzes in detail and compared with standard values according to age, sex of the child.
- Somatometry is used in order to appreciate morphological peculiarities of the organism after taking the measurements stretch determined by using standard technique. This is done by the following ways:

a) Individual measures of a patient of a fix or dynamic stage in the same time according to the morphofunctional level of development.
b) general- parallel investigation of a large group of children to determine the regional standards of age and sex and to form some evaluation tables used for particular case.

**Somatometria** includes the appreciation of the following height, diameters, parameters and body weight. Appreciation of body mass is made through weight count using a medical scale in a standing position. Corporal mass is important measurement of morphological stage of the organism that in general expresses the development of osteomuscular apparatus and adipose tissue and subcutaneous tissue.

**Somatoscopy** permits formation of a general impression about physical development of a body interrelation, proportionally, presence of functional or pathological modification.

Somatoscopy includes examination of locomotor apparatus, scull, to describe the form of the scull, mesocephalic, dolichocephalism, brachiocephalic. Parallel are shown all modifications of fontanels, sutures and form of frontal, parietal, occipital lobes.

For thorax appreciation type: cylindrical, plate, conical. And determine deformity of thorax. Deformities of ribs, lower limbs, are examined in standing position. To determine the deformity of limbs, sole is appreciates after standing part or after sole gram.

- Vertebral- examined in frontal position, deformities and to describes kyphosis, scoliosis.
- Muscular- determine the degree of development.

**3 degrees of development:**

**First degree-** Low development, decreased elasticity, plate thorax, scapula is moved for thoracic surface, abdomen is ptosed and there is low muscular force

**Second degree-** well muscular development, medium elasticity, cylindrical thorax, abdomen in tonus, muscular force-medium

**Third degree-** very good muscular development

# Examination of adipose tissue:

- Is made by appreciation of the degree of vessels and thickness of subcutaneous fatty tissue . The fatty tissue is determined in following regions:
- Thorax – vertical at the level of medioclavicular line, at the level of third rib.
- Abdomen – vertical 5cm to the left from umbilicus.
- On shoulder – on the triceps muscle and the line between acromion and olecranon
- Under the scapula – at inferior angle of scapula.

**4 degrees of development:**

1st degree- bones of scapular region and ribs are well pronounces. The adipose tissue equals 5 mm.

2nd degree- 5-9 mm

3rd degree- 10-15mm, in adults till 20mm

4th degree- 15mm

# The skin is appreciated by following signs:

- Color, elasticity, trugor, humidity, temperature, presence of hypo or hyper trichosis , mucous of eyes and oral cavity. Characterized after inspection and all pathological changes noted.

# Biological age

- Presence and following of the ossification points on x-ray examination.
- Appearance of temporary and permanent teeth.
- Appreciation of development of sexual stage and degree of sexual maturity and is based on development of secondary sexual sign.
- For determination of bone age is made x-ray investigation of left hand and it's joint and is compared with normal.

# Percentile method:

- Centilic or percentilic method at the base of which a line or curves and tables named centilic growth of deferent groups of individuals .
- Main parameters of physical development of healthy children of different age are arranged into a line from minimal up to maximal value.

Percentile represents 100 parts from variation line. For estimation of physical development of children six values are used: **3, 10, 25, 75, 90, 97.**

**classification:**

0-3 …. Very low development

3-10 …. Low development

10-25….. Decreased development

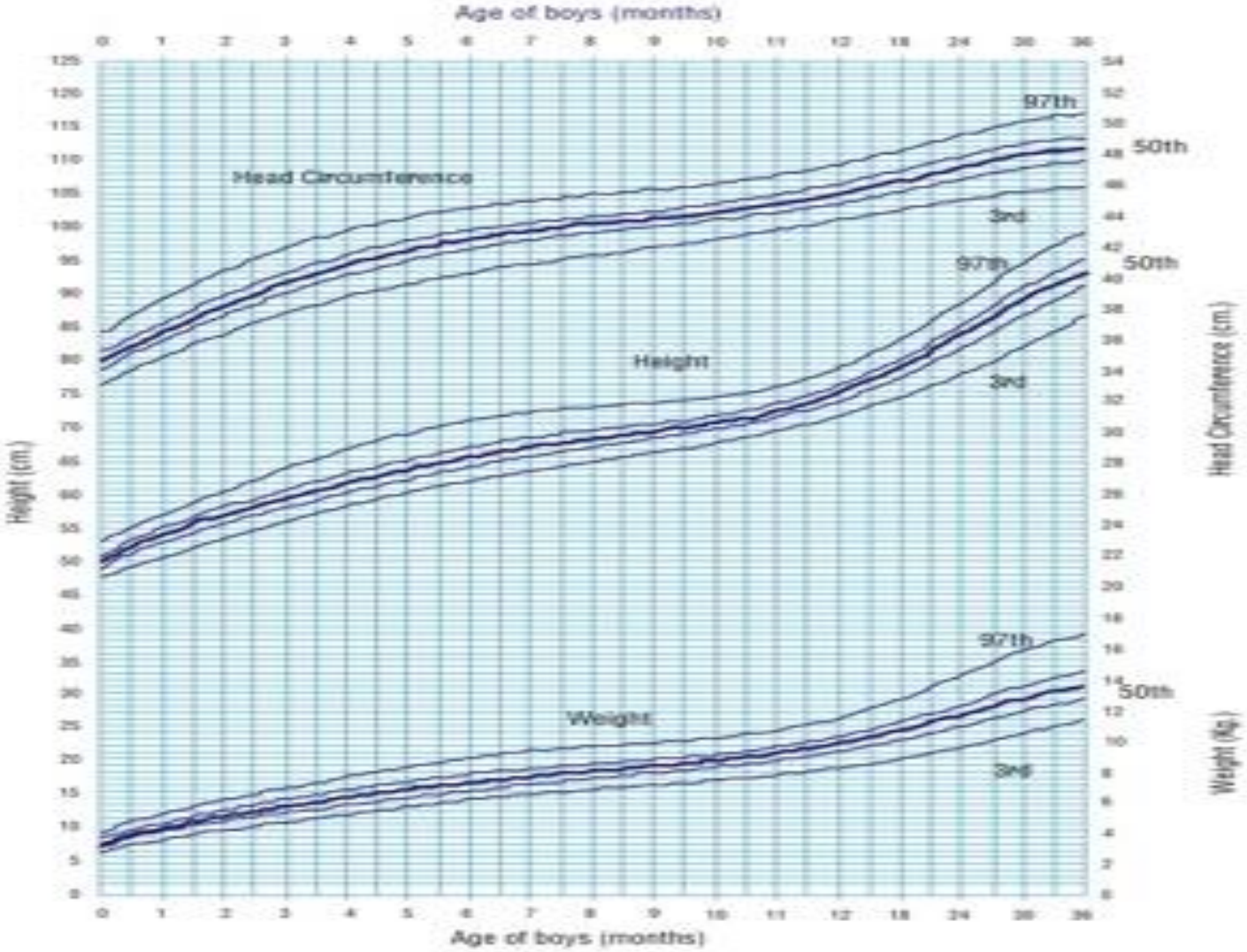
25-75 ….. Medium development

90-97…. High development

97-100…. Very high development

# IAP - GROWTH CURVE (2007)

## Height, Weight and Head circumference for boys from 0-36 months. (Percentiles)

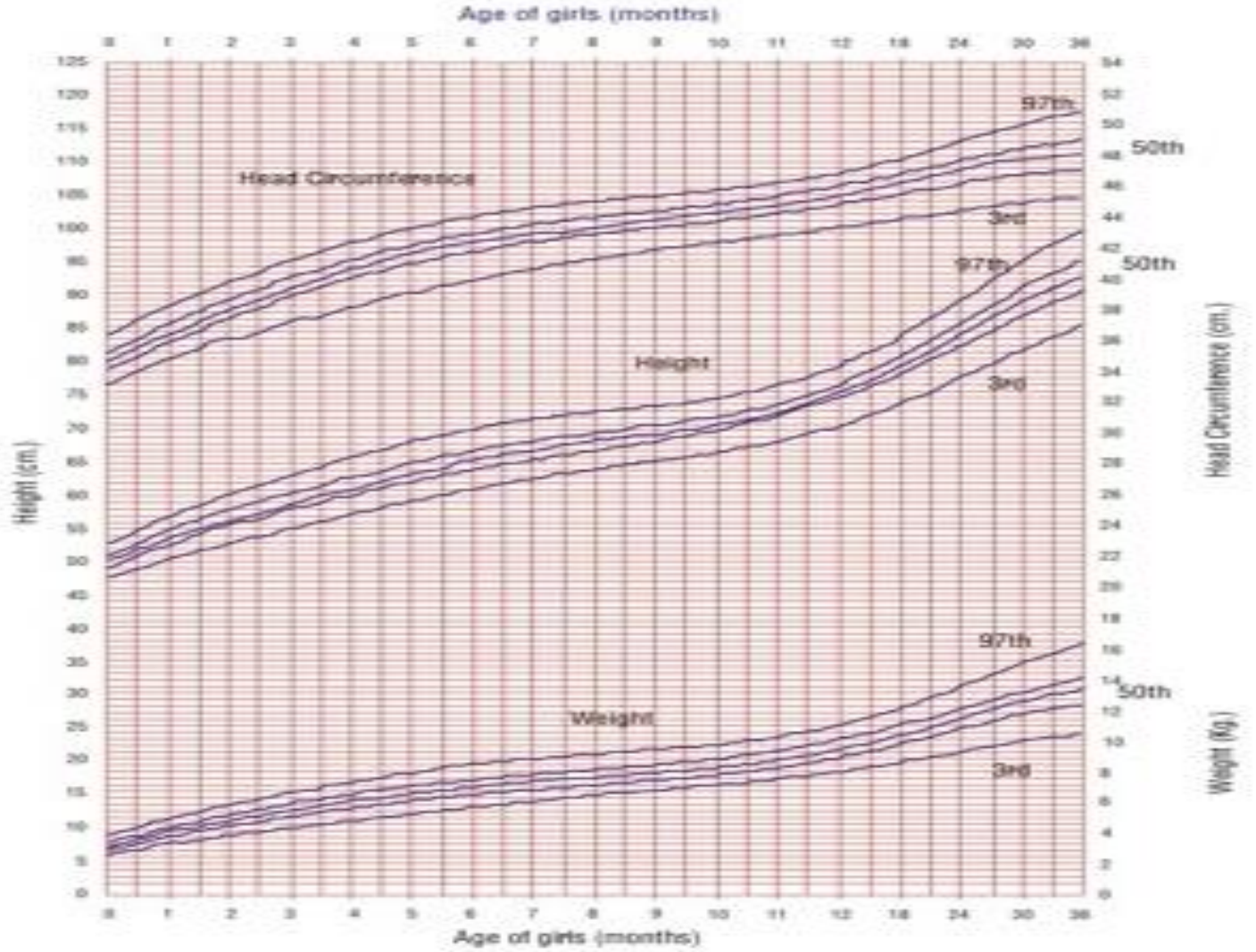



Sequence: 97th, 75th, 50th, 25th, 3rd

Source: Agarwal et al Indian Pediatrics 1994

# IAP - GROWTH CURVE (2007)

## Height, Weight and Head circumference for girls from 0-36 months. (Percentiles)




Source : Agarwal et al Indian Pediatrics 1994

Sequence: 97th, 75th, 50th, 25th, 3rd

# Variability of physical development includes

- Includes hypotrophy, hypostature, paratrophy, nanism, gigantism.
- **Hypotrophy** is an infringement of the physical development of a child during the fist two years mainly due to a reduction of actual body weight in comparison with ideal.
- There are 3 degrees of hypotrophy: 1st degree deficiency in body weight – by 11-20 %, 2nd degree – by 21-30 %, 3rd degree – by 31 % or more. Decrease of turgor and elasticity of the skin is marked, the body length gradually decreases.

**Paratrophy** results from a chronic infringement of feeding in 1-year-old children, which is characterized by an increase of their body weight in comparison with the normal data by 10 % and more.

**Paratrophy has 3 degrees:** 1st degree increase in body weight – by 11-20 %, 2nd degree – by 21-30%, 3rd degree – by 31 % or more. Paratrophy can be caused by exogenic (irrational feeding) and endogenic (constitutional metabolic disorders) factors.

# Body mass index (BMI)

- BMI is a calculation that uses height and weight to estimate how much body fat someone has. Doctors use it to determine how appropriate a child's weight is for a certain height and age.

If you have a BMI of:

- Under 18.5 – you are underweight and possibly malnourished.
- 18.5 to 24.9 – you have a healthy weight range for young and middle-aged adults.
- 25.0 to 29.9 – you are overweight.
- Over 30 – you are obese.

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