

# The McMaster *at night* Pediatric Curriculum



Rose et al. "Evaluating a Short Child".  
*Pediatrics in Review* 26 (11). 2005

# Objectives

- Interpret standardized growth charts and describe methods for **evaluating** short stature
- Differentiate **normal** variants from pathologies that require intervention and/or referral
- Understand the implications of weight-for-height and list clues that suggest **genetic** disorders and **endocrinopathies**
- Discuss **management** options for short stature

# Background

- A **biologic** definition of short stature is based on height distribution in the population, as well as genetic potential conferred by parental height
- Recognize that perceived shortness is also influenced by **parental** and **societal expectations**
- Height  $< 3^{\text{rd}}$  percentile (2 SD below mean) reflects short stature, but does not distinguish normal from abnormal
- **Growth velocity, target height, weight-for-height**, and other clinical features are more important

# Background

- Normal somatic growth results from a **complex interaction** between
  - Genetics
  - Nutrition
  - Oxygen
  - Hormones
  - Sleep
  - Exercise
  - Psychosocial factors
- Note that short stature affects boys and girls equally but boys are referred more often, earlier, and for less severe height deficits

# Background

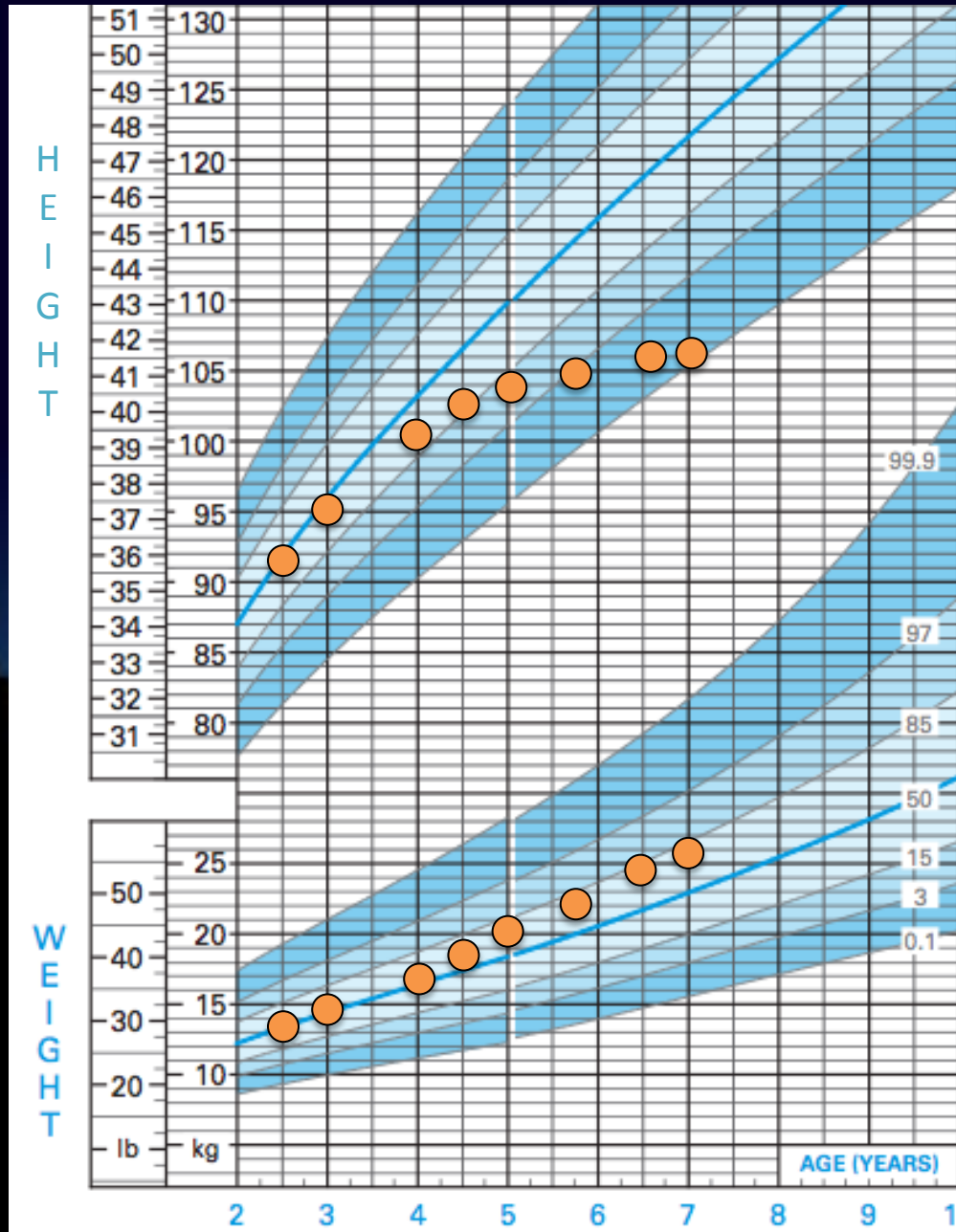
- The most important step in the evaluation is appropriate analysis of a **growth curve**
- **WHO** growth charts are the new international gold standard reflecting optimal conditions for growth
- **Every** pediatric routine visit should include accurate measurement of **weight**, **height** (length < 2 years), and calculation of **BMI** (weight-for-height < 2 years)
- Measurement is a **skill**: measurement and plotting errors are the most common causes of misdiagnosis

# Background

- **Growth velocity**: the most important aspect of evaluation requires 3-6 months of observation
- **Weight-for-height**: can distinguish endocrinopathies (weight is preserved or increased) from other chronic conditions (weight is impaired)
- **Target height**: shortness can only be assessed in the context of genetic potential (most are within 10 cm)
  - **Boys**:  $(\text{father's height} + \text{mother's height} + 13)/2$
  - **Girls**:  $(\text{father's height} + \text{mother's height} - 13)/2$

# Test Your Knowledge

- Examine the growth curve of a 7-year old boy on the following slide. This pattern is most consistent with which of the following conditions?
  - A. Down syndrome
  - B. Childhood obesity
  - C. Cystic fibrosis
  - D. Hypothyroidism





# The Answer

- The growth curve demonstrates decreased growth velocity with increasing weight-for-height, which is typical of an **endocrinopathy**
- Obesity is a feature of a variety of endocrine and genetic disorders but alone is not associated with decreased height velocity



- The growth impairment of genetic conditions typically starts at birth (Down syndrome has its own chart)
- Weight-for-height is decreased in CF

# The Case

- A 7-year-old boy has been referred to your office from his family physician for **short stature**
- The boy himself is not concerned, but his father worries that his son is the shortest in his class, even shorter than the girls
- Careful measurements indicate the boy is on the **3<sup>rd</sup> percentile** for height and weight
- He met his developmental milestones on target and has no medical problems

# History

What would you ask?

The background of the slide features a dark blue gradient. In the lower half, there is a black silhouette of a city skyline. A large, bright, circular full moon is positioned behind the skyline, partially obscured by the buildings. The overall mood is contemplative and historical.

# History

- Has the patient been small since **birth** or was there a **change** in growth velocity?
- For pubertal children, age at onset of body odor, acne, breast development, axillary and pubic hair
- Ask about **appetite** and **nutritional completeness**
- In a complete **review of systems**, include, vision problems, headaches, skin changes, heat and cold intolerance, breathing problems, and GI upset
- Complete a **developmental history**

# History

- The **medical history** should detail chronic medical conditions, medications, and frequent infections
- Include a **perinatal history** with birthweight, gestational age, prenatal exposures (EtOH, smoking, infections) and postnatal problems
- **Family history** must include not only known heritable conditions, but consanguinity, parents' and siblings' heights and age of puberty onset
- Find out **who** is concerned and **why**, including impact on function and quality of life

# Physical Exam

What would you look for?

A dark blue background featuring a silhouette of a city skyline with various skyscrapers. A large, bright full moon is visible behind the buildings in the center-right area.

# Physical Exam

- Accurate **height** and **weight**, and analysis of previous measurements on a **growth chart**
- Assess **general appearance** and nutritional status
- Search for patterns of **dysmorphisms** and malformations suggestive of FAS or genetic disorder
- A careful examination of all systems is required to identify **chronic illness** (CF, IBD, CHF and renal disease in particular are known to affect height)

# Physical Exam

- Similarly, all systems must be examined to identify clues to **endocrinopathies** including hair, skin, nails, facial features, neurological deficits, reflexes, abdominal exam, and direct thyroid exam
- Do not forget to complete **Tanner staging** and look for secondary signs of puberty



# Workup

What would you order?

The background of the slide features a dark blue gradient. In the lower half, there is a black silhouette of a city skyline. A large, bright white full moon is positioned behind the skyline, partially obscured by the buildings. The overall aesthetic is clean and professional.

# Workup

- Investigations should be **directed by history and physical exam**, and in the case of normal variants none may be required
- A **bone age** compares the skeletal maturity of the left hand and wrist against standard images
  - **Delayed**: constitutional growth delay, GH deficiency, hypothyroidism
  - **Normal**: familial short stature
  - **Advanced**: excess sex steroid hormones, precocious puberty, CAH

# Workup

- **Hormones** of the hypothalamic-pituitary axis can all be directly or indirectly measured
  - TSH, T4, T3
  - IGF-1, IGFBP-3, GH-stimulation test
  - LH, FSH, androgens, estrogens
  - ACTH-stimulation test
- Consider **karyotype** and specific **genetic tests**
- Test of **under-nutrition** include CBC, albumin, ferritin
- Consider sweat chloride, echocardiogram, renal function tests, TTG-IgA, and immunoglobulins

# Differential Diagnosis

Short Stature	
Normal Variants	Increased Weight-for-Height
Familial short stature	Congenital hypopituitarism
Constitutional growth delay	Hypoxia/ischemia
	CNS/facial malformations
Decreased Weight-for-Height	
Malnutrition	Acquired hypopituitarism
Neglect	Trauma, surgery
Eating disorder	CNS infection
	Craniopharyngeoma, glioma
Malabsorption	CNS radiation
Inflammatory bowel disease	
Celiac disease	Growth hormone deficiency
Renal disease	Growth hormone insensitivity
Congestive heart failure	Hypothyroidism
Cystic fibrosis	Glucocorticoid excess
Immunodeficiency	Iatrogenic
	ACTH-secreting or adrenal adenoma

# Differential Diagnosis

## Short Stature

### Genetic

Down syndrome

Turner syndrome

Prader-Willi syndrome

Russell-Silver syndrome

Skeletal dysplasias

Many more

### Intrauterine

Fetal alcohol spectrum disorders

Smoking/drug exposure

Congenital (TORCH) infections

# Familial Short Stature

- May cross percentiles downward for the first 2 years until genetic-appropriate percentile is reached
- **Family history** of short stature
- **Normal growth velocity** and pubertal development, but adult height is **short** according to potential
- Absence of genetic disorder, endocrinopathy, or systemic illness
- Treatment is **reassurance**

# Constitutional Delay

- Slowing growth velocity during the first 3 years, followed by near-normal growth velocity below the 5<sup>th</sup> percentile during prepubertal years
- **Family history** of “late bloomer”
- **Delayed bone age** and **pubertal development**, but adult height is often **normal**
- Absence of genetic disorder, endocrinopathy, or systemic illness
- Treatment is **reassurance**

# Turner Syndrome

- Turner Syndrome merits special mention because short stature may be the only clinical manifestation in prepubertal girls
- Caused by **monosomy X** and a karyotype is all that is required to confirm the diagnosis
- Incidence of **1/2000** live born females
- Patients may also present with **ovarian failure** (amenorrhea, absent thelarche), but adrenarche is normal and 30% have some pubertal development



# Turner Syndrome

- **Clinical features**, when present, include:
  - Ptosis, strabismus, cataracts, amblyopia
  - High arched palate, dental crowding
  - Cutis laxa, excessive nevi
  - Hypoplastic or hyperconvex nails
  - Webbed neck, low posterior hairline
  - Shield chest, wide inter-nipple distance
  - Increased carrying angle
  - Short 4<sup>th</sup> metacarpal
  - Scoliosis, congenital hip dislocation
  - Neonate: pedal edema, cystic hygroma

# Test Your Knowledge

- You are following a 15-year-old girl with Turner syndrome. Her initial renal ultrasound was normal, and recent echocardiogram was negative for coarctation. GH replacement was discontinued and she has been on estrogen replacement for 2 years. Bone age remains delayed. Which of the following long-term conditions is she *not* at increased risk for?
  - A. Recurrent UTI
  - B. Hypertension
  - C. Diabetes Mellitus
  - D. Hypothyroidism

# The Answer

- Risk of **diabetes** is increased, and up to 30% of patients will develop **hypothyroidism**
- **Coarctation** occurs in 10% of patients, and is the main cause of decreased life expectancy
- Idiopathic **hypertension** is common even in the absence of heart defects
- UTIs relate to **kidney malformations**
- Perform TSH and HbA1c annually, and echo every 5 years



# GH Deficiency

- **Congenital** deficiency results from hypoxic-ischemic injury or CNS malformations
- **Acquired** deficiency is usually idiopathic, but may result from tumors, trauma, surgery, infection or radiation to the pituitary or hypothalamus
- GH deficiency can be **isolated** or part of **pan-hypopituitarism** along with TSH, ACTH, LH, FSH, ADH
- GH deficiency presents with **slow linear growth, normal weight gain**, young-looking face, fatigue, and eventually dyslipidemia and osteopenia

# GH Deficiency

- Because of wide diurnal fluctuations in serum GH, levels must be measured by **stimulation test** (arginine, clonidine, glucagon or insulin) or by **surrogates** (IGF-1, IGFBP3)
- Subcutaneous **GH replacement therapy** is approved for all forms of GH deficiency, Turner syndrome and Prader-Willi syndrome

# Hypothyroidism

- **Congenital** hypothyroidism is most often detected on newborn screen
- **Acquired** hypothyroidism is usually an auto-immune condition (Hashimoto or lymphocytic), inborn metabolic error, or failure of ectopic gland
- Linear growth is **slowed**, weight-for-height is **increased** and bone age is **delayed**
- Symptoms include fatigue, dry skin, constipation
- Goiter and delayed relaxation may be present

# Hypothyroidism

- Normal **intelligence** is possible if hypothyroidism is detected and treated within 2-3 months of birth, or begins after 2 years of life
- Stature depends primarily on the duration of untreated disease and the adequacy of **hormone replacement therapy**

# Test Your Knowledge

- The parents of a 5-year-old boy bring him to your office for evaluation. You note a height at the 5<sup>th</sup> percentile and weight at the 75<sup>th</sup> percentile, and parents are concerned about his weight gain. His first words were at 24 months. Exam reveals almond-shaped eyes, small hands, mild hypotonia, and small testes. What is the diagnosis?
  - A. Congenital hypothyroidism
  - B. Down Syndrome
  - C. Russell-Silver Syndrome
  - D. Prader-Willi Syndrome



# The Answer

- These features, plus hyperphagia, central obesity, borderline-to-moderate intellectual disability, and characteristic facies are consistent with **PWS**
- PWS is caused by a partial deletion of chromosome 15q11-13, subject to **imprinting** (paternal)



- DS shares stature, hypotonia, eye-shape and intellectual deficits only
- Russell-Silver is a dwarfism featuring low birthweight, triangular face, clinodactyly, GI problems and LDs

# Summary

- The most useful test in distinguishing normal short stature from pathological conditions is the **collection of accurate measurements over time**
- Most apparently healthy children with normal growth velocity are **normal**
- **Declining growth velocity** regardless of height merits evaluation; linear growth is a sensitive and powerful marker of overall health
- A careful **history** and **physical exam** distinguishes endocrinopathy, genetic and chronic conditions



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