



science and policy  
for a healthy future

Measurement of health  
outcomes:

## Pubertal Maturation

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# Chronological age vs. pubertal development



# Pubertal milestones

Girls	90%*
Thelarche (first breast budding)	9-12.5 years
Pubarche (first pubic hair)	9.5-13.5 years
Menarche (first menstruation)	11.7-14 years

Boys	90%*
Gonadarche (testis volume >3 ml)	10.5-13 years
Pubarche (first pubic hair)	10-15 years
Voice break	

\* Based on Danish data on puberty development in healthy children from the general population  
Lawaetz et al 2015, JCEM 100:1376-1385, Johansen et al 2017, JCEM 102:1001-1008



At 10 -15 years of age variations in lifestyle,  
exposures, health measures etc.....

..... may be more related  
to pubertal maturation  
than to age



# Description of pubertal progression

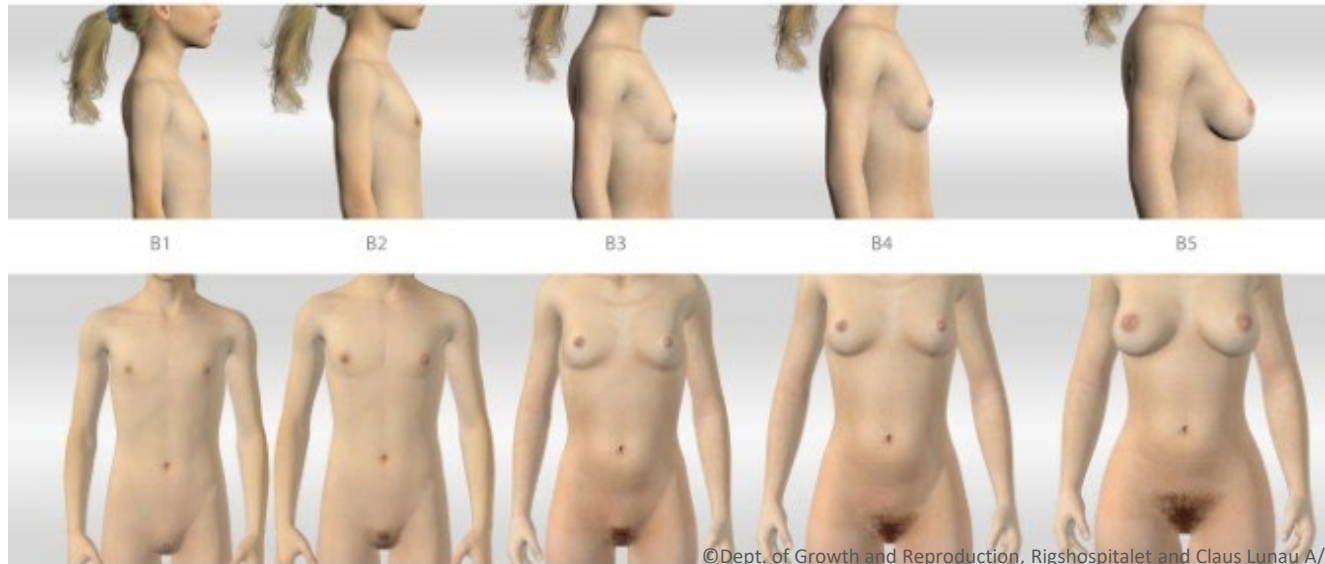
Marshall & Tanner.

Growth and physiological development during adolescence.

Annu Rev Med. 1968;19:283-300.

Girls	Boys
5 breast stages (B1-B5)	5 genitalia stages (G1-G5)
Girls and Boys	
5 pubic hair stages (PH1-PH5)	

# Pubertal Tanner stages: Female



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prepubertal	Pubertal onset			Adult
B1	B2	B3	B4	B5
Small nipples, no breast	A firm, tender swelling can be felt under the areola <sup>1</sup> in one or both breasts (thelarche). The areola has enlarged	Breast and nipple growth continue, and the swelling is also seen outside the areola, which also has become darker.	Nipples and areolas are elevated and form an edge towards the breast. The breast has also grown a little larger.	Fully developed breast. Nipples are protruding and the edge between the areola and breast has disappeared
PH1	PH2	PH3	PH4	PH5
No pubic hair	Sparse straight and long pubic hair, mainly along labia (pubarche)	Considerably darker, coarser, and curlier pubic hair appears. The hair has spread sparsely over the junction of the pubes.	More dense pubic hair growth, but still no spread towards the inner thighs	Adult hair growth. Dense, curly hair extending towards the inner thighs

<sup>1</sup>area with darker skin around the nipple. <sup>2</sup>Adolescent and adult women may have a habit of removing their pubic hair. Pubic hair stages refer to the appearance without hair removal.

# Pubertal Tanner stages: Male



Prepubertal	Pubertal onset			Adult
G1	G2	G3	G4	G5
Scrotum, testes, and penis as in childhood. Testis volume (TV) $\leq 3$ mL	Initial growth of scrotum and testes. Scrotum has become redder, thinner and more wrinkled. Penis may have grown a little in length. TV $> 3$ mL.	Penis has grown in length. Scrotum and testes have grown. The skin of the scrotum has become darker and more wrinkled.	Penis has grown in both length and width and the head of the penis has become larger. The scrotum and testes have grown.	Penis and scrotum as an adult
PH1	PH2	PH3	PH4	PH5 / PH6
No pubic hair	Few straight and long pubic hair, mainly at base of penis (pubarche)	Considerably darker, coarser, and curlier pubic hair appears. Still sparse, mostly located around the base of penis.	More dense, curly, and dark hair. Hair growth is reaching the inner thighs	Dense and curly adult hair growth <sup>1</sup> . PH6: pubic hair extends upwards to the umbilicus.

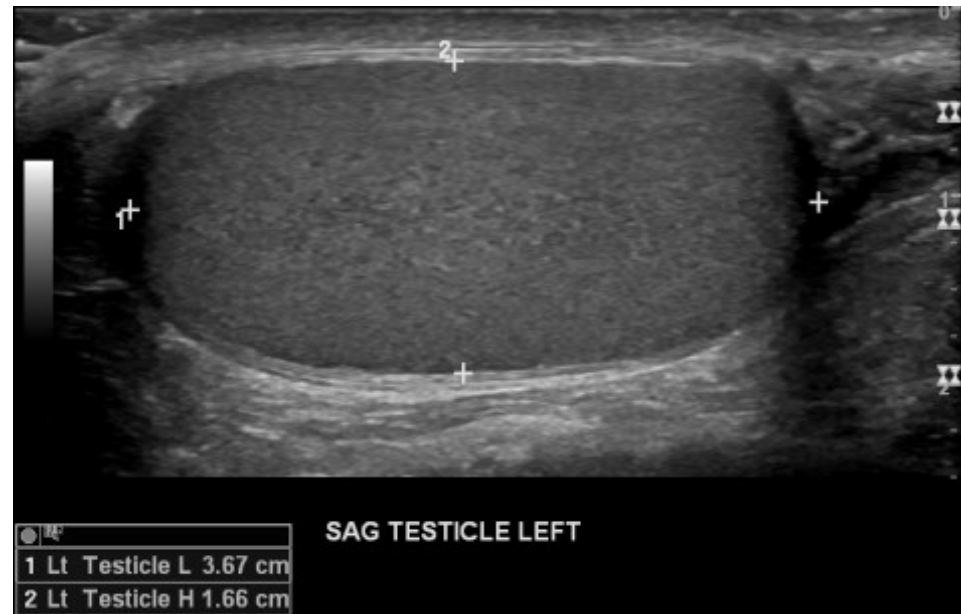
<sup>1</sup>Adolescent and adult men may have a habit of removing their pubic hair. Pubic hair stages refer to the appearance without hair removal.



# Measurement of testicular volume



Prader orchidometer



Ultra-sound



# Examination

## Setting up examination site

A location for the physical examination should be set up so that the privacy of the participant is ensured. Thus, as a minimum a separate secluded room where the examination can take place is needed. Optimally, a private changing room, where the participant can undress and safely store their belongings during the examination, should be available in direct connection to the examination room.

## Equipment

No specific equipment is needed for assessment of puberty development in girls. For measurement of testicular size in boys a Prader orchidometer is needed.

## Safety considerations

In order to avoid risk of abuse as well as risk of being accused of abuse the examiner should be of the same sex as the participant and if this is not possible another person of the same sex as the participant or one of the parents should be in the same room during the examination.

# Examination

## **Girls**

The examination should be performed with the participant standing upright

Breast stage: Breast development is evaluated by palpation to distinguish between fat pads and true breast tissue development

Pubic hair development is evaluated by visual inspection

Information on use of oral contraception is often relevant in studies of adolescents and could likewise be obtained during the examination if done discreetly and in confidentiality

# Examination

## Boys

Measurement of volume of the testes: The individual should be standing upright or lying supine. Testicular volume is estimated by palpation to the nearest 1 ml using Prader's orchidometer. Both testes are measured as they may not be equal in size. Pubertal onset is defined as a testicular volume more than 3 ml in at least one of the testes

Genital stage and pubic hair development are evaluated by visual inspection

# Self-assessment of pubertal maturation



**Male**

<b>Genitalia</b>	<b>Pubic Hair</b>
<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">1.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> Scrotum and Penis same size as when you were younger.                 </div> </div>	<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">1.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> There is no pubic hair.                 </div> </div>
<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">2.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> The Scrotum has lowered a bit and the Penis is a little larger.                 </div> </div>	<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">2.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> There is a little soft, long, lightly-colored hair. Most of the hair is at the base of the penis. This hair may be straight or a little curly.                 </div> </div>
<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">3.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> The Penis is longer the Scrotum is larger.                 </div> </div>	<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">3.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> The hair is darker, coarser and more curly. It has spread out and thinly covers a larger area.                 </div> </div>
<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">4.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> The Penis is longer and wider the Scrotum is darker and bigger than before.                 </div> </div>	<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">4.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> The hair is now as dark, curly, and coarse as that of a grown man. The hair has now spread out to the thighs.                 </div> </div>
<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">5.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> The Penis and Scrotum are the size and shape of an adult.                 </div> </div>	<div style="display: flex; align-items: flex-start;"> <div style="border: 1px solid black; padding: 5px; margin-right: 10px;">5.</div> <div style="text-align: center;">  </div> <div style="margin-left: 10px;"> <input type="checkbox"/> The hair has spread out to the thighs, like a grown man.                 </div> </div>

# Self-assessment vs. Physical examination

Chavarro et al. Validity of Self-assessed sexual maturation against physician assessments and hormone levels. *J Pediatr* 2017, 186: 172-8

Rasmussen et al. Validity of Self-Assessment of Pubertal Maturation. *Pediatrics*. 2015, 135:86–93.

Terry et al. Comparison of Clinical, Maternal, and Self Pubertal Assessments: Implications for Health Studies. *Pediatrics*. 2016, 138:e20154571–e20154571.

**Conclusion** Self-assessment can be validly used in epidemiologic studies for evaluating sexual maturation in children; however, physician assessment may be necessary for accurate assessment of genitalia development in boys. (*J Pediatr* 2017;186:172-8).

**CONCLUSIONS:** Pubertal assessment by the child or the parents is not a reliable measure of exact pubertal staging and should be augmented by a physical examination. However, for large epidemiologic studies self-assessment can be sufficiently accurate for a simple distinction between prepuberty and puberty.

# Questions?