With permission from Hagan JF, Shaw JS, Duncan P, Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents, Third Edition. Performing Preventive Service: Physical Examination.

MARCIA HERMAN-GIDDENS, PA, DrPH
PAUL B. KAPLOWITZ, MD

SEXUAL MATURITY STAGES

Sexual maturity staging is a standard assessment for normal growth and development. Identification of sexual maturity also is important in order to offer appropriate anticipatory guidance and to recognize problems related to pubertal abnormalities that need referral.

Why Is It Important to Assess Sexual Maturity Stages During the Physical Examination?

Children with early puberty may have problems coping with the physical and hormonal changes of puberty. Girls may have difficulty coping with early menses and boys may experience excessive libido. Early and rapidly progressive precocious puberty can sometimes result in adult short stature. Most cases of precocious puberty are idiopathic, but occasionally boys or girls with precocious puberty have intracranial abnormalities or adrenal or gonadal conditions that require intervention.

Children with delayed puberty may have conditions that require intervention. These children may be late maturers because of constitutional delayed puberty, for which there is often a positive family history. Other conditions that may need assessment or intervention include acquired gonadal failure, gonadal dysgenesis due to Turner syndrome, isolated gonadotropin deficiency, or decreased body fat due to exercise (particularly swimming, gymnastics, and ballet dancing), or anorexia nervosa.

The age of pubertal onset may be declining. Recent studies suggest that the age of onset of puberty is close to 1 year earlier in US girls than 30 years ago. Evidence as to whether a similar trend is occuring in boys is inconclusive at this time.

Early puberty may be a marker for environmental exposure to estrogen-like chemicals, known as endocrine disrupters, that may affect the reproductive axis. Currently no clear evidence exists that environmental chemicals are the major cause of earlier puberty in girls, but studies are ongoing.

Several studies suggest that earlier onset of puberty may be associated with being overweight in girls, and late onset may be associated with abnormal thinness or a very high sustained level of physical activity. With regard to boys, data on the relationship between overweight and earlier pubertal development are conflicting.

The issue of whether or not early puberty is associated with more frequent emotional problems is complex, and studies are conflicting. Many early-maturing children do well, but others show an increase in behavioral problems. Several papers report an increased incidence of psychopathology in young adults who started puberty at an early age. This suggests that early-maturing children need close monitoring of their physical and mental health.

Given the younger age of appearance of signs of puberty, anticipatory guidance for children and parents is even more important than it was in the past

Racial and ethnic differences in ages of achieving pubertal milestones vary. Results from the Pediatric Research in Office Settings study of puberty published in 1997 indicate that by the age of 8 to 9, approximately half of African-American girls and 15% of white girls will have some evidence of breast development, pubic hair growth, or both.

Girls: Median Age of Transition to Tanner Stages by Race/Ethnicity			
Stage	**White**	**African-American**	**Mexican-American**
Pubic Hair			
2	10.57	9.43	10.39
3	11.8	10.57	11.70
4	13.00	11.90	13.19
5	16.33	14.70	16.30
Breast Development			
2	10.38	9.48	9.80
3	11.75	10.79	11.43
4	13.29	12.24	13.07
5	15.47	13.92	14.70

Source: Sun SS, Schubert CM, Cameron W, et al. National estimates of the timing of sexual maturation and racial differences among US children. *Pediatrics*. 2002:110;911–919.

Boys: Median Age of Transition to Tanner Stages by Race/Ethnicity			
Stage	**White**	**African-American**	**Mexican-American**
Pubic Hair			
2	12	11.2	12.3
3	12.6	12.5	13.1
4	13.5	13.7	14.1
5	15.7	15.4	15.8
Genital Development			
2	10.1	9.5	10.4
3	12.4	11.8	12.5
4	13.5	13.4	13.7
5	15.9	14.9	15.7

Source: Herman-Giddens ME, Wang L, Koch G. Secondary sexual characteristics in boys. Estimates from the National Health and Nutrition Examination Survey III, 1988–1994. *Arch Pediatr Adolesc Med.* 2001:155.

Reliable data for American boys are not available for testicular growth. During the fourth grade (age 9), about 21% of African-American boys and 4% of white boys have at least Stage 2 pubic hair.

What Are the Stages of Sexual Maturity?

The system of sexual maturity rating most commonly used is based on the work of Marshall and Tanner. The stages are commonly referred to as the Tanner stages. This rating system has been widely used for decades in studies worldwide. There is no conventionally accepted scale for axillary hair development.

Pubic Hair: Male and Female

Pubic Hair Stage 1

Prepubertal. The vellus over the pubis is similar to that on the abdomen. This hair has not yet developed the characteristics of pubic hair.

Pubic Hair Stage 2

There is sparse growth of long, slightly pigmented downy hair, straight or only slightly curled, mainly at the base of the penis.

Pubic Hair Stage 3

The hair is considerably darker, coarser, and more curled. It is spread sparsely over the pubis.

Pubic Hair Stage 4

The hair is adult in type, but the area over which it is present is smaller than in most adults. It has not yet spread to the medial thighs or along the linea alba (in males).

Pubic Hair Stage 5

The hair is adult in quality and quantity and has the classical triangular distribution in females. It may spread to the medial surface of the thighs.

Breasts: Females

Breast Stage 1

There is no development. Only the nipple is elevated.

Breast Stage 2

The "breast bud" stage, the areola widens, slightly darkens, and elevates from the rest of the breast. A bud of glandular tissue is palpable below the nipple.

Breast Stage 3

The breast and areola further enlarge, presenting a rounded contour. There is no change of contour between the nipple and areola and the rest of the breast. The diameter of breast tissue is still smaller than in a mature breast.

Breast Stage 4

The breast continues to grow. The papilla and areola project to form a secondary mound above the rest of the breast.

Breast Stage 5

The mature adult stage. The secondary mound disappears. Some females never progress to Stage 5.

Genitals: Males

Genital Stage 1

Prepubertal. Penis, testes, and scrotum are about the same size and proportions as in early childhood. It is important to take into account whether the penis is uncircumsized when assessing penile growth, as the uncircumsized penis may appear larger than it really is.

Genital Stage 2

Only the testes and scrotum have begun to enlarge from the early childhood size. The penis is still prepubertal in appearance. The texture of the scrotal skin is beginning to become thinner and the skin appears redder due to increased vascularization.

Genital Stage 3

There is further growth of the testes and scrotum. The penis is also beginning to grow, mainly in length with some increase in breadth. It can be difficult to distinguish between Stages 2 and 3.

Genital Stage 4

The penis enlarges further in length and breadth and the glans becomes more prominent. The testes and scrotum are larger. There is further darkening of the scrotal skin.

Genital Stage 5

The penis, testes, and scrotum are adult in size and shape.

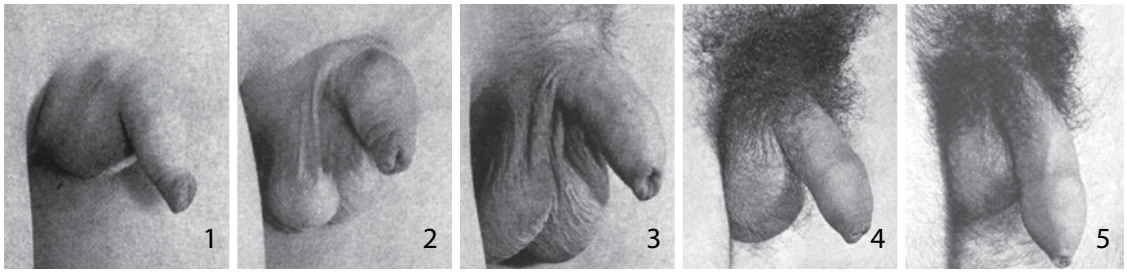
How Should You Perform Sexual Maturity Staging?

Pubic Hair Staging

- Ensure adequate lighting, and examine the genital area with the pants and underwear completely removed or lowered to the knees. This is especially true in girls, where the first pubic hair may initially be only along the labia.
- In assessing pubic hair do not confuse fine, light-colored hair in the genital area with pubic hair if it is similar to the hair found on other parts of the trunk or thighs.
- Familiarity with the pictures in standard texts (such as those shown in this chapter) is helpful but, in some children, the appearance does not match the pictures, as some children may be in between stages.

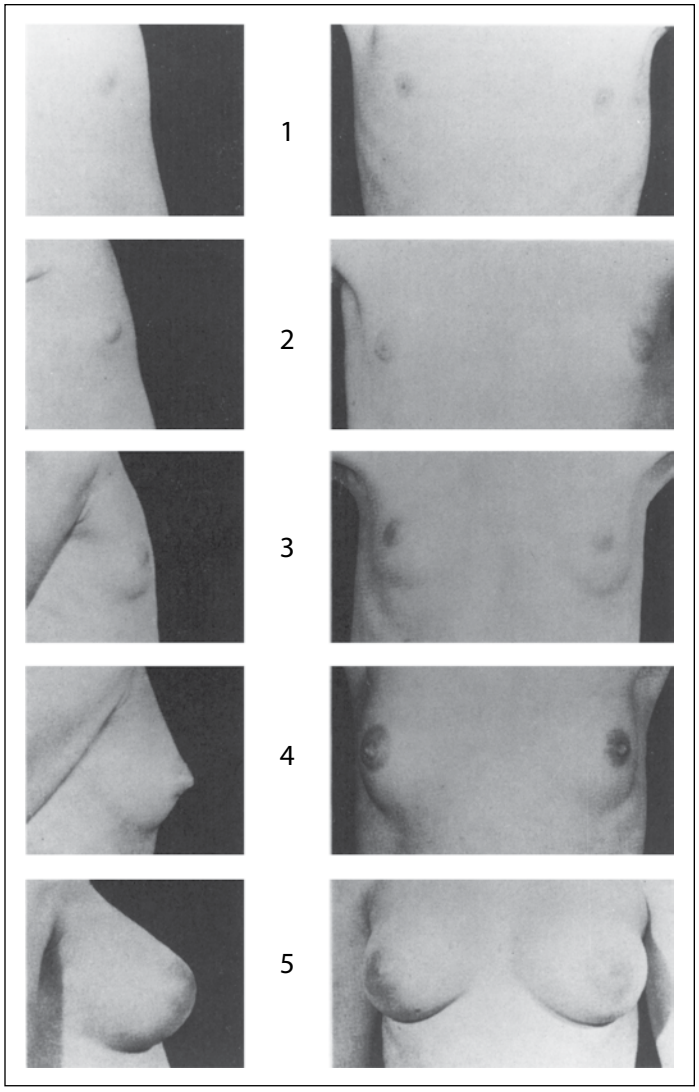
Breast Staging

- The Tanner method, which involves staging of breast development by **inspection alone** and comparing it with standard pictures found in many texts, needs to be supplemented by palpation for overweight girls.
  - If further assessment is needed
    - Examine breast with patient in supine position. If the consistency under the areola is similar to peripheral tissue, it is likely adipose tissue. Breast tissue is firmer and discoid in shape.
    - In girls, the areola becomes thicker and darker with progressive exposure to estrogens.



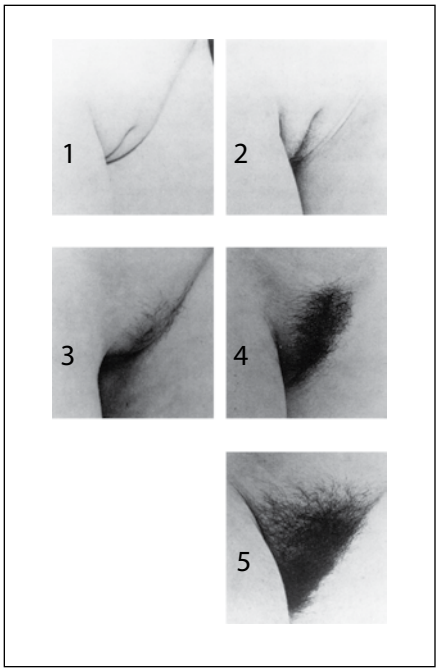
Boys stages of genital and pubic hair development.

Source: Reprinted of Elsevier from van Wieringen JC, Wafelbakker F, Verbrugge HP, De Haas JH. *Growth Diagrams 1965*. Groningen, The Netherlands: Wolters-Noordhoff; 1971. As included in Yen SSC, Jaffe RB, eds. *Reproductive Endocrinology: Physiology, Pathophysiology and Clinical Management*. 2nd ed. Philadelphia, PA: WB Saunders; 1978.



Girls stages of breast development

Source: Reprinted of Elsevier from van Wieringen JC, Wafelbakker F, Verbrugge HP, De Haas JH. Growth Diagrams 1965. Groningen, The Netherlands: Wolters-Noordhoff; 1971. As included in Yen SSC, Jaffe RB, eds. *Reproductive Endocrinology: Physiology, Pathophysiology and Clinical Management*. 2nd ed. Philadelphia, PA: WB Saunders; 1978.



Girls stages of pubic hair growth.

Source: Reprinted of Elsevier from van Wieringen JC, Wafelbakker F, Verbrugge HP, De Haas JH. Growth Diagrams 1965. Groningen, The Netherlands: Wolters-Noordhoff; 1971. As included in Yen SSC, Jaffe RB, eds. *Reproductive Endocrinology: Physiology, Pathophysiology and Clinical Management*. 2nd ed. Philadelphia, PA: WB Saunders; 1978.

Male Genital Measurements

- The examiner should verify that the testes are descended and that the urethral opening is at the tip of the glans (ie, that the boy does not have hypospadius).
- In boys, the earliest and most reliable sign of pubertal development is enlargement of the testes, as it reflects increased secretion of the pituitary gonadotropins.
- Where further assessment is needed
  - Testicular size can be assessed by comparing testes with beads of varying size developed by Prader, known as an orchidometer. The beads correspond to testicular volumes of 1 mL through 25 mL. Other methods of measurement include rulers, calipers, and ultrasound. Ultrasound is the most accurate measurement method.
  - Another widely used method is to measure the greatest diameter by positioning the testis between the thumb, index, and middle finger and lining up a small ruler along the long axis of the testis.
  - Prepubertal boys nearly always have a testicular length of 2.5 cm or less or volume of 4 mL or less. As puberty progresses, the increase in testicular size usually precedes the increase in penis size, and eventually reaches the adult size of 5.0 cm or 25 mL.
  - Increasing penile length occurs later than initial growth of the testes.
  - To measure penile length accurately, use either a ruler or a marked tongue blade pressed at the base of the penis while applying firm stretch to the penis itself.
  - In normal prepubertal boys, the penile length is usually between 5 to 7 cm. A stretched length of 8 cm or greater indicates increased testosterone effect.
  - The physical examination record should note for undescended testicles; penile abnormalities, such as chordee; hypospadias; or anomalous genital development.
    - Adrenal androgens, which cause pubic hair development, do not increase penile length.

What Should You Do With an Abnormal Result?

Precocious Puberty

General Observations

Any child with signs of early puberty should have growth carefully plotted. Pathology is not common but is more likely in those children showing clear acceleration of linear growth.

If the only abnormal finding is appearance of pubic hair (often accompanied by axillary hair and odor), the diagnosis is likely premature adrenarche, a benign normal variant due to an early increase in adrenal androgen secretion. It occurs more often in girls but is not infrequent in boys. The risk of pathology is low, and extensive hormone testing and x-ray evaluation are generally not needed, unless there is rapid progression of pubic hair and/or growth acceleration.

- Labs are of limited use in typical cases in which there is early appearance of pubic hair. Dehydroepiandorsterone sulfate (DHEA-S), 17-hydroxyprogesterone, testosterone, and bone age should be considered in higher-risk cases. Luteinizing hormone (LH), follicle stimulating hormone (FSH), and estradiol are of no value if there is no breast development.

Breast Development

Isolated breast development with normal growth starting before age 3 is most likely due to premature thelarche, another benign normal variant. These girls can be monitored by the primary care physician if there is no progression or referred to a specialist if there is rapid growth or significant increase in breast diameter over time.

Breast development starting between the ages of 3 and 7 should generally be referred if it has persisted for at least 6 months.

In girls ages 7 to 8, early breast development is most often found in normal girls who start to mature at the early end of the normal range. However, girls whose breast enlargement progresses rapidly (eg, already at Tanner 3 when first seen or rapidly increases to Tanner 3) are at higher risk of pathology.

- Useful labs for high-risk cases: LH, FSH, estradiol, and bone age

Nearly 20% of girls who start puberty before age 6 have abnormal brain magnetic resonance imaging findings (eg, a hypothalamic hamartoma [nonmalignant] or a glioma or astrocytoma), compared with about 2% of girls starting puberty between the ages of 6 and 8. The risk is much higher if there are new neurologic findings, such as visual abnormalities, severe and frequent headaches, or new onset of seizures.

Genital Development

Boys who have an increase in testicular and penile size before age 9 need to be referred for evaluation. Boys with a significant increase in penis size but not testicular enlargement may have congenital adrenal hyperplasia or a virilizing adrenal or testicular tumor. Boys with pubic hair only most likely have premature adrenarche; they should also be referred, though with less urgency.

- Useful labs if there is both testicular and penile growth: LH, FSH, testosterone, and bone age
- Useful labs if there is increased penile growth but prepubertal testes: testosterone, 17-hydroxyprogesterone, DHEA-S, and bone age

Delayed Puberty

Girls who have not started having breast enlargement by age 13 and boys who have not started having penile and testicular enlargement by age 14 are, by definition, delayed and need to be evaluated and appropriately managed.

- Useful labs: LH, FSH (will be elevated in gonadal failure), testosterone (in boys), estradiol (in girls), and bone age

A child with delayed puberty and significant slowing of growth may need to be evaluated for growth hormone and possibly other pituitary hormone deficiencies, as well as other chronic diseases (eg, gastrointestinal, renal, cardiac, pulmonary).

What Results Should You Document?

Record Tanner staging in the chart at all routine health supervision visits. For patients showing signs of early or delayed pubertal maturation, it may be helpful in these cases to see the child every 6 months rather than yearly, before deciding if a referral to an endocrinologist is needed.

Document lab tests and x-rays ordered, and results, as well as the follow-up plan.

If the child is referred to a specialist for further evaluation, be certain to give a copy of the results of any hormone testing or x-rays done as well as the growth chart to the parents to take to the appointment.

Be certain to send full evaluation testing on growth chart to referral source.

ICD-9-CM Codes	
259.0	Delayed puberty
259.1	Precocious puberty, premature adrenarche; premature thelarche

The American Academy of Pediatrics publishes a complete line of coding publications, including an annual edition of *Coding for Pediatrics*. For more information on these excellent resources, visit the American Academy of Pediatrics Online Bookstore at **www.aap.org/bookstore/.**

Resources

Evidenced-based Guidelines

Kaplowitz PB, Oberfield SE; Drug and Therapeutics and Executive Committee of the Lawson Wilkins Pediatric Endocrine Society. Reexamination of the age limit for defining when puberty is precocious in girls in the United States: implications for evaluation and treatment. *Pediatrics*. 1999;104:936–941

Books

Herman-Giddens ME, Bourdony CJ. *Assessment of Sexual Maturity Stages in Boys*. Elk Grove Village, IL: Pediatric Research in Office Settings, American Academy of Pediatrics; 2005

Herman-Giddens ME, Bourdony CJ. *Assessment of Sexual Maturity Stages in Girls*. Elk Grove Village, IL: Pediatric Research in Office Settings, American Academy of Pediatrics; 1995

Kaplowitz PB. *Early puberty in Girls: The Essential Guide to Coping With This Common Problem*. New York, NY: Ballantine Books; 2004

Articles

General

Chalumeau M, Chemaitilly W, Trivin C, Adan L, Breart G, Brauner R. Central precocious puberty in girls: an evidence-based diagnosis tree to predict central nervous system abnormalities. *Pediatrics.* 2002;109:61–67

Freedman DS, Khan LK, Serdula MK, Srinivasan SR, Berenson GS. Secular trends in height among children during 2 decades: the Bogalusa Heart Study. *Arch Pediatr Adolesc Med.* 2000;154:155–161

Gafni RI, Chow C, Bryant J, Baron J. Assessment of thelarche by the inspection method of Tanner is less accurate than palpation. *Hormone Res.* 2005:64(suppl 1):205–206

Herman-Giddens ME, Slora EJ, Wasserman RC, et al. Secondary sexual characteristics and menses in young girls seen in office practice: a study from the Pediatric Research in Office Settings Network. *Pediatrics.* 1997;99:505–512

Herman-Giddens ME, Wang L, Koch G. Secondary sexual characteristics in boys: estimates from the national health and nutrition examination survey III, 1988–1994. *Arch Pediatr Adolesc Med.* 2001;155:1022 1028

Kaplowitz PB, Slora EJ, Wasserman RC, Pedlow SE, Herman-Giddens NE. Earlier onset of puberty in girls: relation to increased body mass index and race. *Pediatrics.* 2001;108:347–353

Karpati AM, Rubin CH, Kieszak SM, Marcus M, Troiano RP. Stature and pubertal stage assessment in American boys: the 1988–1994 Third National Health and Nutrition Examination Survey. *J Adolesc Health.* 2002;30:205–212

Marshall WA, Tanner JM. Variations in the pattern of pubertal changes in boys. *Arch Dis Child.* 1970;45:13–23

Marshall WA, Tanner JM. Variations in the pattern of pubertal changes in girls. *Arch Dis Child.* 1969;44:291–303

Prader A. Testicular size: assessment and clinical importance. *Triangle.* 1966;7:240–243

Wu T, Mendola P, Buck GM. Ethnic differences in the presence of secondary sex characteristics and menarche among US girls: the Third National Health and Nutrition Examination Survey, 1988–1994. *Pediatrics.* 2002;110:752–757

Pubertal Abnormalities

Kaplowitz P. Precocious puberty: update on secular trends, definitions, diagnosis, and treatment. *Adv Pediatr.* 2004;51:37–62

Kaplowitz, PB. Delayed puberty. *Pediatr Rev.* 2010;31:189–195

Rosen DS, Foster C. Delayed puberty. *Pediatr Rev.* 2001;22:309–315