Growth and development of the child

Tomáš Honzík

Department of Paediatrics and Inherited Metabolic Disorders
First Faculty of Medicine, Charles University and General University Hospital in Prague

Psychomotor development

gross motor, fine motor development
language, social interaction

Physical development

growth, body proportions
GIT, cardiovascular, lymphatic system

childhood periods

- Embryonic period (6.day-8 week)
- Fetal period (9 week-birht)
- Newborn (0-28.day)
- Infant (29.day-1 year)

- Todler (1-3.year)

- Preschool (3-6.year)

- School age, Middle childhood

- Adolescence

Health maintenance visits
In the first year 10x
1-19years 11x

vstupní prohlídka po propuštění z porodnice

14 dní: preventivní prohlídka a nasazení vitaminu D

6 týdnů: preventivní prohlídka a ev. I. očkování proti rotavirům

9 týdnů: I. očkování hexavakcina a ev. pneumokoky,II. očkování proti rotavirům

3 měsíce: preventivní prohlídka, III. dávka rotavirů (očkovací látka Rotateq)

4 měsíce: preventivní prohlídka a pokračování očkování hexavakcina pneumokoky (II. dávka)

6 měsíců: preventivní prohlídka

8 měsíců: preventivní prohlídka

10 měsíců: preventivní prohlídka

1 rok: preventivní prohlídka a očkování hexavakcínou III. dávka, ev. pneumokok

13-15 měsíců: očkování spalničky, příušnice, zarděnky I. dávka

18 měsíců: preventivní prohlídka

3 roky: preventivní prohlídka

5 let: preventivní prohlídka a očkování záškrt, tetanus,č. kašel, přeočkování spalničky, příušnice, zarděnky

7 let: preventivní prohlídka

9 let: preventivní prohlídka

10 let: přeočkování záškrt, tetanus, č. kašel, dětská obrna

11 let: preventivní prohlídka

13 let: preventivní prohlídka a event. nepovinné očkování proti HPV/2 dávka za 6 měs./

15 let: preventivní prohlídka

17 let: preventivní prohlídka

19 let: výstupní preventivní prohlídka

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN®

Recommendations for Preventive Pediatric Health Care

Bright Futures/American Academy of Pediatrics

Bright Futures
prevention and health promotion for infants, children, adolescents, and their families™

Each child and family is unique; therefore, these Recommendations for Preventive Pediatric Health Care are designed for the care of children who are receiving nurturing parenting, have no manifestations of any important health problems, and are growing and developing in a satisfactory fashion. Developmental, psychosocial, and chronic disease issues for children and adolescents may require more frequent counseling and treatment visits separate from preventive care visits. Additional visits also may become necessary if circumstances suggest concerns.

These recommendations represent a consensus by the American Academy of Pediatrics (AAP) and Bright Futures. The AAP continues to emphasize the great importance of continuity of care in comprehensive health supervision and the need to avoid fragmentation of care.

Refer to the specific guidance by age as listed in the *Bright Futures Guidelines* (Hagan JF, Shaw JS, Duncan PM, eds. *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents*. 4th ed. American Academy of Pediatrics; 2017).

The recommendations in this statement do not indicate an exclusive course of treatment or serve as a standard of medical care. Variations, taking into account individual circumstances, may be appropriate.

The Bright Futures/American Academy of Pediatrics Recommendations for Preventive Pediatric Health Care are updated annually.

	INFANCY								EARLY CHILDHOOD							MIDDLE CHILDHOOD							ADOLESCENCE										
AGE[1]	**Prenatal**[2]	**Newborn**[3]	**3-5 d**[4]	**By 1 mo**	**2 mo**	**4 mo**	**6 mo**	**9 mo**	**12 mo**	**15 mo**	**18 mo**	**24 mo**	**30 mo**	**3 y**	**4 y**	**5 y**	**6 y**	**7 y**	**8 y**	**9 y**	**10 y**	**11 y**	**12 y**	**13 y**	**14 y**	**15 y**	**16 y**	**17 y**	**18 y**	**19 y**	**20 y**	**21 y**
HISTORY Initial/Interval	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
MEASUREMENTS																																	
Length/Height and Weight		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Head Circumference		●	●	●	●	●	●	●	●	●	●	●																					
Weight for Length		●	●	●	●	●	●	●	●	●	●																						
Body Mass Index[5]												●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Blood Pressure[6]		★	★	★	★	★	★	★	★	★	★	★	★	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
SENSORY SCREENING																																	
Vision[7]		★	★	★	★	★	★	★	★	★	★	★	★	●	●	●	●	★	●	★	●	★	●	★	★	●	★	★	★	★	★	★	★
Hearing		●[8]	●[9] →	→	→	★	★	★	★	★	★	★	★	★	●	●	●	★	●	★	●	★	●	←	←	←	●[10] →	←	● →	←	←	● →	←	● →
DEVELOPMENTAL/SOCIAL/BEHAVIORAL/MENTAL HEALTH																																	
Maternal Depression Screening[11]				●	●	●	●																										
Developmental Screening[12]								●			●		●																				
Autism Spectrum Disorder Screening[13]											●	●																					
Developmental Surveillance		●	●	●	●	●	●		●	●		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Behavioral/Social/Emotional Screening[14]		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Tobacco, Alcohol, or Drug Use Assessment[15]																						★	★	★	★	★	★	★	★	★	★	★	★
Depression and Suicide Risk Screening[16]																							●	●	●	●	●	●	●	●	●	●	●
PHYSICAL EXAMINATION[17]		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
PROCEDURES[18]																																	
Newborn Blood		●[19]	●[20] →	→																													
Newborn Bilirubin[21]		●																															
Critical Congenital Heart Defect[22]		●																															
Immunization[23]		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Anemia[24]						★			●	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★
Lead[25]							★	★	● or ★[26]		★	● or ★[26]		★	★	★	★																	
Tuberculosis[27]				★			★		★			★		★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★
Dyslipidemia[28]												★			★		★		★	←	● →	★	★	★	★	★	★	←			●	→		
Sexually Transmitted Infections[29]																						★	★	★	★	★	★	★	★	★	★	★	★
HIV[30]																						★	★	★	★	●	→						→
Hepatitis B Virus Infection[31]		★ →	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Hepatitis C Virus Infection[32]																														●	→	→	→	→
Sudden Cardiac Arrest/Death[33]																						★	→	→	→	→	→	→	→	→	→	→	→	→
Cervical Dysplasia[34]																																		●
ORAL HEALTH[35]							●[36]	●[36]	★		★	★	★	★	★	★	★																	
Fluoride Varnish[37]							←			●					→																			
Fluoride Supplementation[38]							★	★	★		★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★	★						
ANTICIPATORY GUIDANCE	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

USA – 6x during infancy

21x between 1-19 years of age

Lenght

at birth

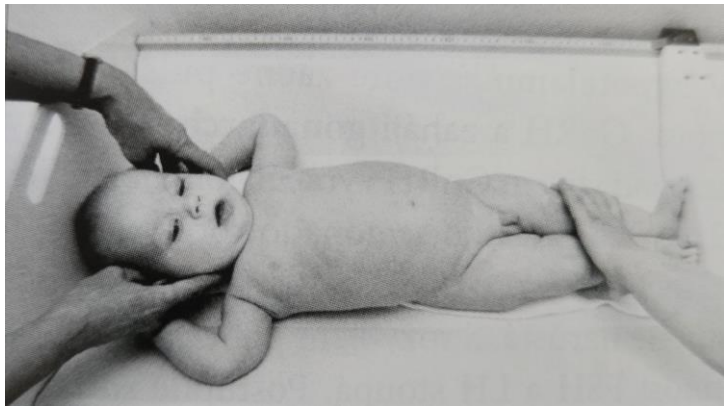
50 cm

1Y

75 cm

2Y

87cm



height at age 3.5Y 100 cm

height at age 5 Y 110 cm

height at age 10Y 140 cm

Growth

per month I.: 3-4cm, II.: 2 cm, III-IV.:1cm

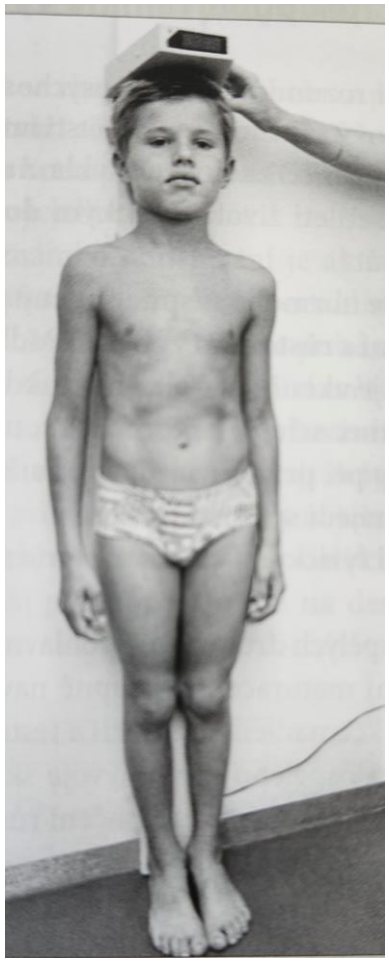
2nd Y **+ 11** cm

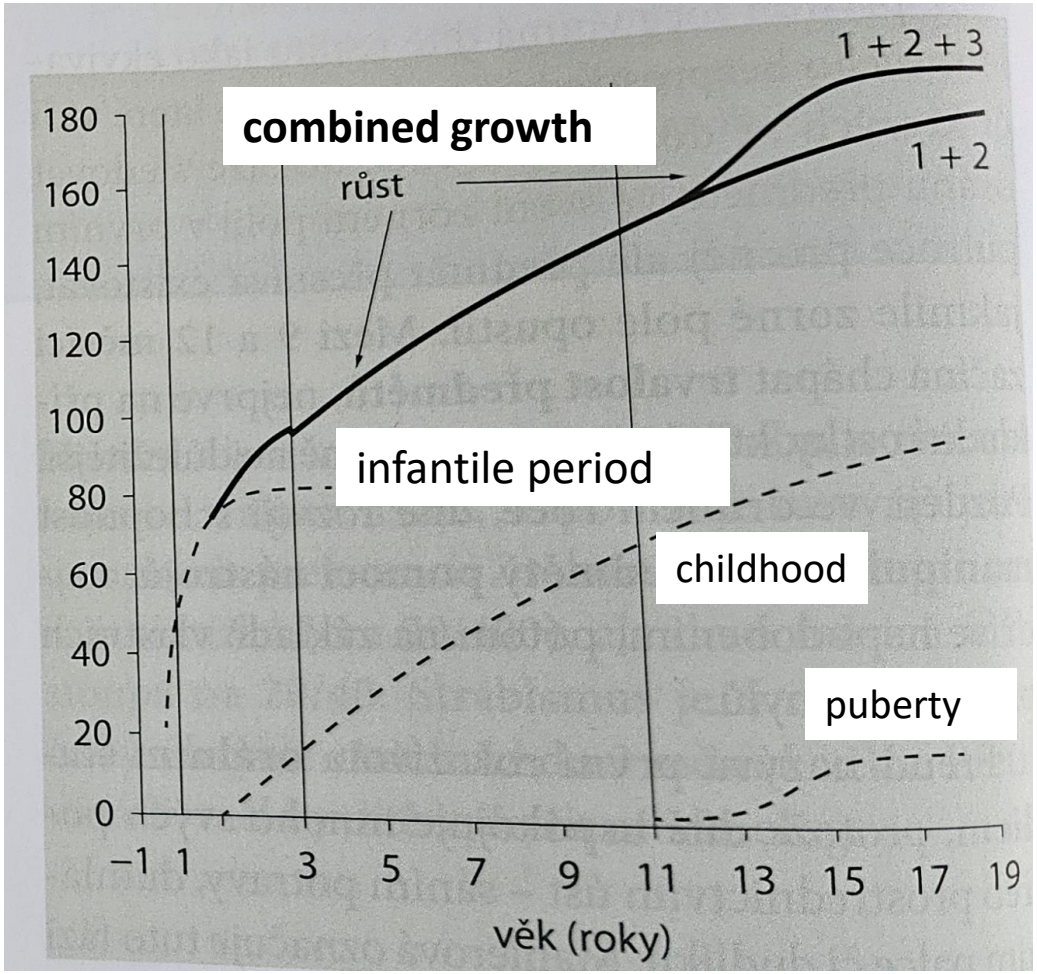
3rd Y **+ 9** cm

preschool and school period yearly +5 až 7.5 cm

Puberta 8-11 cm (boys), 6.5-9.5 cm (girls)

> 2 years





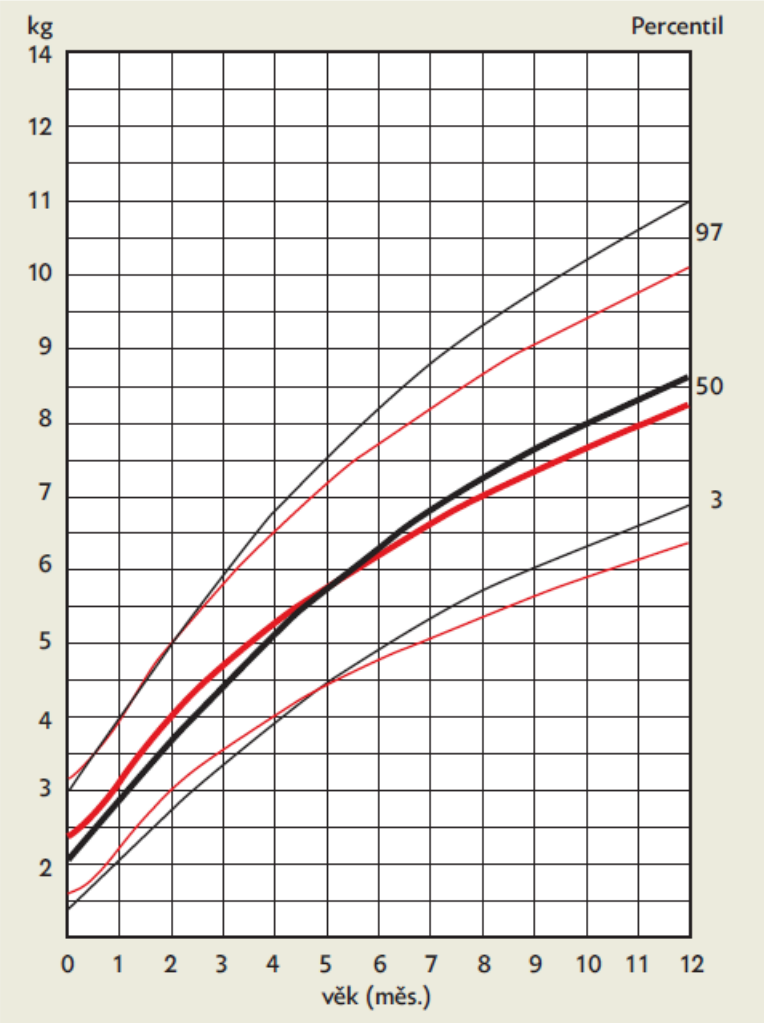
Girls at 1.5 y and
Boys at 2 y
50 % of its final height

Weight

at birth **3500**g
double
till 4-5 months of life
triple
till 1 year (cca **10.5** kg)
quadruple
till 2 years (**13** kg)
at age 5 Y 20 kg (19 kg)
at age 10Y 30 kg (33 kg)

Weight gain

Infants- weekly trim.I.: 150-200g, trim.
II.: 150g, trim.III.: 100g.
Toddlers, preschool, school children yearly **+2 kg**
Puberta yearly +2.5 až 6 kg



Breastfed Infants Study (2009-2011)
Thriving - n=960 children
versus - not breastfed/shortly breastfed

Initially faster thriving (by 2-3m)
falls below the curve
after the first six months

Schematic weight chart, comparison of breastfed and non-breastfed babies. Black - Czech references CAV 1991, red - breastfed 2009

head circumference

neonate
34 cm

6 months
43 cm

1 year
47 cm

3 years
50 cm **(90% of final brain volume)**

HC 1 cm/month first year of life (2 cm/month first 3 months)

energy requirements

Preterm neonate	120-150kcal/kg/day
Infant	100kcal/kg/day
10-year old child	60-70kcal/kg/day
20-year old adult	45 kcal/kg/day

energy requirement for growth

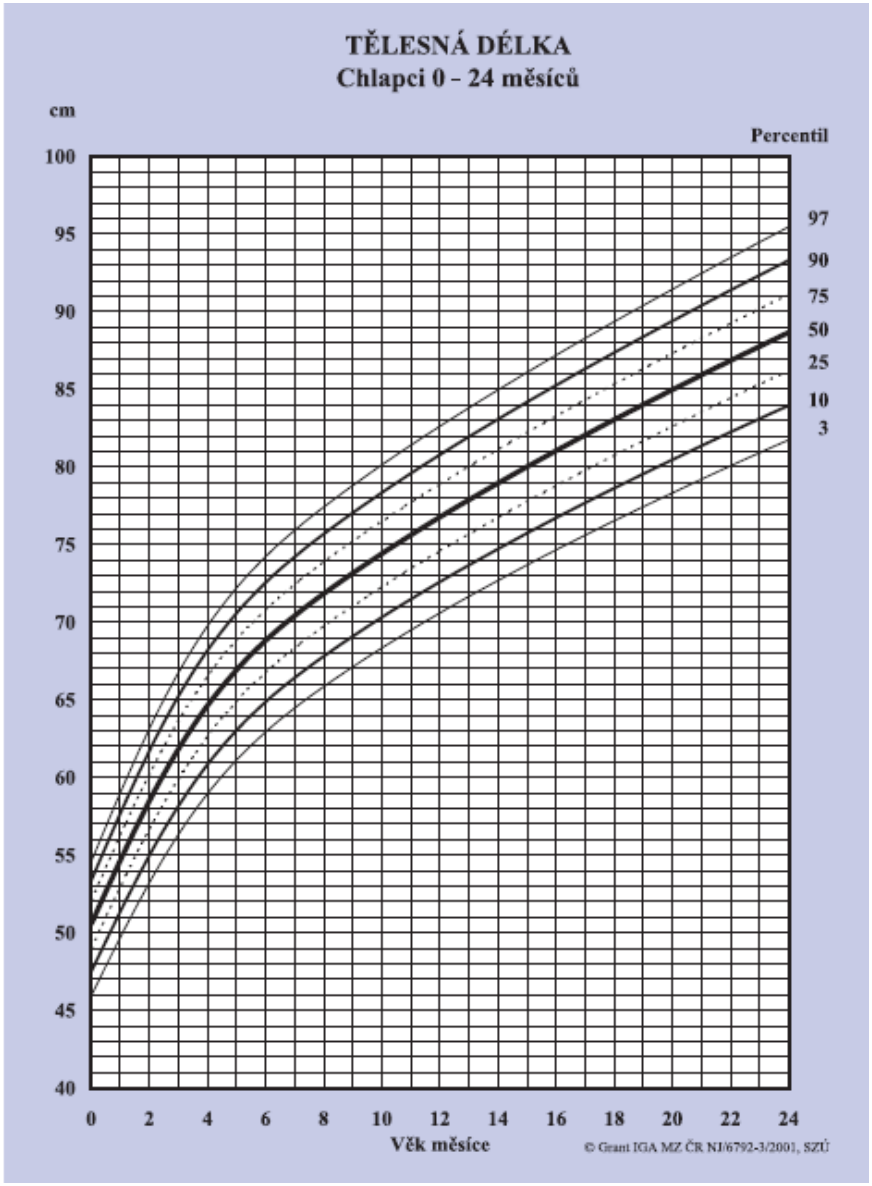
Preterm neonate	50%
5-year old child	12%

Basal energy expenditure - tissues

	Infant	Man(30yrs)	Woman(30yrs
Liver	14 %	21%	21%
Brain	44%	20%	21%
Heart	4%	9%	8%
Kidney	6%	8%	9%
Muscle	6%	22%	16%
Others	26%	20%	25%

	Neonate
Brain	60%

1000 kcal/day/m^2



growth charts

SD-standart deviation

determine the extent of mean variation

1 SD= 68%

2 SD= 95%

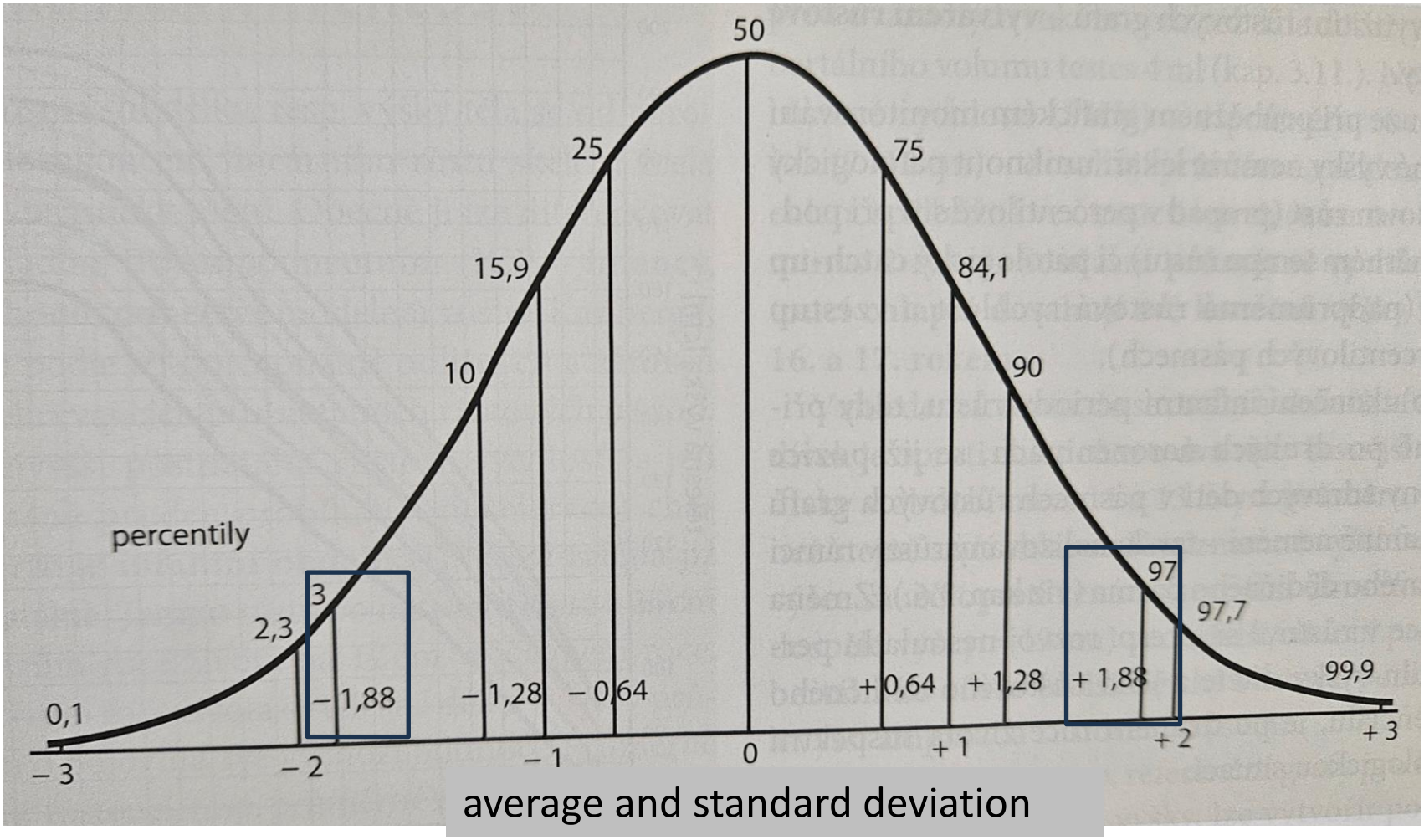
3 SD= 99.7%

5.perc.= – 1.65 SD

10.perc.= – 1.3 SD

25.perc.= – 0.25 SD

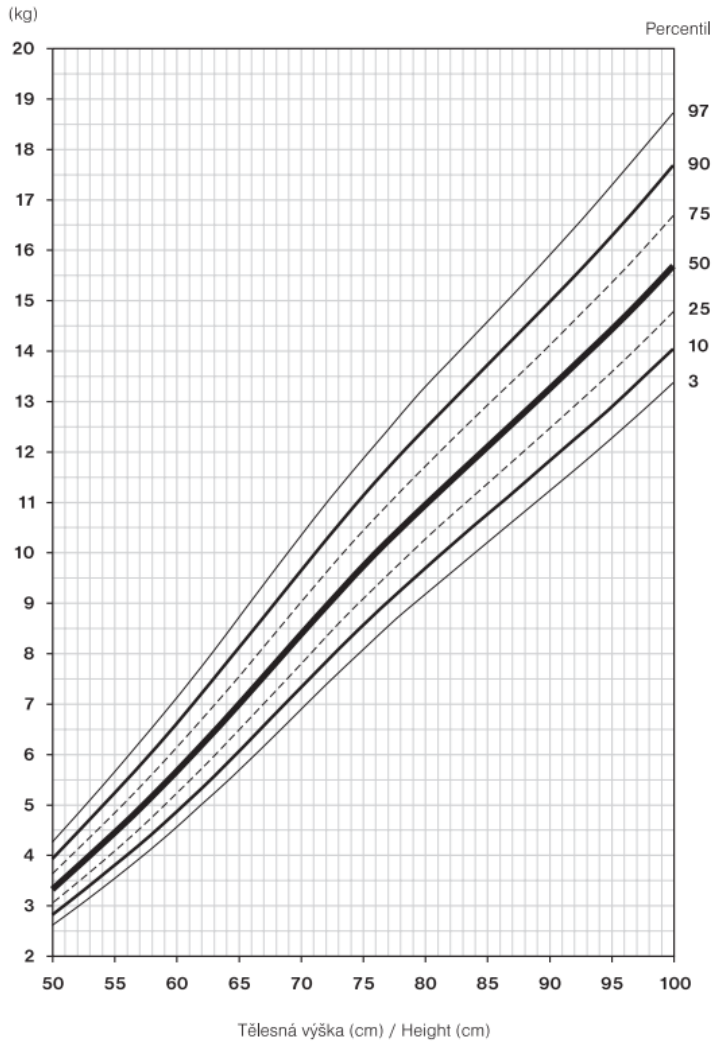
50.p identical to the arithmetic average



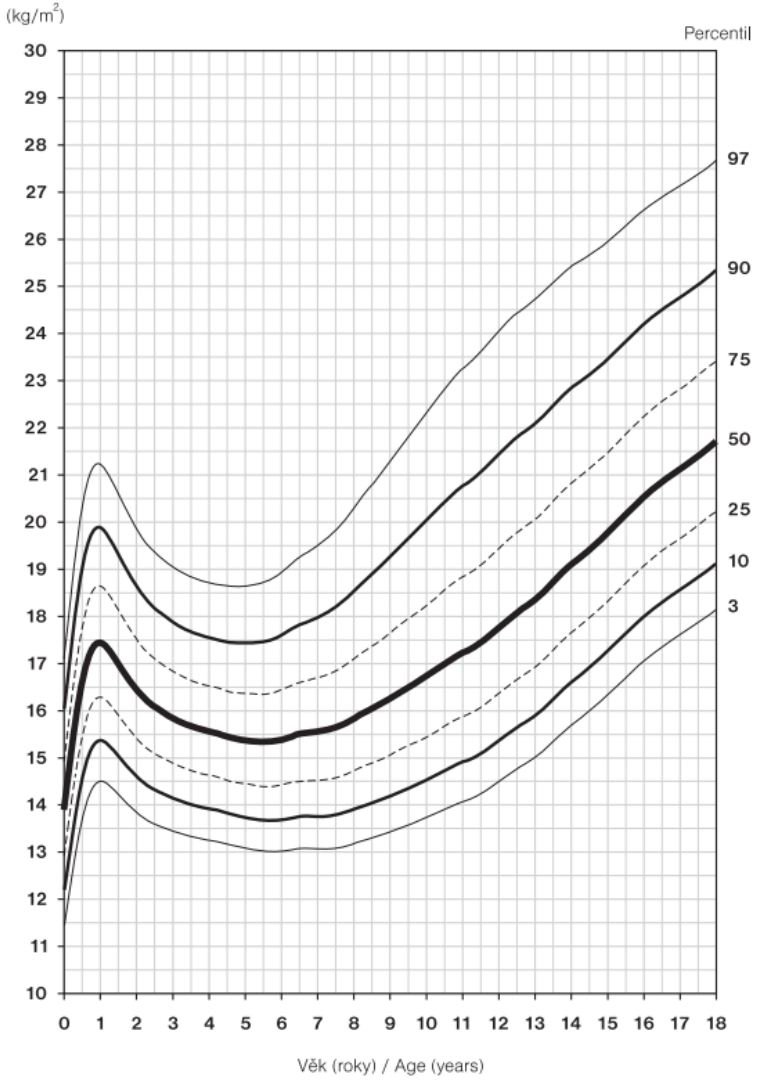
average and standard deviation

3.-97.p 94% of the population, wider average 25.-75.p - 50% of the population

Hmotnost k tělesné výšce (50 - 100 cm)
Weight-for-height (50 - 100 cm)
Chlapci / Boys



Body Mass Index (BMI) (0 - 18 roků)
Body Mass Index (BMI) (0 -18 years)
Chlapci / Boys

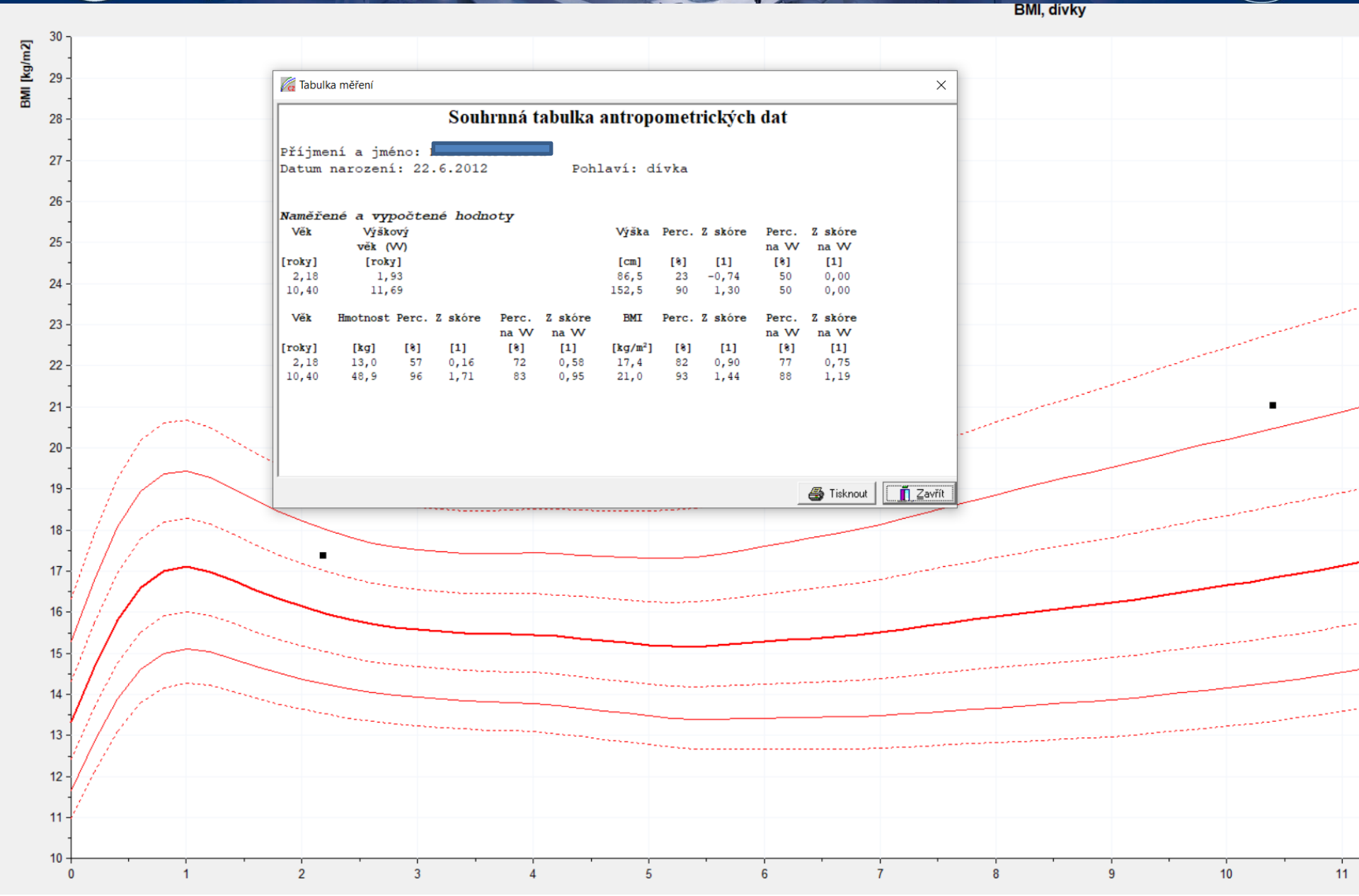


Genetics

Metabolic disorders

GH deficiency

cong. lense subluxation
marfanoid habitus
17 years
177cm (90.P), 59kg, BMI18,8
mother 163cm, father 170cm
Scoliosis, pectus excavatus
16 years
Hormonal birth control
headache, seizures
Cerebral plexus thrombosis



Tabulka měření

Souhrnná tabulka antropometrických dat

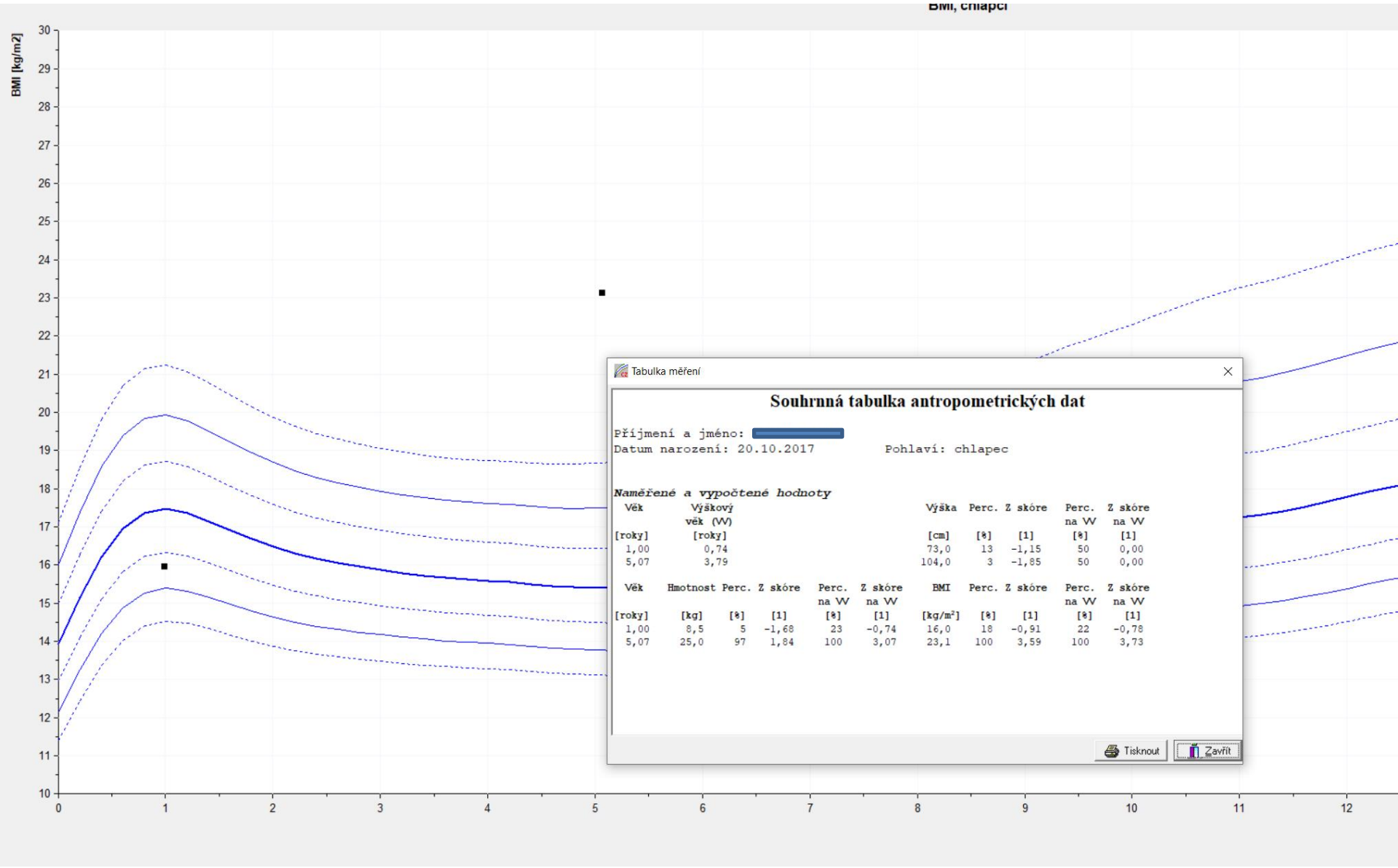
Příjmení a jméno: [redacted]
Datum narození: 22.6.2012 Pohlaví: dívka

Naměřené a vypočtené hodnoty

Věk	Výškový věk (W)			Výška	Perc.	Z skóre	Perc. na W	Z skóre na W
[roky]	[roky]			[cm]	[%]	[1]	[%]	[1]
2,18	1,93			86,5	23	-0,74	50	0,00
10,40	11,69			152,5	90	1,30	50	0,00

Věk	Hmotnost	Perc.	Z skóre	Perc. na W	Z skóre na W	BMI	Perc.	Z skóre	Perc. na W	Z skóre na W
[roky]	[kg]	[%]	[1]	[%]	[1]	[kg/m²]	[%]	[1]	[%]	[1]
2,18	13,0	57	0,16	72	0,58	17,4	82	0,90	77	0,75
10,40	48,9	96	1,71	83	0,95	21,0	93	1,44	88	1,19

Tisknout Zavřít



Tabulka měření

Souhrnná tabulka antropometrických dat

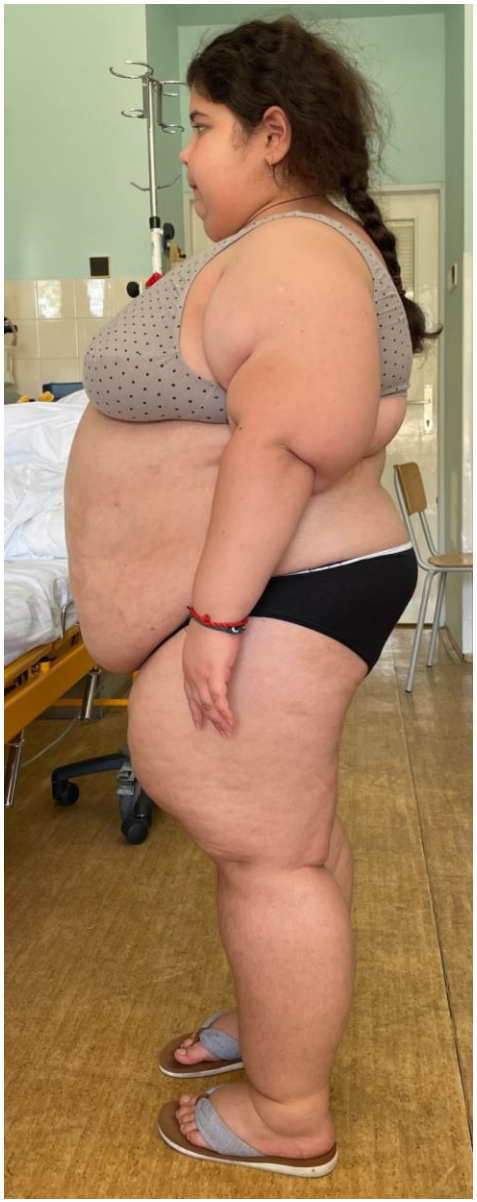
Příjmení a jméno: [redacted]
Datum narození: 20.10.2017 Pohlaví: chlapec

Naměřené a vypočtené hodnoty

Věk	Výškový věk (W)	Výška	Perc.	Z skóre	Perc. na W	Z skóre na W
[roky]	[roky]	[cm]	[%]	[1]	[%]	[1]
1,00	0,74	73,0	13	-1,15	50	0,00
5,07	3,79	104,0	3	-1,85	50	0,00

Věk	Hmotnost	Perc.	Z skóre	Perc. na W	Z skóre na W	BMI	Perc.	Z skóre	Perc. na W	Z skóre na W
[roky]	[kg]	[%]	[1]	[%]	[1]	[kg/m²]	[%]	[1]	[%]	[1]
1,00	8,5	5	-1,68	23	-0,74	16,0	18	-0,91	22	-0,78
5,07	25,0	97	1,84	100	3,07	23,1	100	3,59	100	3,73

Tisknout Zavřít



Cushing syndrome

weight 9.9 kg (8.1. p.)
length 83 cm (70. p.)
HC 48 cm (79. p)

-1.5kg within 5M

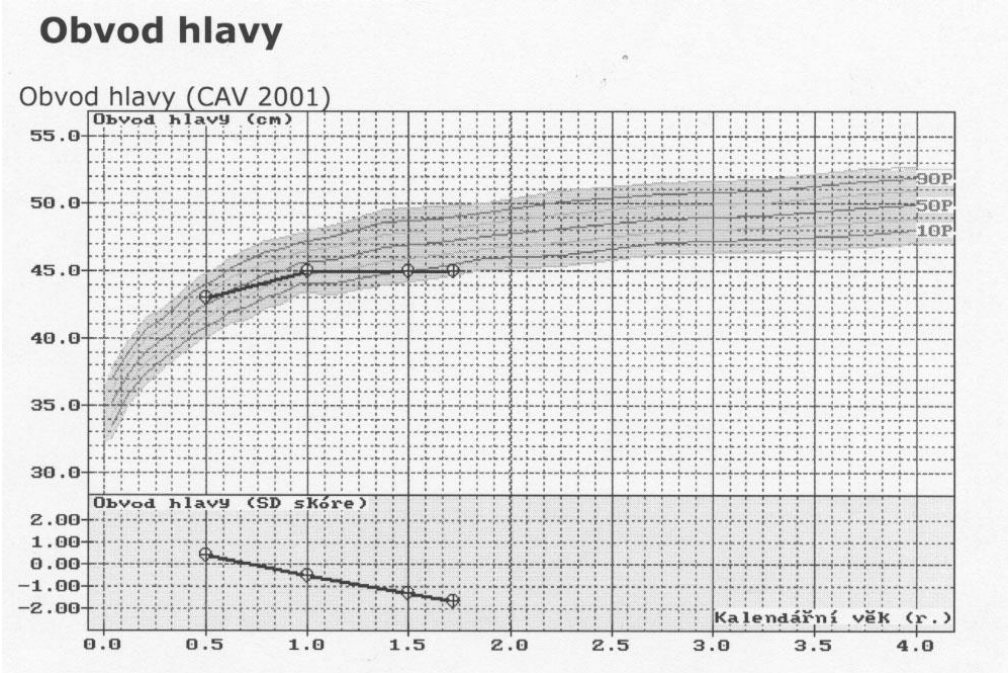
Weight for length
2.P, -1.9SD)

18M old girl

9M girl, at birth 28 cm,
HC 33cm

6M girl, at birth 34 cm,
HC 38cm

Glycogenosis – case report



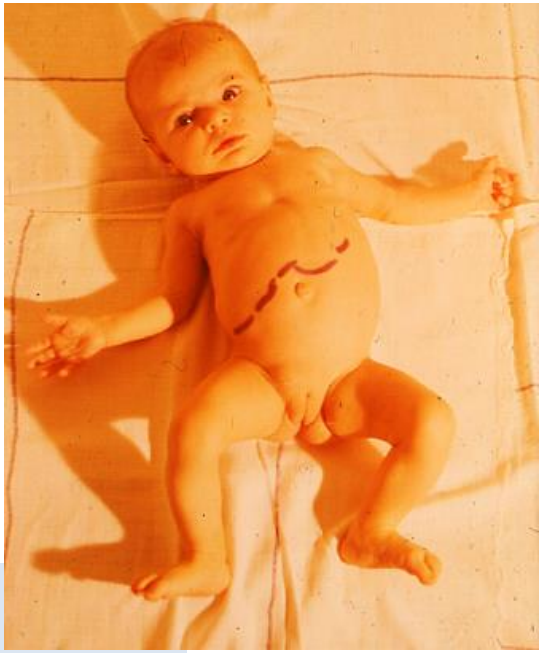
I/I gravidity, at term,
BW 3420g, BL 51cm,
FH: negative
<u>Hospitalisation at the age of 12M:</u>
acute pyelonephritis L**+2cm**
ALT **2.45** μkat/l (N<0.60), AST **2.6** μkat/l (N<0.69)

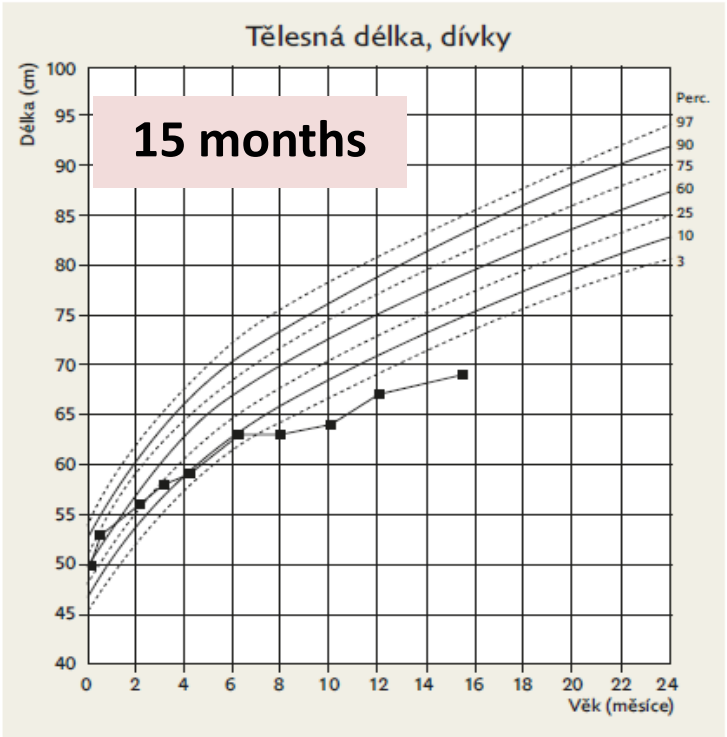
at 20M of age admission - mother´s request

Glycogenosis – case report

Doll face
borderline microcephaly (3.P)
EEG abnormalities - epilepsy
normal psychomotor development

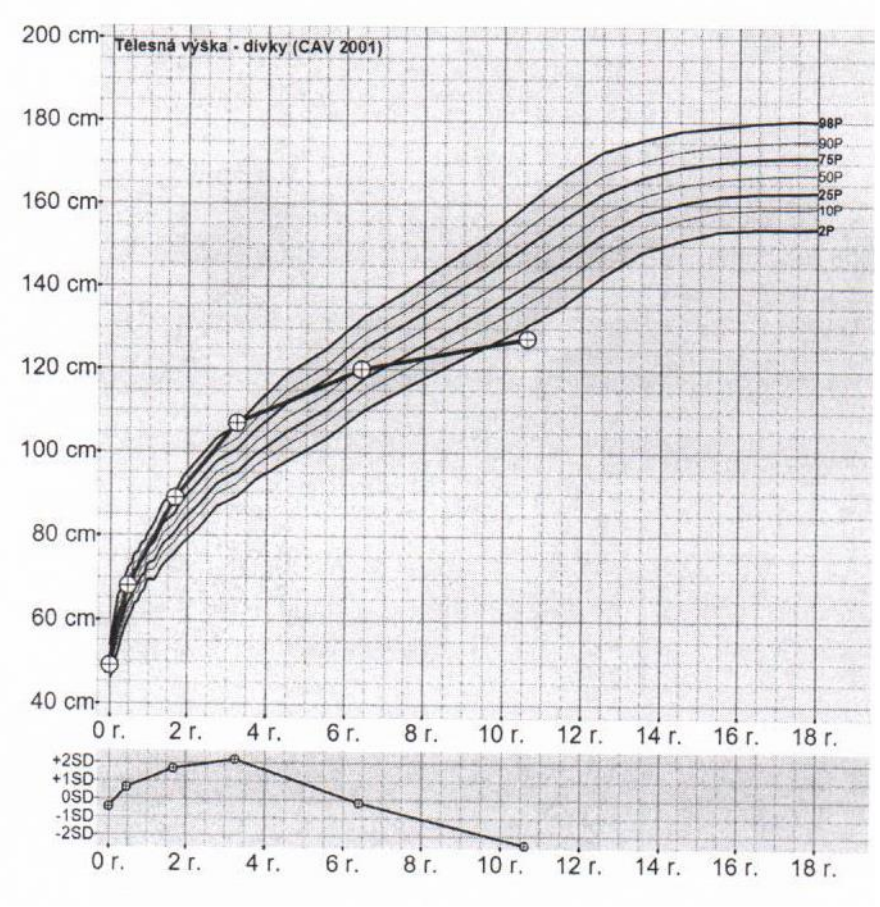
Lab:
ALT **26.61** AST **67.85**
TRG **11.93**
Cholesterol **7.39,** Kys.močová **394**
B-laktát **3.8**,
Glycemic profile: asymptomatic night hypoglycemia (**2.2** mmol/l)





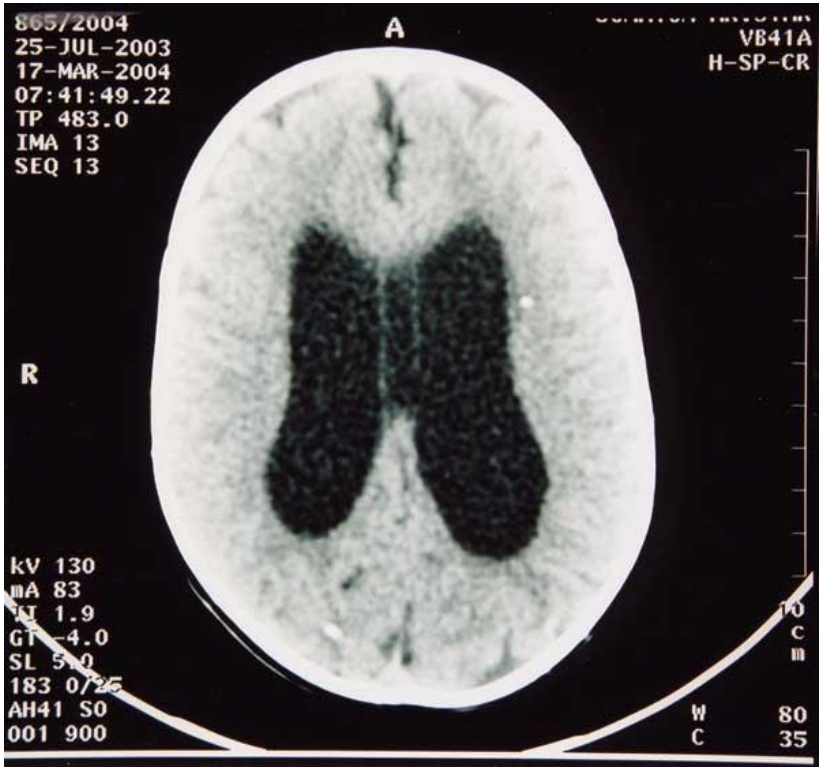
- hepatomegaly
- hepatopathy
- growth failure
- dyslipidemia
- hypoglycemia
- hyperuricemia
- lactic acidosis

Glycogen storage disease typ Ia



hypothyreosis

Sturge-Weber syndrom



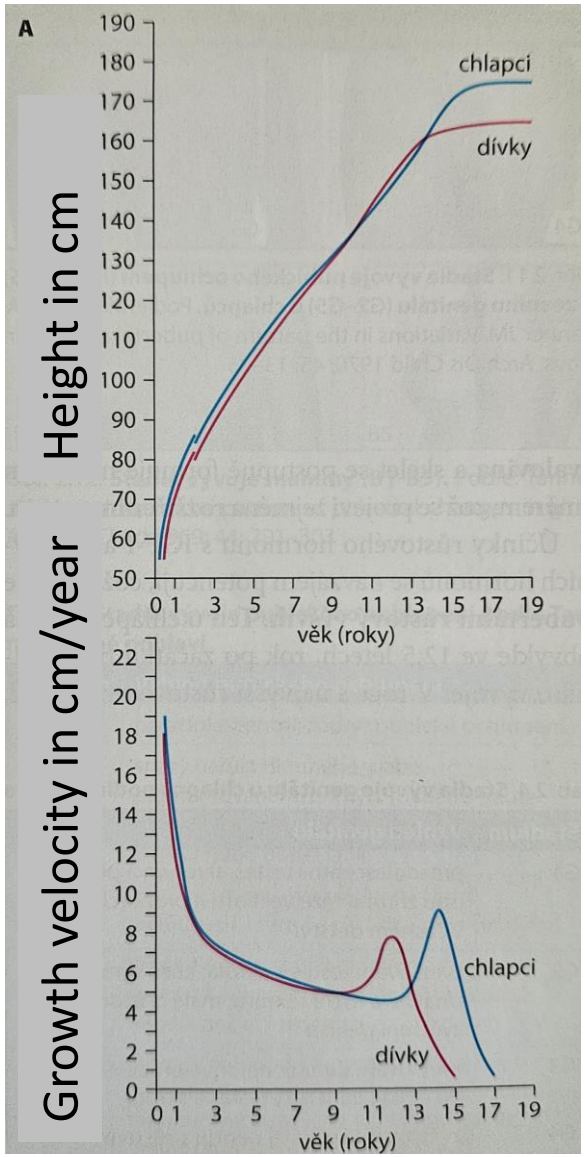
centiles growth charts changes

2/3 of children change major percentile lines during first 2Y

LAG-DOWN GROWTH

CATCH-UP GROWTH

Different hormonal regulation



Women 167.2cm, Men 180.1cm/r. 2001

Growth during puberty

girls 25-30cm
(completed two years after menarche, median 15 years /13-16.5)

boys 25-30cm (median 16.5 years /14.5-18.5)

Puberty 15% of final height

adolescence/puberty

Adolescence – refers to the passage from childhood to adulthood,

early (10-13 Y), middle (14-16 Y), late (17-20 Y)

Puberty - refers to those biologic changes that
lead to reproductive capacity

Height during puberty +15-20% (boys 25-30 cm, girls 18-23 cm)
Muscle mass double between 10-17 years

beginning of puberty

Girls:

Menarche is a relatively late pubertal event

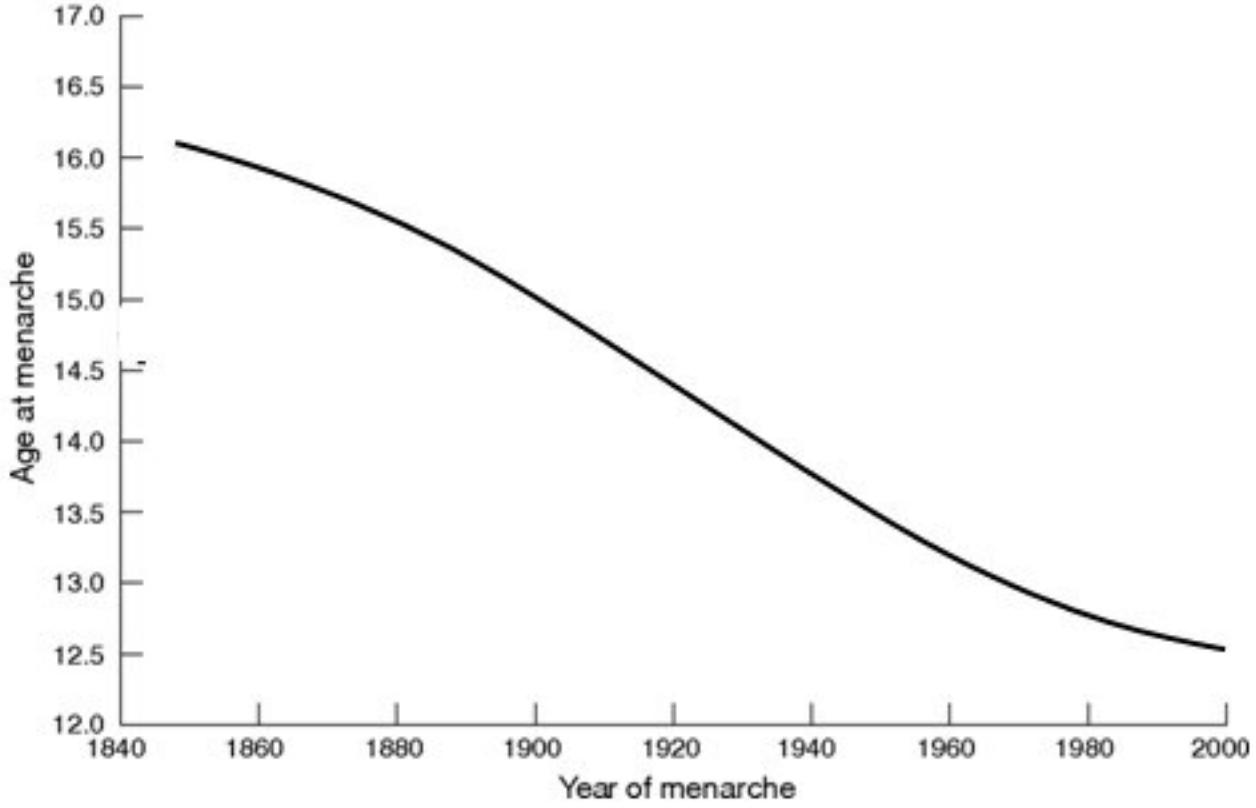
8-13 years (average 11 year) first sign of puberty-*Thelarche*

Boys:

Testicular enlargement

9.5-13.5 years (average 11.5 years)-testes 4-6 ml

MENARCHE
Evropa and USA 1840-2000



CZE

1895

15.1 let

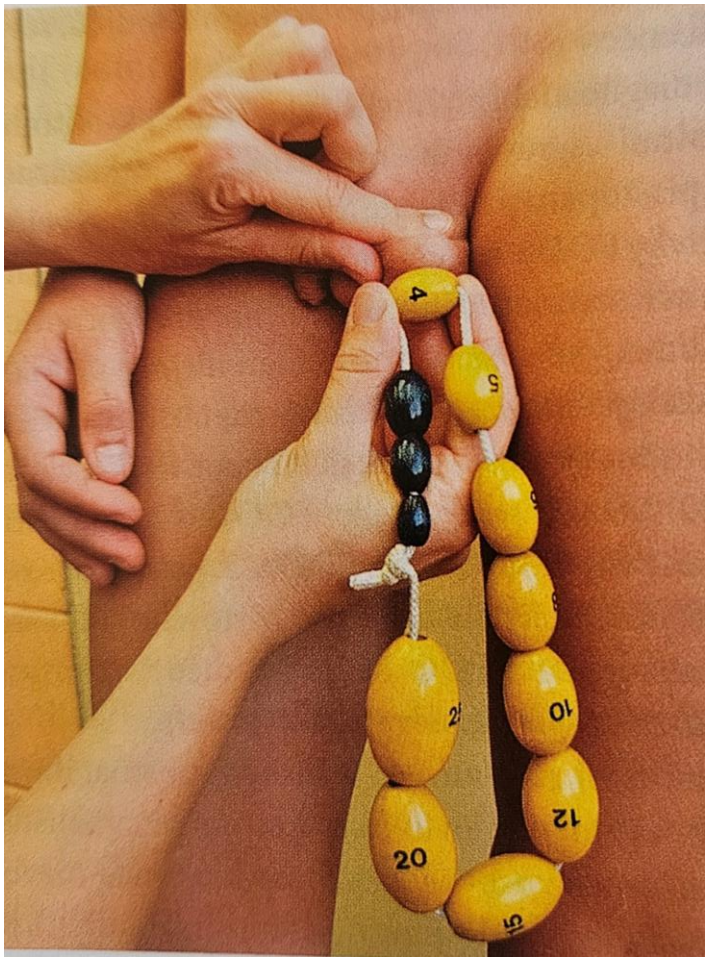
2001

13.0 let

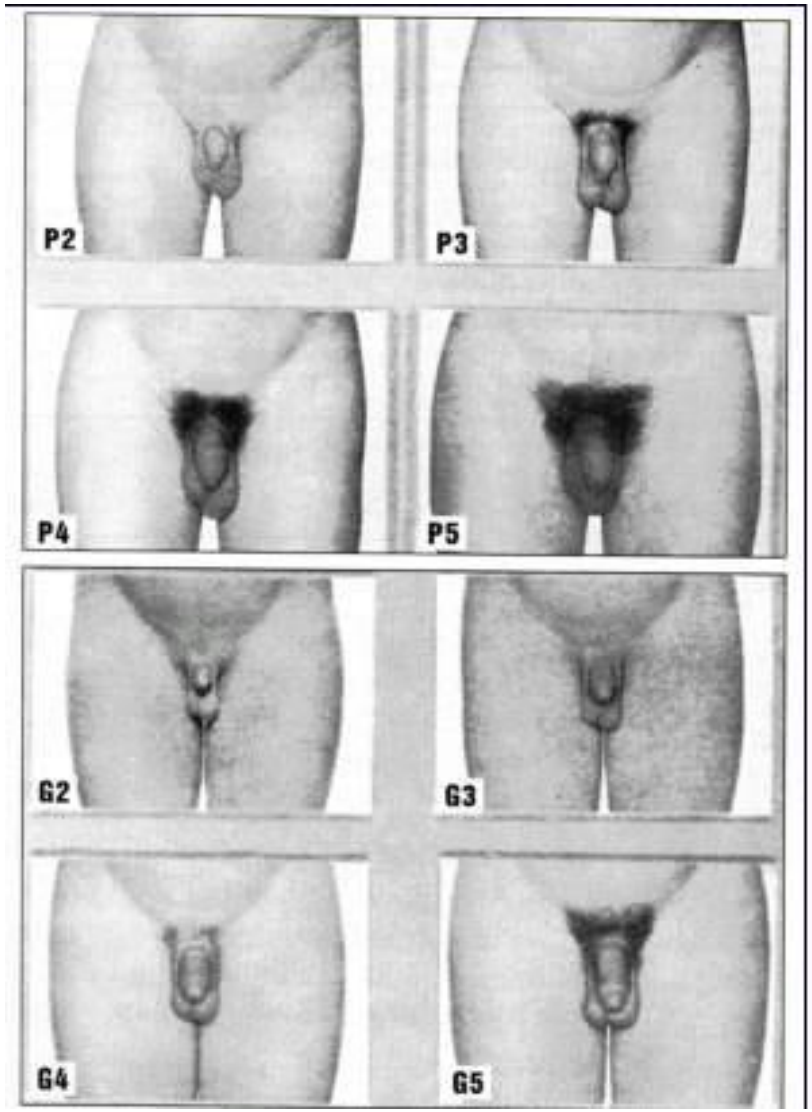
Now

12.5 let

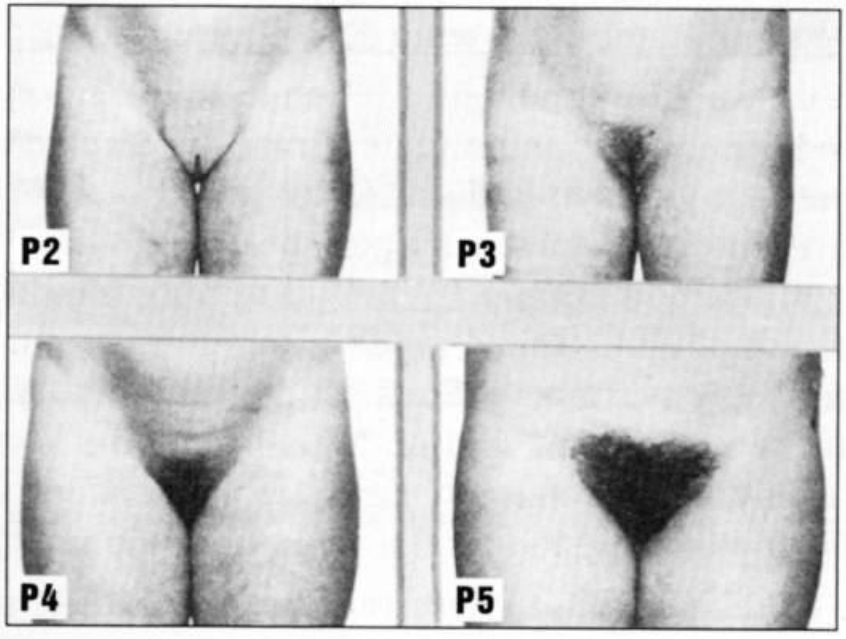
Orchidometer



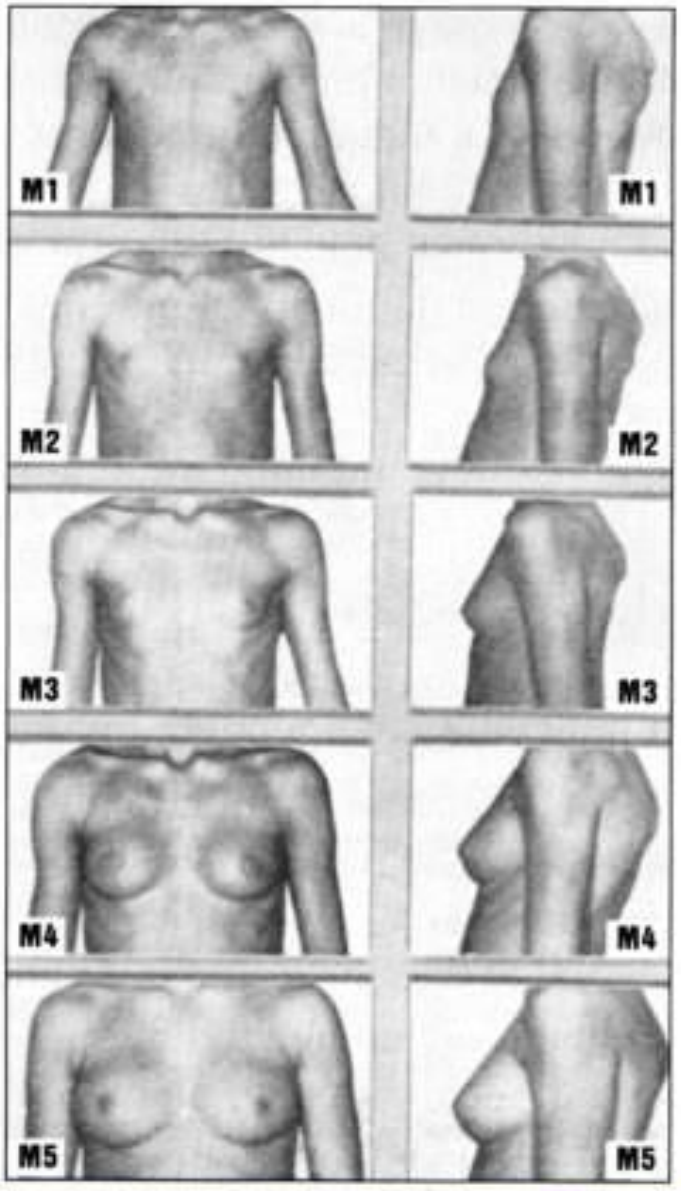
assessment of pubertal development

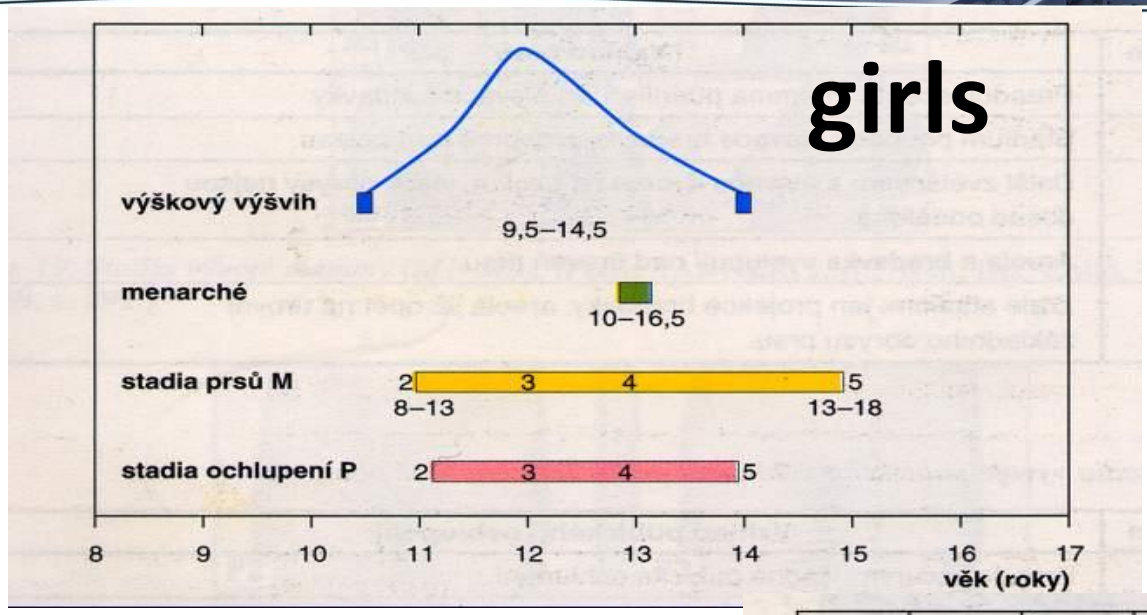


(Tanner, Marshall, 1970)

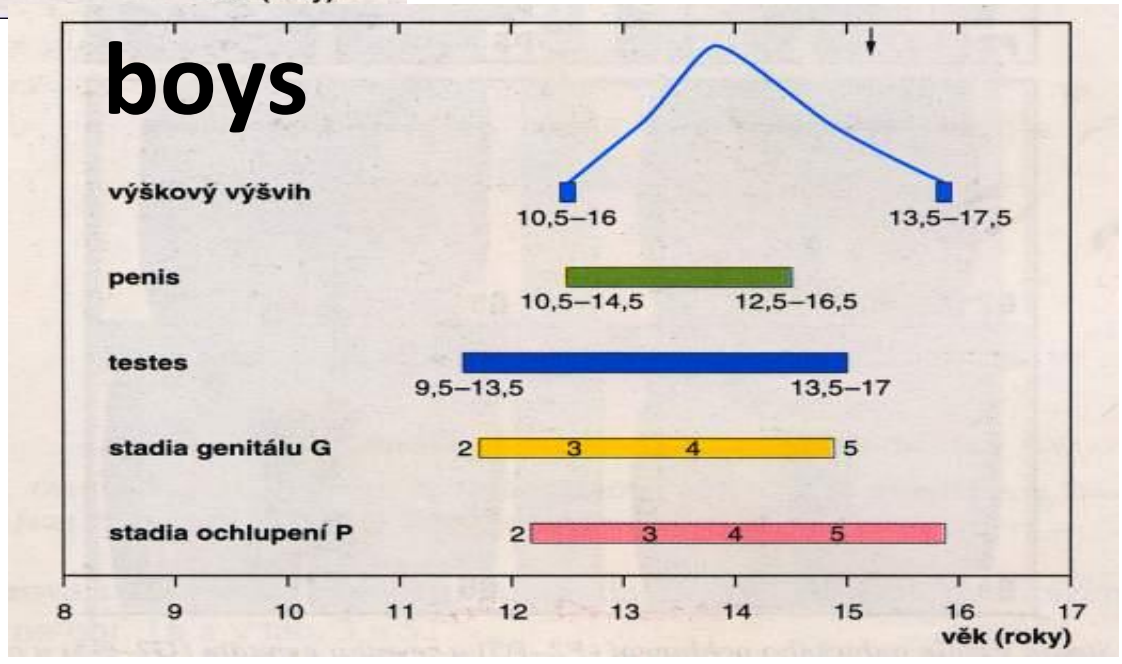


(Tanner, Marshall, 1970)





sequence of pubertal events



growth reference values

Nation wide antropometric studies: first 1895, 6-14 years old children
100 000 children

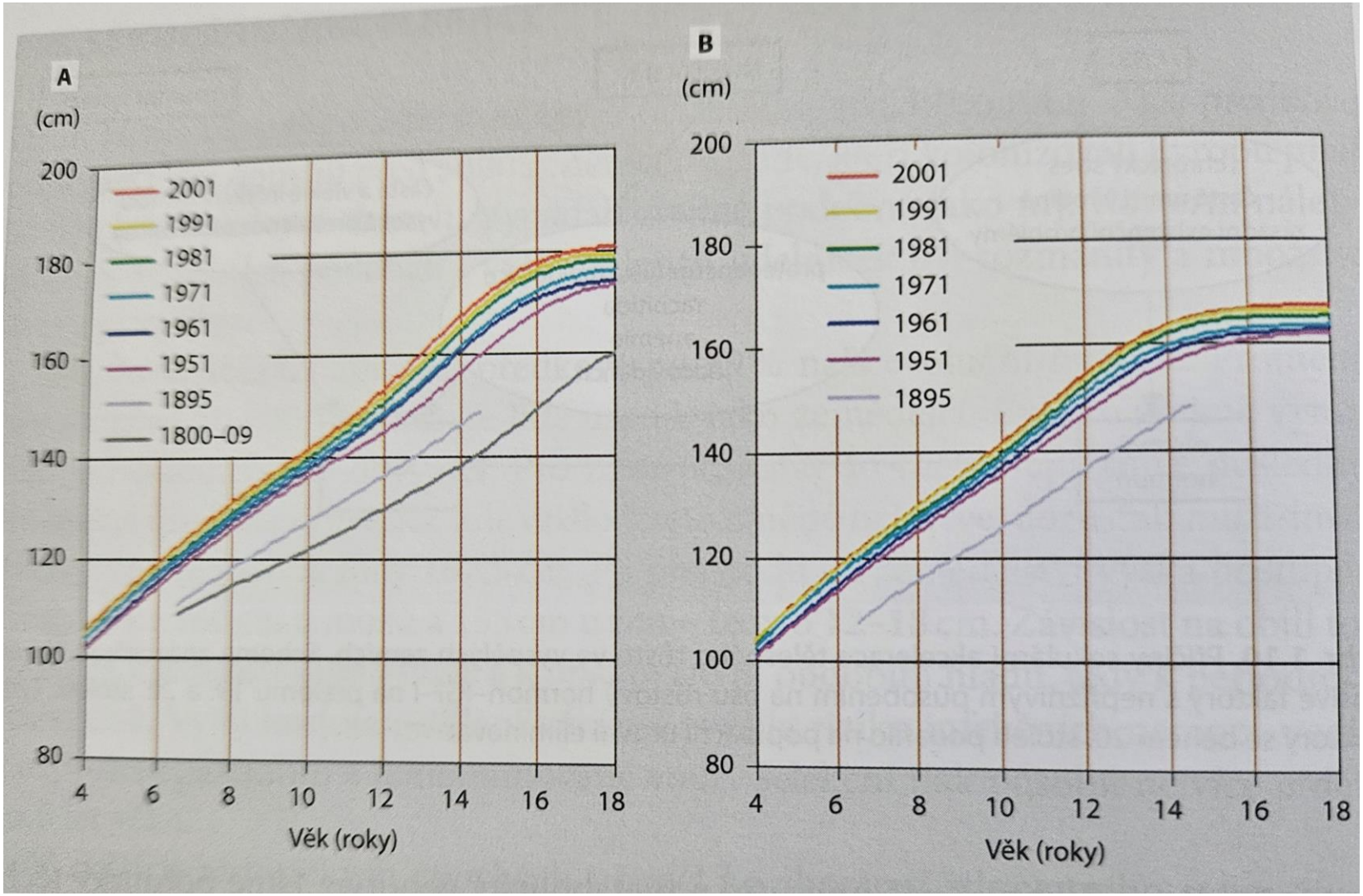
Every 10 years (1991; 2001) 0-18 years old children
(cca 3% children of particular age)

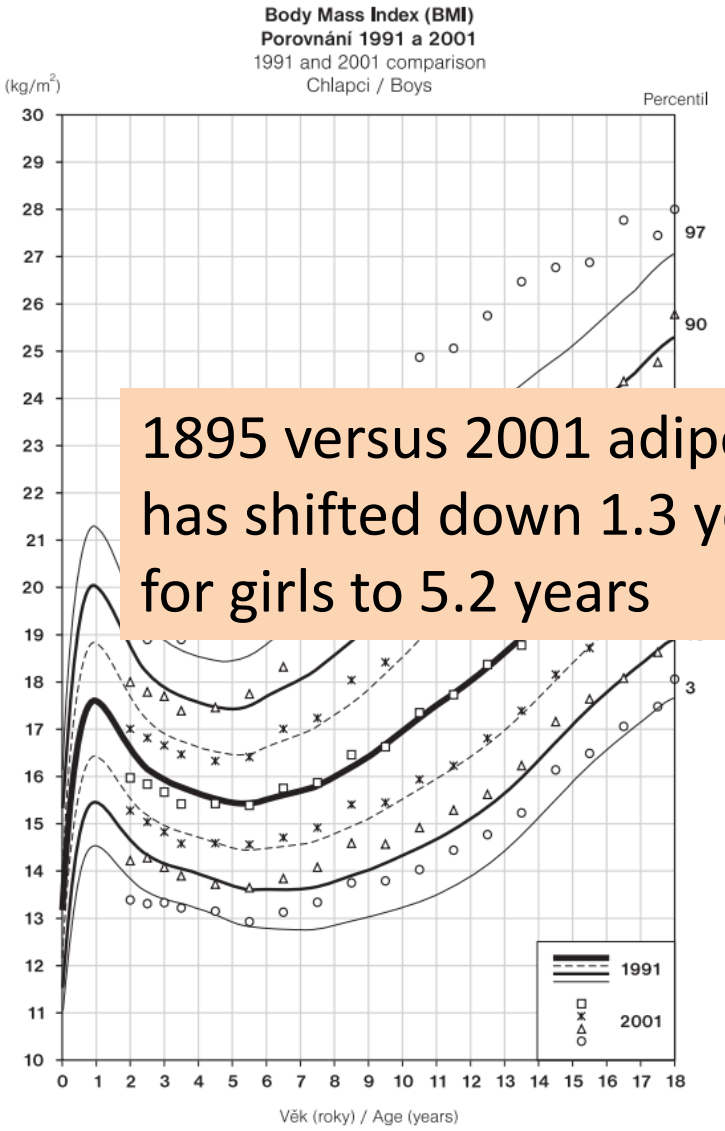
Secular trend of growth: 17 years old boys +7,5 cm, girls +4.7 cm

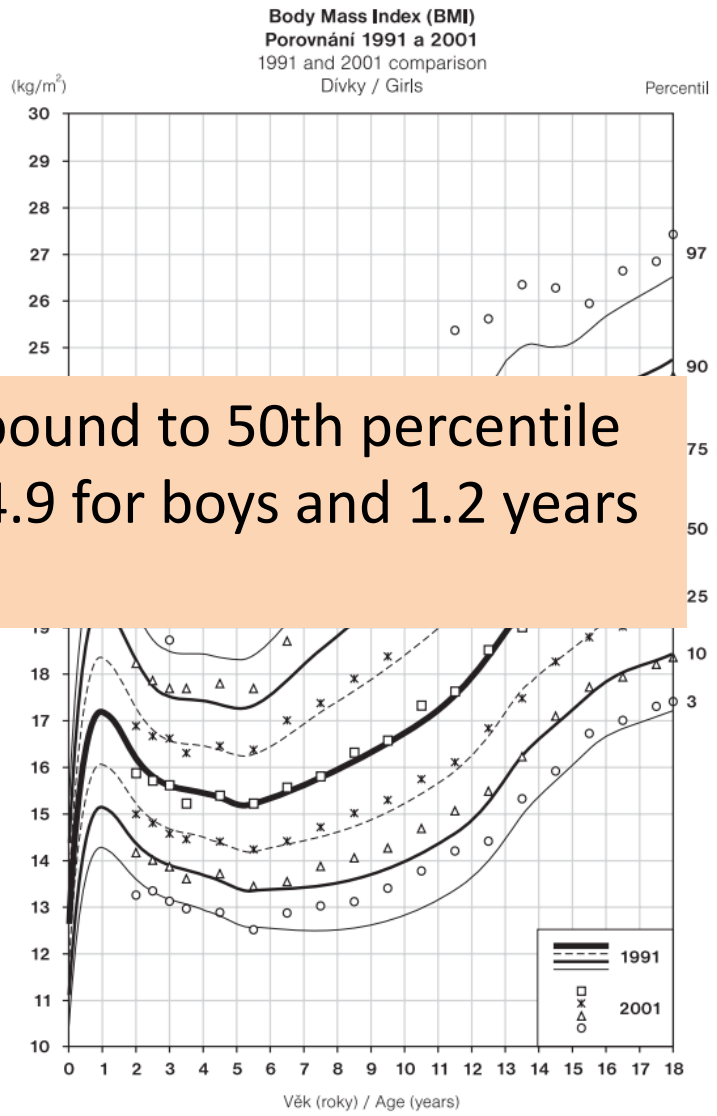
Problem and Caution: breast-fed x bottle-fed infants

applying the charts to adolescence

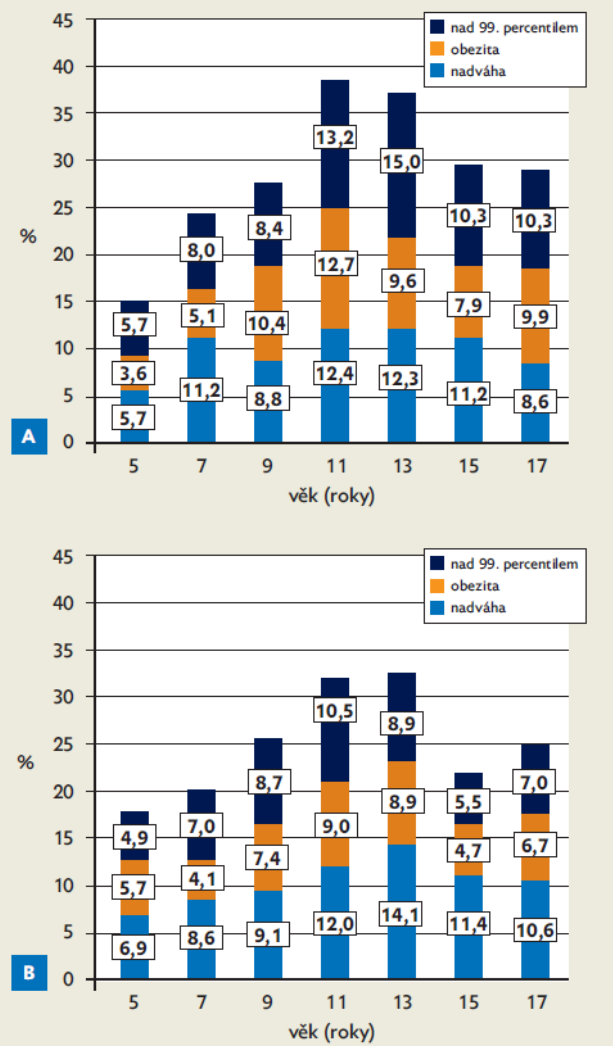
growth 1895-2001







1895 versus 2001 adiposity rebound to 50th percentile has shifted down 1.3 years to 4.9 for boys and 1.2 years for girls to 5.2 years

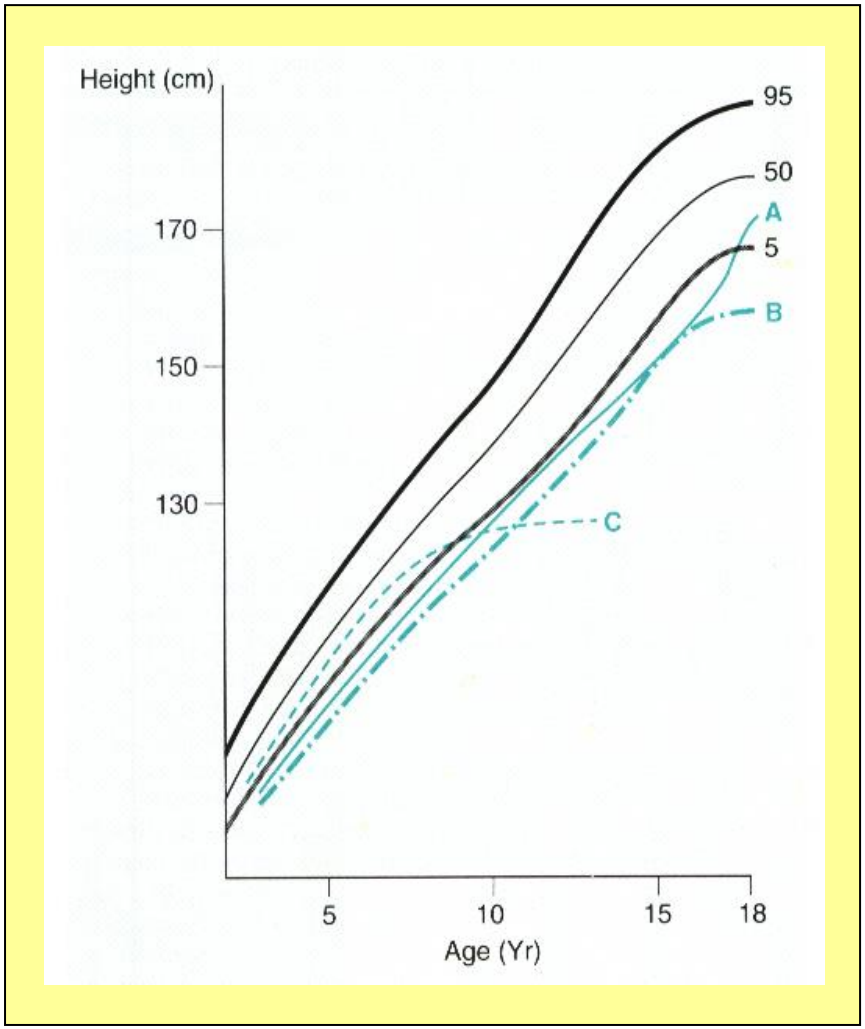


Prevalence of overweight and obesity 2021,
A boys and B girls

Study COVID-19 (2021)

Overweight and obesity - n=3517 children

11-13 year old boys - 38, 3 and 36.9%

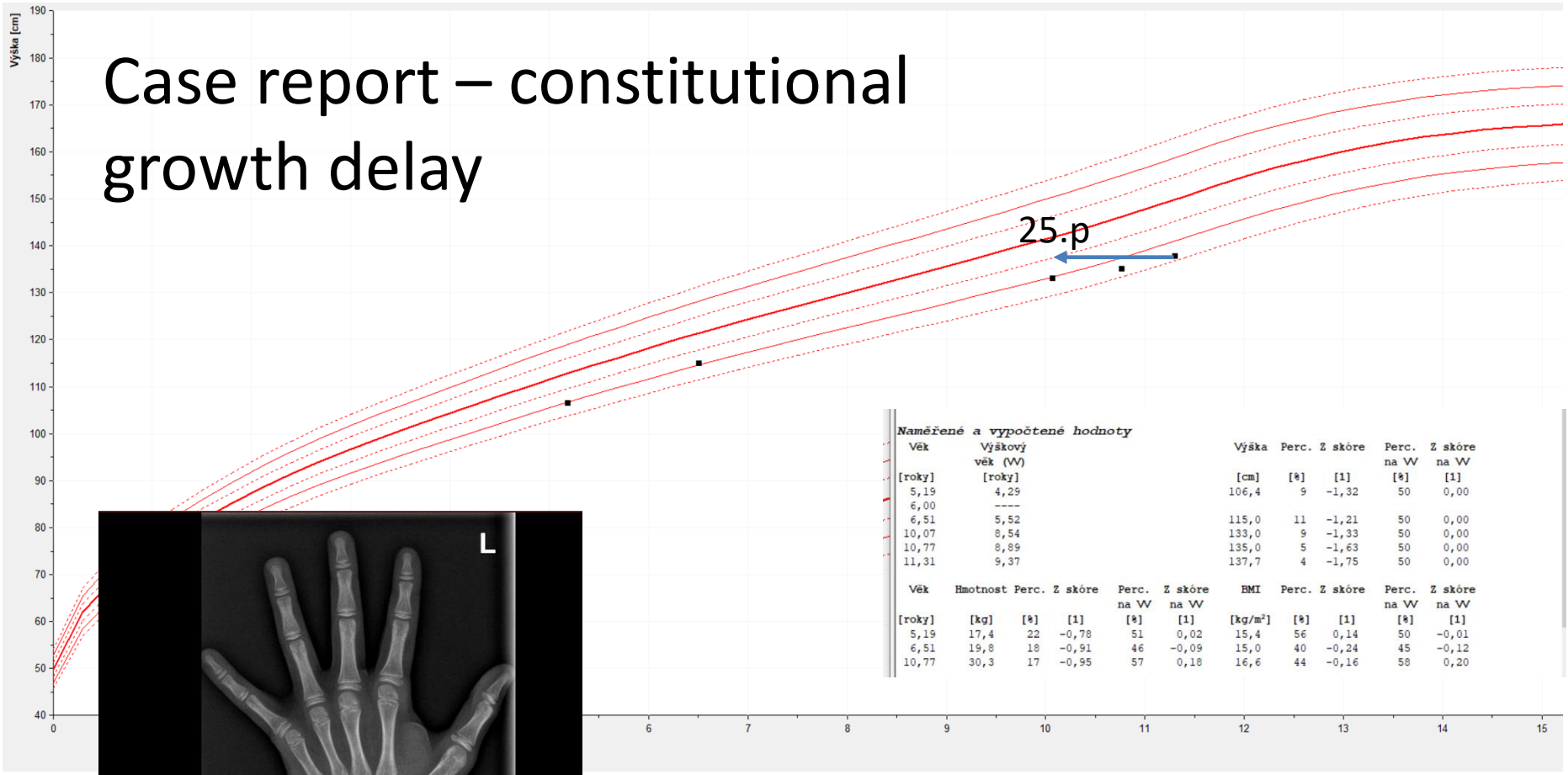


growth failure

Familial short stature

constitutional growth delay

Case report – constitutional growth delay

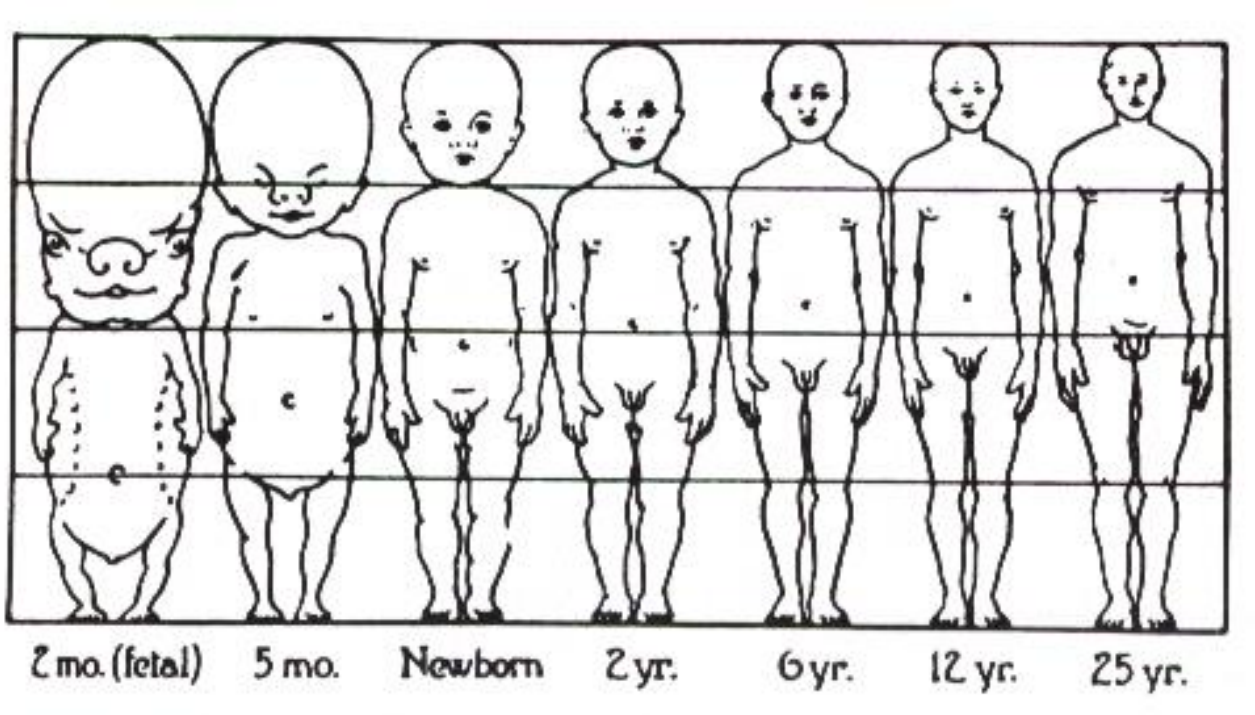


Naměřené a vypočtené hodnoty

Věk	Výškový věk (W)	Výška	Perc.	Z skóre	Perc. na W	Z skóre na W
[roky]	[roky]	[cm]	[%]	[1]	[%]	[1]
5,19	4,29	106,4	9	-1,32	50	0,00
6,00	----					
6,51	5,52	115,0	11	-1,21	50	0,00
10,07	8,54	133,0	9	-1,33	50	0,00
10,77	8,89	135,0	5	-1,63	50	0,00
11,31	9,37	137,7	4	-1,75	50	0,00

Věk	Hmotnost	Perc.	Z skóre	Perc. na W	Z skóre na W	BMI	Perc.	Z skóre	Perc. na W	Z skóre na W
[roky]	[kg]	[%]	[1]	[%]	[1]	[kg/m²]	[%]	[1]	[%]	[1]
5,19	17,4	22	-0,78	51	0,02	15,4	56	0,14	50	-0,01
6,51	19,8	18	-0,91	46	-0,09	15,0	40	-0,24	45	-0,12
10,77	30,3	17	-0,95	57	0,18	16,6	44	-0,16	58	0,20

body proportions



Head/trunk ratio

Infants 1/4

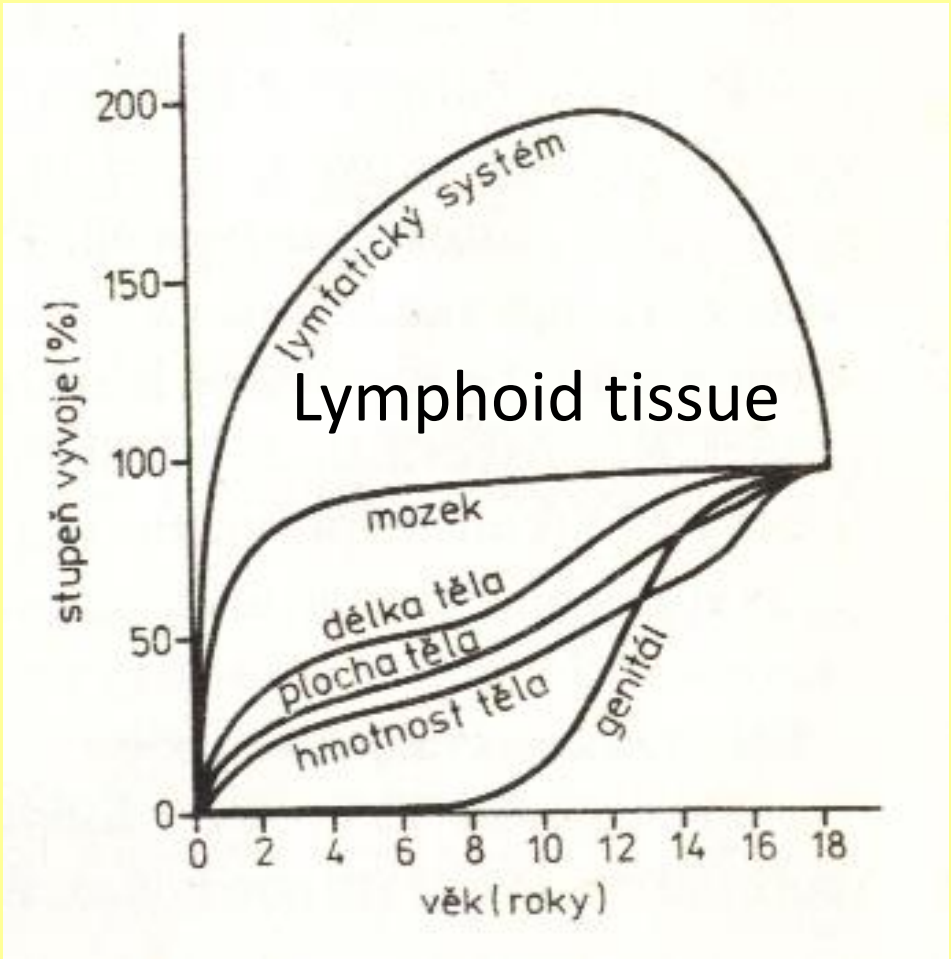
Adults 1/8

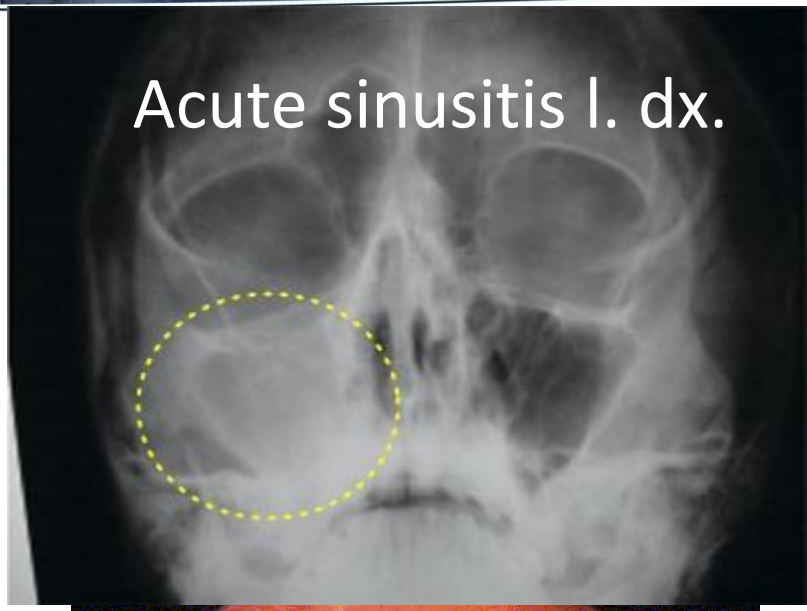
body surface area:

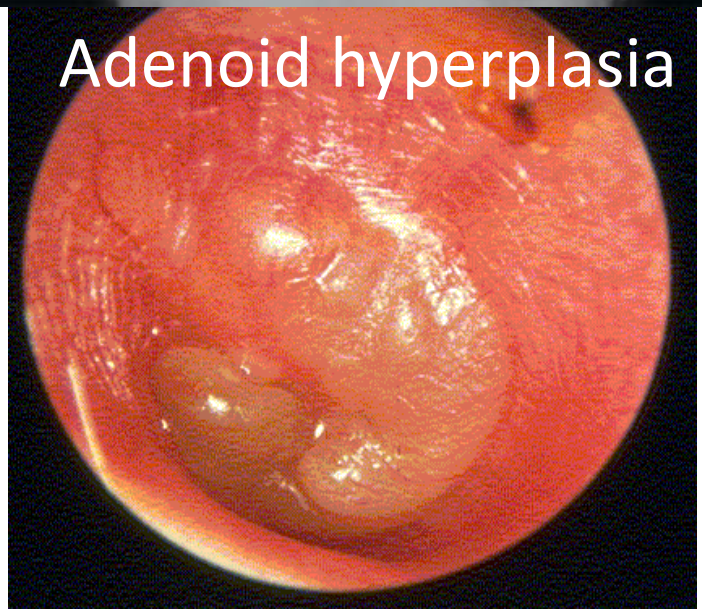
neonate 0,25 m^2; 6M 0,45 m^2; 6L 0,65 m^2; 10L 1,15 m^2;


Wormian
Bones


D
100
90
80
70


Lymphoid tissue
stupeň vývoje (%)
200
150
100
50
0
lymfatický systém
mozek
délka těla
plocha těla
hmotnost těla
genitál
0 2 4 6 8 10 12 14 16 18
věk (roky)


Acute sinusitis l. dx.


Adenoid hyperplasia

neonatal reflexes

Palmar grasp: (28) 32.wk - 4.months

Plantar grasp: till 12 - 14.months

Moro reflex: (32) 37 wk – 3.(6). Months

Rooting reflex, sucking reflex (32) 36. wk – 6.months

Walking and placing reflex: 37. wk

Asymetric tonic neck reflexes: (35) 1.months – 5.months

Babinsky (till 12.months)

Parachute reflex (7-10.months)

gross motor dev.

Turns head from side to side (1-4 wk)

Head up 45° (1-2M)

Pull to sit, no head lag (3M)

Hands together in midline (3M)

Sits without support, pivots (6M)

Rolls back to stomach (6.5M)

gross motor dev.

Sits up alone and indefinitely without support (7M)

Crawling (7-8M)

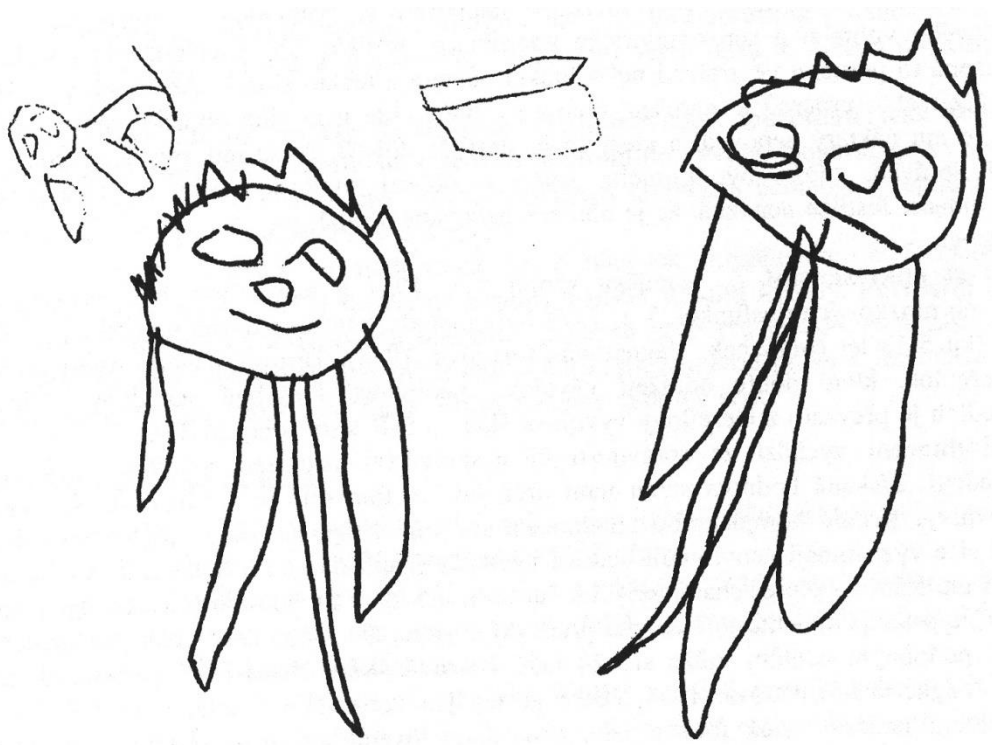
Pulls to standing position (8M)

Walks with support (10M)

Walks alone (12M, range 10-17M)

Walks alone, crawls up stairs (15M)

drawing



Scribbles (15M)

Imitates vertical stroke (18M)

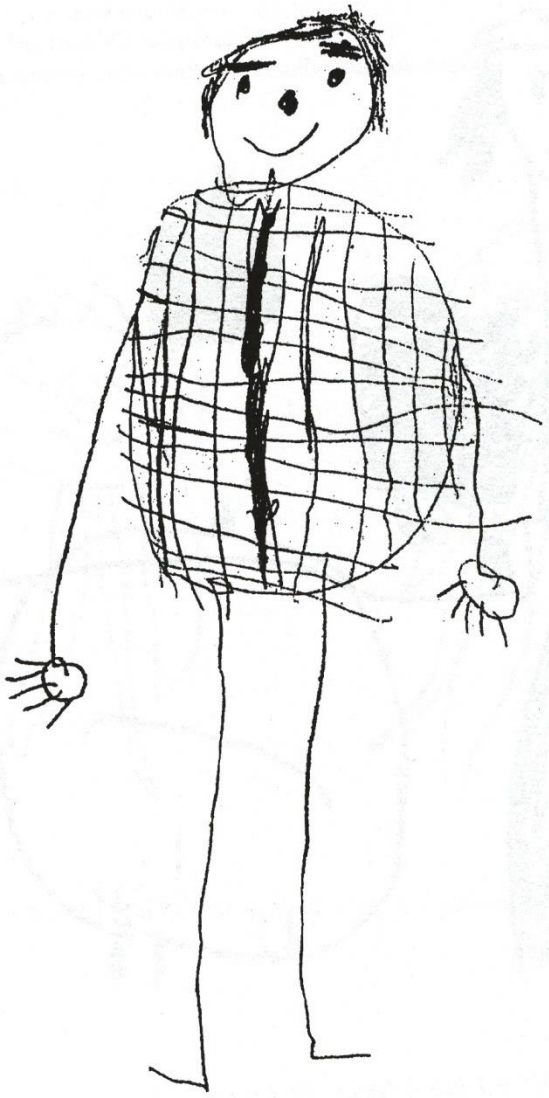
Imitates horizontal stroke (24M)

Makes vertical and horizontal strokes,not join them to make a cross (30M)

Copies a circle, imitates a cross (36M)

Copies cross and square, draws a man with 2 to 4 parts (+ head) (48M)

Draws triangle from copy (60M)



language

Babling begins by age 6M

Speaks first real word (12M)

Speaks 4-6 words, jargon, may name a familiar object (ball) (15M)

The number of words 6-10, names pictures (18M)

Speaks two-word sentences (19M)

Puts 3 words together knows 100-270 words (24M)

Refers to self by pronoun („I“), knows full name (30M)

Knows age and sex, counts 3 objects correctly, knows 900 words (36M)

social and play development

Smiles in response to face, voice (1.5M)

Stares at own hand (4M)

Face to face interaction with a trusted adults (3-6M)

Inhibits to „no“ (7M)

Bangs two cubes (8M)

Separation anxiety (8M)

social and play development

Uncovers toy (after seeing it hidden) (8M)

Object constancy (9M)
Object continue to exist even when not seen

Follows one-step command without gesture-“give it to me“ (10M)

Egocentric pretend play (pretends to drink from cup) (12M)

Indicates some desires or needs by pointing, hugs parents, makes tower of 3 cubes (15M)

Uses stick to reach toy (17M)

Pretend play with doll (gives doll bottles) (17M)

social and play development

During preschool period, play is marked by increasing complexity and imagination, **from simple scripts-shopping, putting baby to bed** (2-3 yr) to more extended scenario involving singular events such as **going to zoo, going on a trip** (3-4 yr) to the creation of scenario that have only Been imagined-such as **flying to the moon** (4-5 yr).

From minimal social interaction with peers during play (**parallel play** 1-2 yr) to **cooperative play** (3-4 yr)