COMPLICATIONS OF CHILDHOOD OBESITY

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Five book chapter, twenty-five original papers and number of abstracts, which can be cited, have been published (impact factor: 50.198 /without abstracts/, citations: 388). She is a member in several national and international societies, she takes part in the work of European Childhood Obesity Group (ECOG) since 1993. She was the Vice-President of ECOG between 2010-2013, then the Scientific Advisor 2014-2017, now she is also a Board Member. She was the President of Endocrine Working Group of Hungarian Paediatric Society between 2012-2014, now she is still a Board Member there, and she is the Secretary of the Childhood Diabetes Section of Hungarian Diabetes Association.
Margherita Caroli (MD, PhD) is a paediatrician and a nutritionist with a PhD in Paediatric nutrition. She has been the head of the Nutrition Unit of the Prevention Dept of the Azienda Locale Brindisi for 20 years. Founder member and President of ECOG for the term 2007-2010 and member of the Italian Society of Obesity and the Italian Society of Preventive and Social Paediatrics. She has been the scientific coordinator of several national and European projects and author or co-author of more than 400 items including published papers and lectures. She has had a role as expert for several European DGs (DG SANCO, RESEARCH, AGRI, and DGJRC) and she is often temporary advisor for WHO.
Anders Forslund (MD, PhD) is an Associate Professor at the Department of Women’s and children’s health, Uppsala University, Sweden. He defended his thesis 1998 with the title “The Effect of Protein Intake and Physical Exercice on Energy Turnover and Substrate Utilisation at Energy Balance in Man”. He has published > 40 articles around nutrition, energy turnover, body composition, substrate utilization, metabolic disorders and childhood obesity. He has been working as a Paediatrician since 2007, and working clinically with childhood obesity > 10 years. He is the head of the Childhood Obesity Unit at Uppsala University Hospitals since 2007. He is a member of the Swedish childhood obesity society, and a Board Member in the European Childhood Obesity Group (ECOG).
Dénes Molnár (MD, PhD, DSc) is professor in pediatrics, nutrition and metabolism, at Dept. Paediatr. Univ. Pécs. He was the chairman of the Dept. Pediatr. Univ. Pécs from 2007 until 2015. Served as the president and for two terms the scientific advisor of the European Childhood Obesity Group (ECOG), and the vice-president of the Hungarian Association for the Study of Obesity. He was the president of the Hungarian Paediatric Association in the period of 2012-2015. He is the member of the editorial board of Obesity Facts and Nutrition, Metabolism and Cardiovascular Diseases, Journal of Pediatric Biochemistry and The Scientific World Journal; besides that of more national journals. He participated in 9 international research programs, and won 11 national research grants. He is PhD program leader in the topic of Nutritional research in children and infants. Special interest: metabolic disorders, eating disorders, prevention of adult diseases in childhood. He has published 396 original articles in peer-reviewed journals and 18 book chapters (cumulative IF: 950,47; number of citations ~ 7700, Hirsch index: 45
OBJECTIVES OF THIS MODULE

At the end of this module you should

• Be sure about the fact that childhood obesity can cause a number of problems from difficulties in daily activity to serious health conditions.
• Know how to define hypertension in children and which guideline is the best for it.
• Know the key sign of insulin resistance, risk factors for Type 2 diabetes mellitus (T2DM) and the possibilities to evaluate the disorders of glucose metabolism.
• Be aware of the questions about the definitions of metabolic syndrome and know the screening possibilities for non-alcoholic fatty liver disease as the most frequent asymptomatic complications of children with obesity.
• Know some real and quasi endocrine conditions which are the consequences of childhood obesity.
• Know the most frequent pulmonary complications in children with obesity
• Recognize some orthopedic conditions which are commonly present in children with obesity and differentiate among them
ALGORITHM FOR THE EXAMINATION OF AN OBESE CHILD

Family and personal history, diet, psychomotor development

Early beginning (< 6 years of age)
Delayed psychomotor development

- Suspect genetic syndrome e.g. Prader Willi
  Bardet Biedl
  Fragile X....

Early beginning (< 6 years of age)
Normal psychomotor development

- Suspect gene mutation of the appetite regulation pathway
  e.g. leptin, leptin receptor, MC4R,

No age specific
Decreased linear growth
Delayed bone age

- Suspect endocrine disease
  Negative investigation

No age specific
normal or increased linear growth
normal psychomotor development

Primary obesity

79 genetic syndromes including obesity are described nowadays and only partly elucidated. Primary obesity may be of polygenic or epigenetic origin.

Ref 14
COMPLICATIONS OF PRIMARY OBESITY

- Children with primary obesity are at high risk for multiple complications which may affect almost any organ in the body.
- 26% of 1-2 years-old and 83% of 10-14 years-old children with obesity will become obese adults.
- The severity of complications increases with the degree and duration of obesity.
- Early onset obesity increases mortality rate in adulthood.
- The purpose of the evaluation of children with obesity is to assess obesity-related comorbidities resulting from excess fat mass and body weight overload.

Ref 2, 3, 9, 13
BODY MASS INDEX (BMI) DURING ADOLESCENCE AND SUBSEQUENT CARDIOVASCULAR MORTALITY

![Graph showing cumulative mortality from cardiovascular disease over years of follow-up for different BMI percentiles.](graph)

<table>
<thead>
<tr>
<th>BMI Percentile</th>
<th>Participants at risk</th>
<th>Cumulative person-yr</th>
<th>Cumulative cardiovascular deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;5th</td>
<td>1,712,018</td>
<td>17,201,301</td>
<td>185</td>
</tr>
<tr>
<td>5th–24th</td>
<td>1,042,018</td>
<td>30,718,320</td>
<td>609</td>
</tr>
<tr>
<td>25th–49th</td>
<td>540,636</td>
<td>38,472,521</td>
<td>1,577</td>
</tr>
<tr>
<td>75th–84th</td>
<td>160,145</td>
<td>41,926,636</td>
<td>2,676</td>
</tr>
</tbody>
</table>

No. at Risk

2,298,130 participants

Ref 10
**Respiratory**
- Asthma
- Hypoventilation
- Obstructive sleep apnoea (OSA)
- Exercise intolerance

**Metabolic & cardiovascular**
- Chronic inflammation
- Insulin resistance
- Dyslipidaemia
- Atherosclerosis
- Hypertension
- Stroke
- Cardiac remodelling & dysfunction
- Hyperuricemia

**Neurological**
- Idiopathic intracranial hypertension
  (presudotumor cerebri)
- Adverse effect on cognitive function

**Complications of obesity in children and adolescents**

**Liver and digestive tract**
- Non alcoholic fatty liver disease (NAFLD/NASH)
- Gallstone

**Renal**
- Glomerulosclerosis

**Endocrine**
- Type 2 diabetes
- Early onset/delayed puberty
- Menstrual irregularities
- Accelerated linear growth
- Polycystic ovary syndrome
- Hypogonadism/Gynecomastia
- Pseudogynecomastia

**Musculoskeletal**
- Pain & impaired mobility
- Slipped femoral epiphysis
- Tibia vara
- Blount’s disease
- Ankle sprains
- Genu valgum & Flat foot

**Psychosocial**
- Social stigmatization
- Low health-related quality of life
- Poor self-esteem
- Anxiety
- Depression
- ADHD/ADD
- Eating disorders

**Dermatological**
- Hyperandrogenism
  (acne, hirsutism)
- Acanthosis nigricans
- Hidradenitis suppurativa
- Intertrigo

**Neurologic**
- Idiopathic intracranial hypertension
  (presudotumor cerebri)
- Adverse effect on cognitive function

**Psychosocial**
- Social stigmatization
- Low health-related quality of life
- Poor self-esteem
- Anxiety
- Depression
- ADHD/ADD
- Eating disorders
CARDIOVASCULAR AND METABOLIC COMPLICATIONS

• vast majority of short and long term complications of childhood obesity
• common background including micro vascular alterations,
• mild chronic inflammation
• Include
  • Hypertension
  • Insulin resistance and type 2 diabetes
  • Dyslipidaemia
  • Non alcoholic fatty liver disease

And their combinations into the “metabolic syndrome”

are partly reversible with weight loss
DETERMINANTS OF OBESITY RELATED ENDOTHELIAL DYSFUNCTION in children

Dysfunction of small resistance vessels is the primum movens in the pathogenesis of atherosclerosis

Cardiovascular risk factors influencing endothelial dysfunction

Non invasive techniques of investigation of micro- and macrovascular dysfunction

Ref 15
HYPERTENSION

• The risk of hypertension is 2.5 – 3.7 times higher in children with obesity compared to children with normal weight.

• Prevalence of hypertension is ~ 25 % or higher among overweight and obese children.

• New definition and reference of blood pressure (BP) at rest according to sex, age and height percentile in children and adolescents were published in 2017. (ref 5.)

• Early cardiac remodeling and dysfunction
  ▪ Increased thickness of intraventricular septum
  ▪ Left ventricular hypertrophy
  ▪ Increased left ventricular and left atrial diameter
  ▪ Systolic and diastolic dysfunction

Ref 5, 7, 12, 19
# DEFINITION OF HYPERTENSION

<table>
<thead>
<tr>
<th>Age range</th>
<th>0-13 years</th>
<th>&gt; 13 years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Normal</strong></td>
<td>&lt; 90th percentile</td>
<td>&lt;120/&lt;80 mmHg</td>
</tr>
<tr>
<td><strong>Elevated blood pressure (BP)</strong></td>
<td>≥ 90th percentile to &lt; 95th percentile or 120/80 mmHg to &lt; 95th percentile</td>
<td>120/&lt;80 to 120/&lt;89 mmHg</td>
</tr>
<tr>
<td><strong>Stage 1. hypertension</strong></td>
<td>≥ 95th percentile + 12 mmHg or 130/80 to 139/89 mmHg</td>
<td>130/80 to 139/89 mmHg</td>
</tr>
<tr>
<td><strong>Stage 2. hypertension</strong></td>
<td>≥ 95 th percentile + 12 mmHg or ≥ 140/90 mmHg</td>
<td>≥ 140/90 mmHg</td>
</tr>
</tbody>
</table>

**Note:** adapted BP cuffs size is of critical importance in children in order to avoid under or overestimation of BP

Ref 5
# RECOMMENDED SIZE OF BP CUFF

<table>
<thead>
<tr>
<th>Ages</th>
<th>Width (cm)</th>
<th>length (cm)</th>
<th>Circumference of arm (maximum -cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn</td>
<td>4</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Infant</td>
<td>6</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Child</td>
<td>9</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>Adolescent</td>
<td>10</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Adult</td>
<td>13</td>
<td>30</td>
<td>34</td>
</tr>
</tbody>
</table>

*The cuff bladder length should encircle 80% to 100% of the arm circumference;*

*A cuff bladder with a width-to-arm circumference ratio 0.45 to 0.55 is recommended.*

*For children with severe obesity in whom the appropriate cuff size is difficult to determine, the midarm circumference should be measured as the midpoint between the acromion of the scapula and olecranon of the elbow, with the shoulder in a neutral position and the elbow flexed to 90°.*

Ref 5, 12
HYPERTENSION
Ambulatory blood pressure monitoring (ABPM)

ABPM should be performed

1. for confirmation of HTN in children and adolescents
   • with office BP measurements in the elevated BP category for 1 year or more
   • or with stage 1 HTN over 3 clinic visits.

2. by using a standardized approach
   • with monitors that have been validated in a pediatric population
   • results should be interpreted by using pediatric normative data

Ref 5
Insulin resistance

- one of the commonest metabolic disturbances of obesity
- key element of the metabolic syndrome
- may evolve toward type 2 diabetes
- increases cardiovascular risk

Additional risk factors

- family history of diabetes in first or second degree of relatives
- ethnicity
- SGA
- Smoking during gestation

Clinical features linked to insulin resistance

- Acanthosis nigricans
- PCOS
- NAFLD
- Hypertriglyceridemia
SCREENING FOR DISTURBANCES OF GLUCOSE METABOLISM

• ISPAD criteria for overweight children
  • 2 or more risk factors
  • at the beginning of puberty or at the age of 10 years.

• ECOG position: idem but no age threshold should be applied

• Screening tests
  • fasting plasma glucose (no caloric intake for at least 12 hours),
  • hemoglobin A1C (HbA1C),
  • 2-hours oral glucose tolerance test.

• Derived indexes of insulin resistance
  • useful in paediatric settings but widely accepted international standards are needed.

  **HOMA – IR**: homeostasis model assessment for insulin resistance
  \[
  \text{Fasting insulin} (\mu U/ml) \times \text{fasting glucose} (\text{mmol/l}) / 22.5
  \]

  **QUICKI**: quantitative insulin-sensitivity check index
  \[
  1/(\log \text{fasting insulin} [\mu U/ml] + \log \text{glucose} [mg/dl])
  \]

Ref 1, 2, 5
ACANTHOSIS NIGRICANS
a key sign of insulin resistance
Aspects according to skin phototype

White skin
Light brown skin
Dark skin

Ref 6
CARDIOMETABOLIC COMPLICATION
Dyslipidaemia

• **Definition of dyslipidaemia**
  - elevated total cholesterol, LDL-cholesterol, triglyceride (TG),
  - decreased HDL-cholesterol

• **Prevalence**
  - the most common consequence of childhood obesity
  - Reaches up to 40 % of adolescents with obesity

• Before lab tests 12 hours of fasting needed to get reliable results. If the first result is positive then repeated measurement is needed.

Ref 2, 3, 6
Non Alcoholic Fatty Liver Disease

Overweight/Obesity  Insulin Resistance
Metabolic Syndrome  Hypercaloric Diet

Oxidative Stress  Mitochondrial dysfunction
Pro-inflammatory cytokines  Gut dysbiosis & endotoxin

NAFLD  NASH

FFA

V Nobili, Ref 6
HEPATIC COMPLICATIONS

• The spectrum of nonalcoholic fatty liver disease (NAFLD) ranges from simple steatosis, to nonalcoholic steatohepatitis, cirrhosis and to end-stage liver disease.

• Prevalence of NAFLD varies by the sensibility and specificity of the method of detection such as screening by alanine aminotransferase (ALT) or imaging for steatosis or confirmation by liver biopsy.

• Depending on the type of diagnostic tool the prevalence of NAFLD is estimated to be between 3–12%.

• For the diagnosis of NAFLD, the measurement of ALT is recommended. If the ALT level in obese children exceeds the sex-specific upper normal level 2 times or more, the diagnosis of NAFLD is very likely. In the case that ALT is less than 2 times higher than the upper normal value, but elevated then diagnoses can be confirmed by an additional raised GGT.

• NAFLD in obese children is of concern because of:
  high risk of the progression to nonalcoholic steatohepatitis (NASH) and cirrhosis (the latter has been reported as early as 8 years of age).

Always evaluate NAFLD in patients with Metabolic syndrome (MS)  
Always evaluate MS in patients with NAFLD
METABOLIC SYNDROME (MS)

- Already detectable in children with obesity
- Prevalence increases with age and/or duration of obesity.
- No general consensus on definition in children.
- The most widely accepted definition for MS given by the International Diabetes Federation (IDF) in 2007

- **BUT** several questions are still raised:
  - **age threshold**: does it exist before the age of 10 yrs?
  - **age, gender and population specific standards for lipids and blood pressure are not taken into account.**
  - **no international waist circumference standards exist for children.**

Ref 2, 3, 6, 11
# DEFINITIONS OF PEDIATRIC METABOLIC SYNDROME

<table>
<thead>
<tr>
<th>Definition</th>
<th>Excess adiposity</th>
<th>Blood pressure</th>
<th>Blood lipids</th>
<th>Blood glucose/ insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IDF</strong>*</td>
<td>WC ≥ 90(^{th}) percentile</td>
<td>SBP ≥ 130 mmHg or DBP ≥ 85 mmHg</td>
<td>Triacylglycerols ≥ 150 mg/dl or HDL cholesterol &lt; 40 mg/dl</td>
<td>Impaired fasting glucose ≥ 110 mg/dl</td>
</tr>
<tr>
<td><strong>IDFICS</strong>-monitoring level</td>
<td>WC ≥ 90(^{th}) percentile</td>
<td>SBP ≥ 90(^{th}) percentile or DBP ≥ 90(^{th}) percentile</td>
<td>Triacylglycerols ≥ 90(^{th}) percentile or HDL cholesterol ≤ 10(^{th}) percentile</td>
<td>HOMA-insulin resistance ≥ 90(^{th}) percentile or Fasting glucose ≥ 90(^{th}) percentile</td>
</tr>
<tr>
<td><strong>IDFICS-action level</strong></td>
<td>WC ≥ 95(^{th}) percentile</td>
<td>SBP ≥ 95(^{th}) percentile or DBP ≥ 95(^{th}) percentile</td>
<td>Triacylglycerols ≥ 95(^{th}) percentile or HDL cholesterol ≤ 5(^{th}) percentile</td>
<td>HOMA-insulin resistance ≥ 95(^{th}) percentile or Fasting glucose ≥ 95(^{th}) percentile</td>
</tr>
</tbody>
</table>

*IDF=International Diabetes Federation  
** IDEFICS= Identification and prevention of Diatery and lifestyle-induced health Effeects in Children and infantS  
Altogether 18 169 aged 2-9 years children from 8 European countries participated in IDEFICS study. European standards for components of the MS have been developed.

Ref 8, 11
ENDOCRINE COMPLICATIONS
impact on puberty and linear growth

• Increased adiposity (particularly central) mediates alterations in leptin and insulin secretion/sensitivity thus interfering with the process of pubertal development at different levels.

• Obesity is associated with accelerated linear growth and bone age in both sexes, but final height is not affected.

<table>
<thead>
<tr>
<th>Girls</th>
<th>Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early onset of puberty</td>
<td>Delayed onset of puberty</td>
</tr>
<tr>
<td>Hyperandrogenism</td>
<td>Gynecomastia alone/pseudogynecomastia</td>
</tr>
<tr>
<td>Polycystic ovary syndrome</td>
<td>Hidden penis</td>
</tr>
</tbody>
</table>

Ref 2, 6
ENDOCRINE COMPLICATIONS
Thyroid

• An estimated 7 to 23% of obese children are reported to have moderately elevated TSH levels together with normal FT4 or slightly elevated FT4 and/or FT3.

• These changes do not reflect abnormal thyroid function and do not require further investigation nor treatment.

In which children or adolescents with obesity should endocrine investigations be performed?

According to the newest recommendation there is no need for routine laboratory evaluations for endocrine etiologies of pediatric obesity unless the patient’s stature and/or height velocity are attenuated.

Ref 4, 6
RESPIRATORY DISEASE AND PAEDIATRIC OBESITY

• Impact of obesity on the cardiorespiratory system on
  • respiratory mechanics
  • respiratory muscle strength and endurance
  • airway resistance
  • lung volume and function
  • gas exchange
  • control of breathing

• Role of metabolic dysregulation on paediatric obesity related asthma through
  • Non atopic systemic mild inflammation
  • lower airways obstruction
  • Exercise induced bronchoconstriction
  • Lower responsivness to steroid treatment

• ROHHAD
  • Rapid onset Obesity with Hypothalamic Dysfunction, hypoventilation and autonomic dysfunction
  • rare paediatric syndrome

• Obstructive sleep apnoea

Ref 16, 17, 18
Increased prevalence of asthma in childhood obesity results from the combination of adiposity mediated inflammation and mechanic constraints.
RESPIRATORY COMPLICATIONS AND SLEEP DISORDERS

- Pulmonary and sleeping problems are associated with obesity.

- Children with obesity have higher risk to develop asthma which is connected with inflammatory markers.

- The severity of obstructive sleep apnoea (OSA) increases with the degree of obesity.

- Epidemiological studies show that obesity, defined by the body mass index (BMI) higher than 28 kg/m², increases the risk for OSA by 4-5 times in a group of children aged 2-18 years.

- The risk developing OSA is much greater if there is a family history of it.

- Children with severe obesity may have alveolar hypoventilation which can cause severe oxygen desaturation.

Ref 2, 3, 6, 18
OBSTRUCTIVE SLEEP APNOEA (OSA)

- OSA is documented 1-5% in children.

- If the children have got a positive history for OSA, refer to pulmonology for nocturnal polysomnography or if it’s not available—overnight oximetry.

- Unrecognized and untreated OSA may affect nearly every major system, causing daytime fatigue, growth delay, cardiovascular dysfunction, hypertension, behavior disorders, cognitive impairment.
The orthopaedic conditions that tend to present more commonly in children with obesity include:

- Perthes’ disease (avascular necrosis)
- Slipped capital femoral epiphysis
- Blount’s disease
- Misalignment of the legs axis
- Flat foot
ORTHOEPEDIC COMPLICATIONS

- More frequent in male at the age of 5-7 years
- **Clinical signs**: hip pain - worsens with movement, and limitation of mobility.
- In the initial phase the X-ray may not show any signs of skeletal alteration, therefore Magnetic Resonance is recommended.

It develops slowly or precipitated by a trauma

**Clinical signs**: uncertain pain and persistent limping in a child with obesity.

**Diagnoses**: comparison image of the hips in anterior and frog-leg lateral views.

Ref 6
Blount's Disease most often affects the lower leg bone i.e. tibia which is also more commonly recognized as shin bone.
MISALIGNMENT OF THE LEGS AXIS

• The anatomical shape of the leg axis needs to be distinguished between
  • an abduction adjustment (with normal anatomical axis of the leg but with pathological positioning) and
  • genu valgum as pathology of the anatomic leg axis in its osseous form.

• Genuine genu valgum has a static consequence, but also dynamic implications, so it requires a guided correction of angular deformity of the knee to avoid osteotomy or osteoarthritis later in life.

• Orthopaedic examination is a mandatory part of the clinical examination of any child or adolescents with obesity.

Ref 6
False genu valgum by abduction adjustment due to the fat mass of the tights
(from Lechevallier, 2013)

Severe form of genu valgum
FLAT FOOT

• The most common clinically diagnosed deformity in children with obesity

• Develops when the greater mid-foot contact surface is no longer sufficient to compensate for the patient’s overweight.

• Physiotherapy and insertion of a temporary orthotic may be useful to optimize the position of the foot during gait.

Flat foot is a common early feature of child and adolescent obesity
Hollow feet in obesity should draw the attention toward an underlying neurological disease.
PSYCHOLOGICAL COMPLICATIONS

Child and adolescent obesity may either be the cause or the consequence of psychological disturbances or both

• Psychological consequences are early and sometimes severe.
• Psychological complications require a precise evaluation and follow up.
• Decreased quality of life is a key common complication.
• A vicious circle is generated in most cases (cf next slide)
• The role of the clinician is to try to disentangle causes and consequences prior to settle therapeutic goals.
• Physical complications such as SAOS which have psychological consequences should be identified.
• If children with obesity have a positive history of psychosocial complications refer them to mental health specialist.

For more information, please refer to emodule on Psychological assessment
PSYCHOLOGICAL COMPLICATIONS
The vicious circle of childhood obesity

Diet or restriction increase the trouble
Snacking Overeating
Increase by low appetite regulation

Obesity

Social background

Bullying
School mates Family

Diet or restriction increase the trouble
Snacking Overeating
Increase by low appetite regulation

Boredom Decreased self esteem

Avoidance
Increased screen use

Diet or restriction increase the trouble
Snacking Overeating
Increase by low appetite regulation

Boredom Decreased self esteem

Avoidance
Increased screen use

Multiple consequences Decreased school results Increased screen use

Increase by SAOS

Genetic and epigenetic background

Decreased physical activity Low quality of life

Ref 2,4
QUESTIONS

• Can the severity and duration of obesity influence the severity of complications in children? – **yes**

• What parameters are important in the assessment of hypertension according to the newest guideline? - **sex, age, height percentile**

• What type of screening tests can be used for evaluating the disturbance of glucose metabolism in children? – **fasting plasma glucose, HbA1c, 2-hours oral glucose tolerance**

• What’s the prevalence of dislipidaemia in adolescents with obesity? – **up to 40 %**

• When would you evaluate the risk of NAFLD in a child with obesity? – **in patients with metabolic syndrome**

• Is it necessary to examine children with obesity for endocrine etiology? - **no, just in case if the patient’s stature and/or height velocity are attenuated.**

• Do children with obesity have higher risk to develop asthma? - **yes**

• What is the difference in the clinical signs of Perthes’ disease and slipped capital femoral epiphysis? - **pain**
REFERENCES


REFERENCES


REFERENCES


