Rome 2012
Growth, Maturation and Performance

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Overview

- How does performance change with age?
- The change in height with age ('chronological age')
- What is Growth / Maturation? Definitions. How is maturational status assessed?
- Variability
- Sexual Dimorphism
- The hormonal stimulus
- Relative Age

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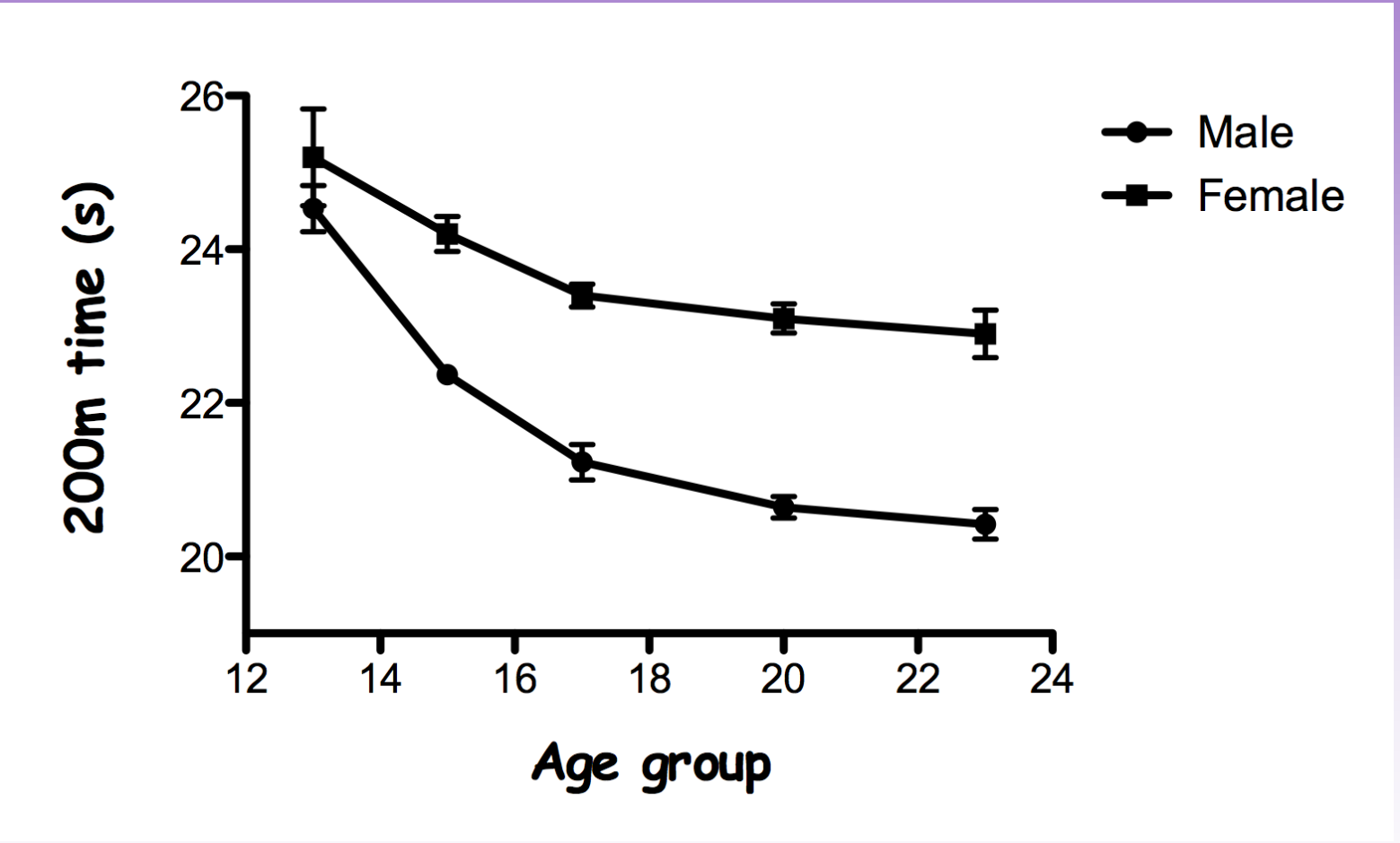
Field Based Performance



UK All-time best performances - Whittingham and Matthews, 2005, *British Athletics Statistical Review*

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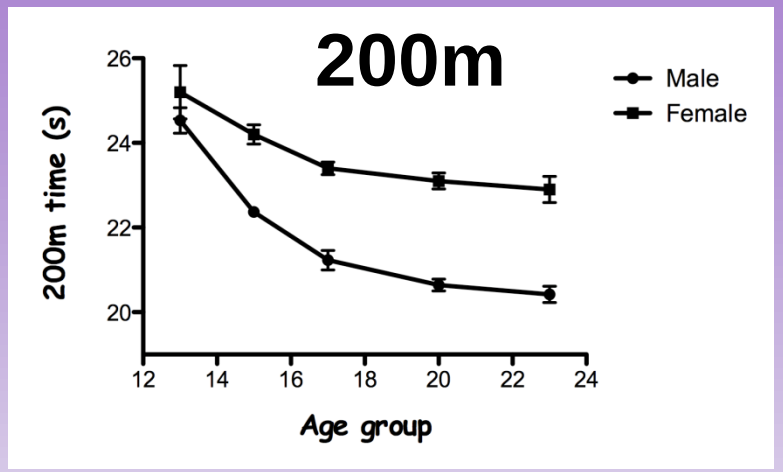
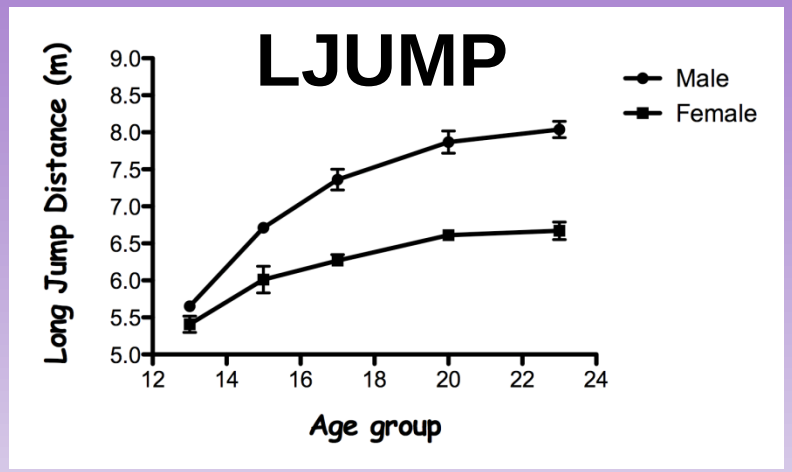
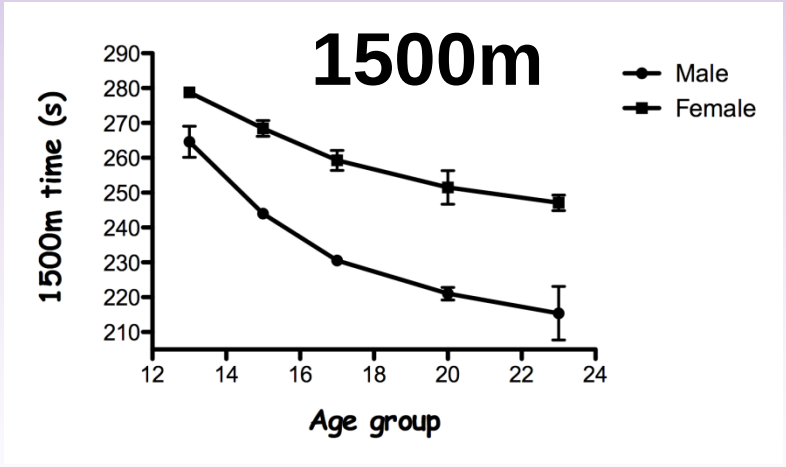
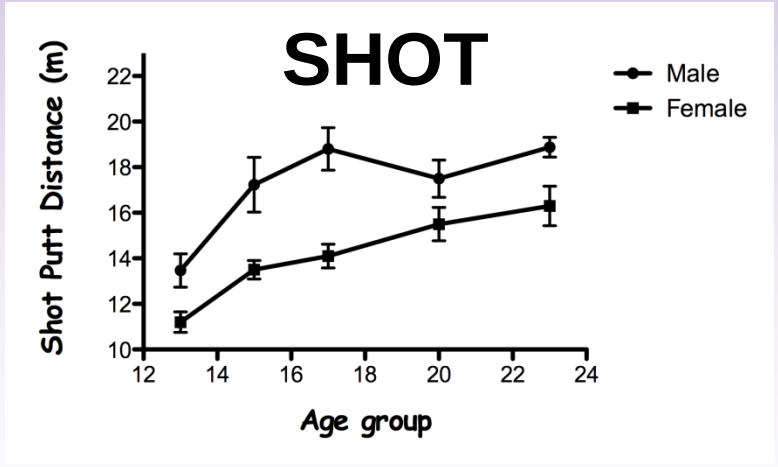
Field Based Performance









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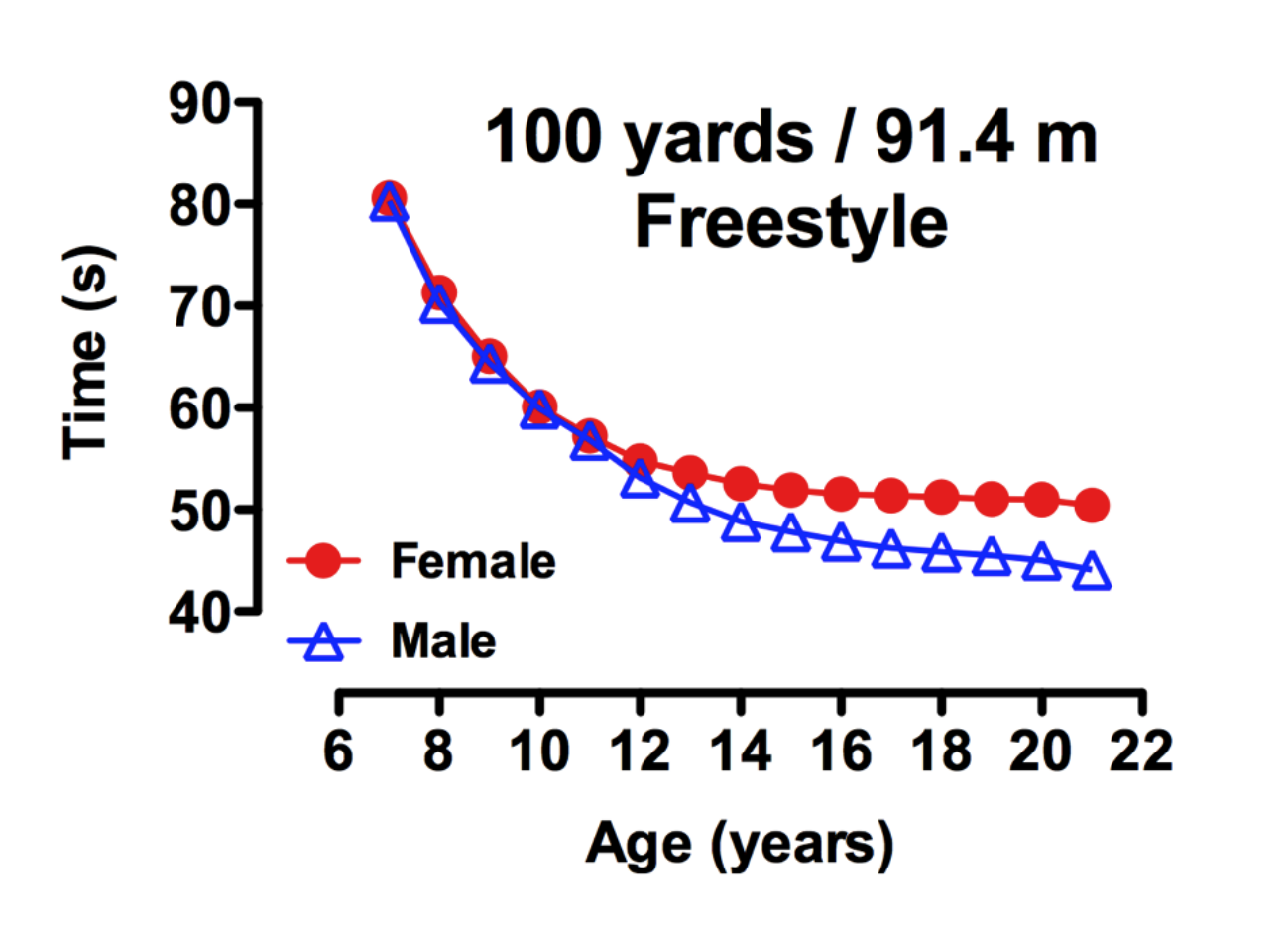
Field Based Performance



Kojima et al., 2005, *Journal of Sports Sciences, 30(3): 313-320*

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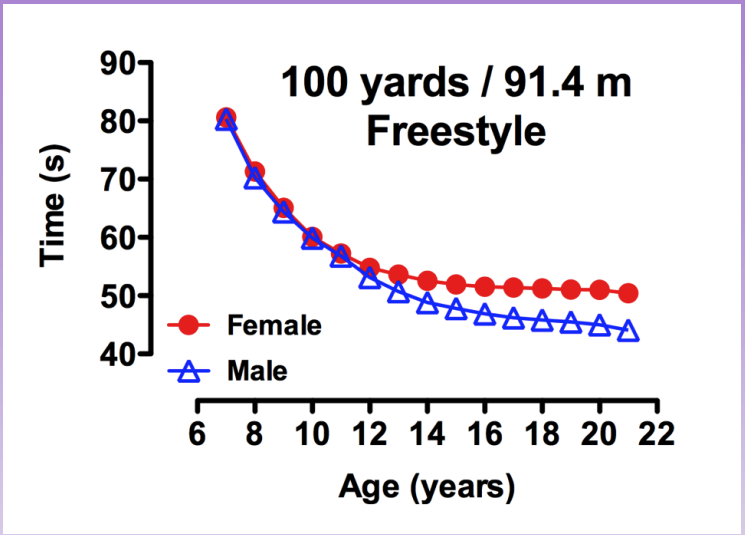
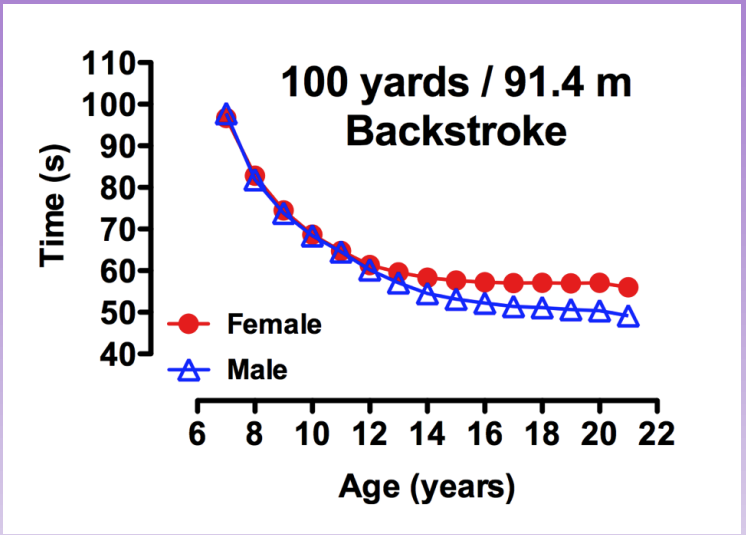
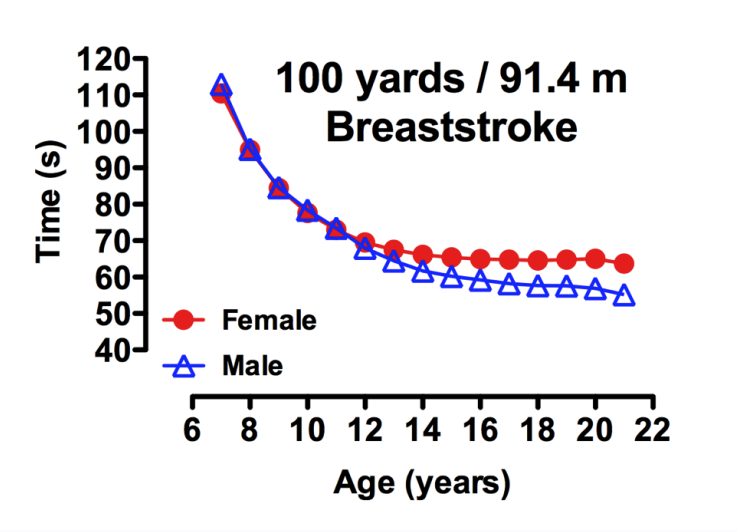
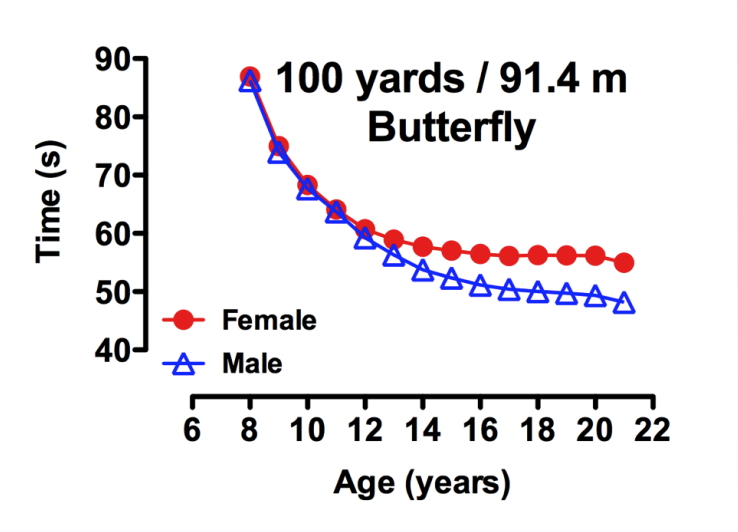
Field Based Performance



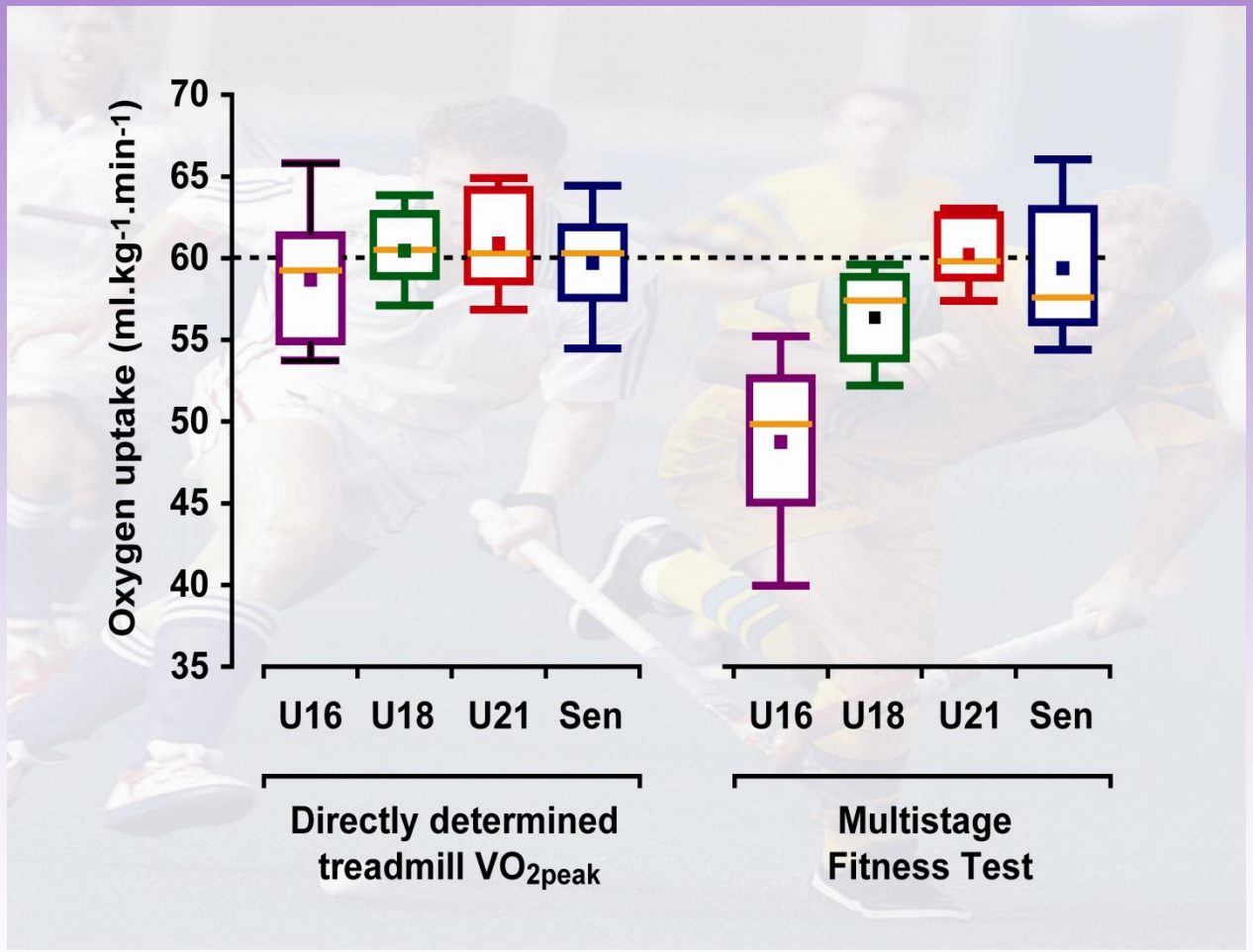






Kojima et al., 2005, *Journal of Sports Sciences, 30(3): 313-320*

Physiological characteristics of elite games players



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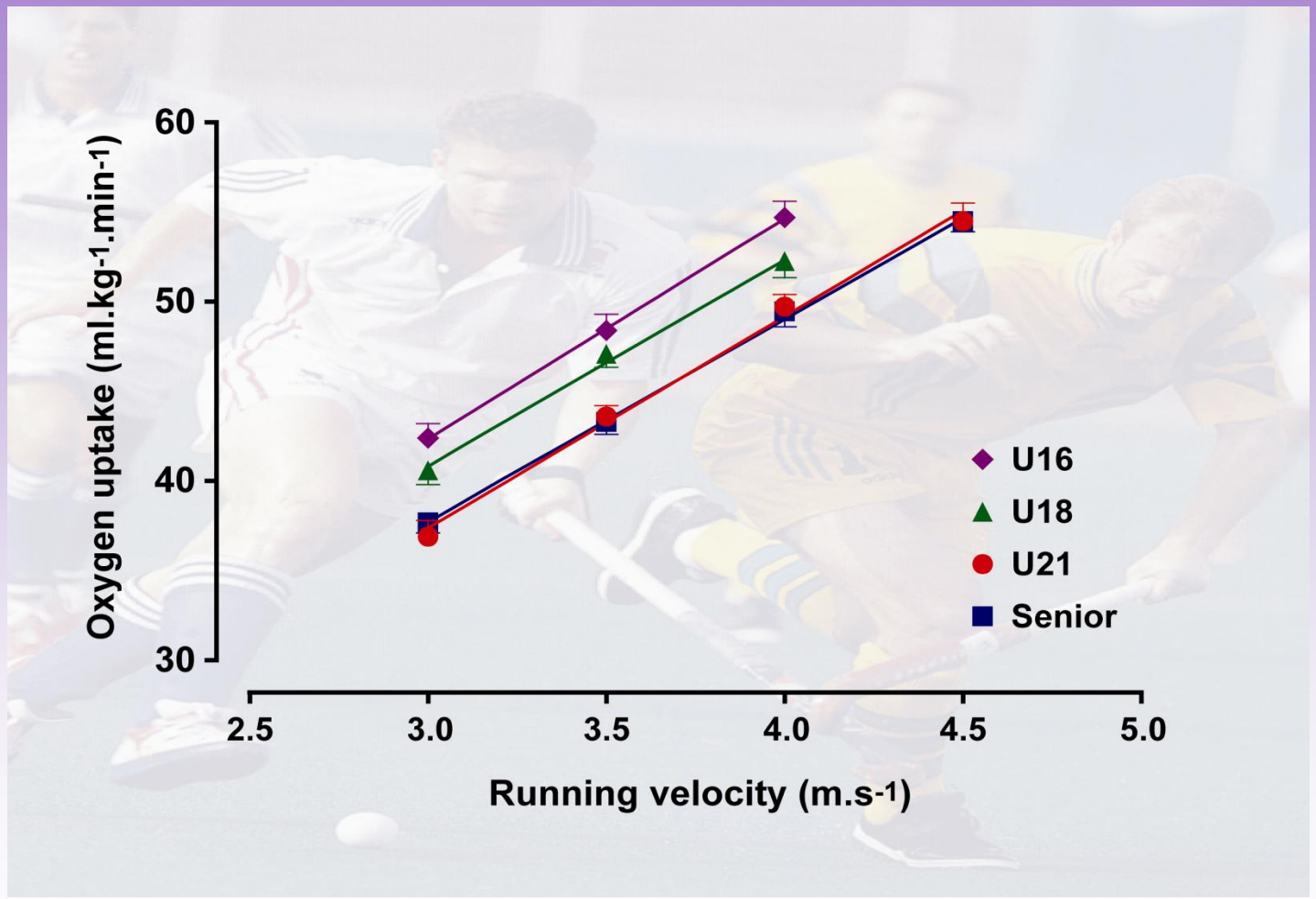
Physiological characteristics of elite games players



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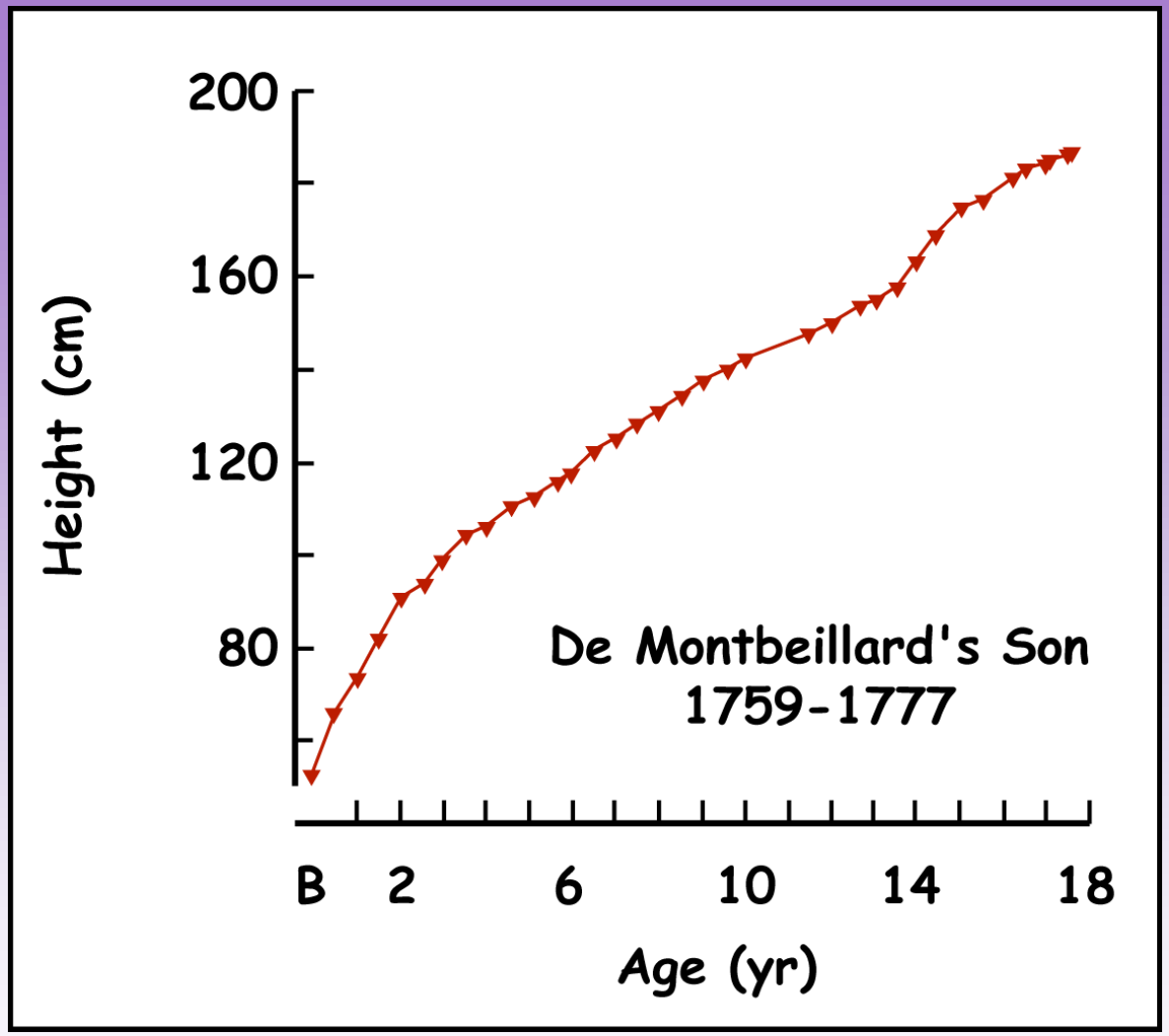
Childhood, Adolescence Adulthood



(Redrawn from Tanner, 1989, Foetus into Man.)

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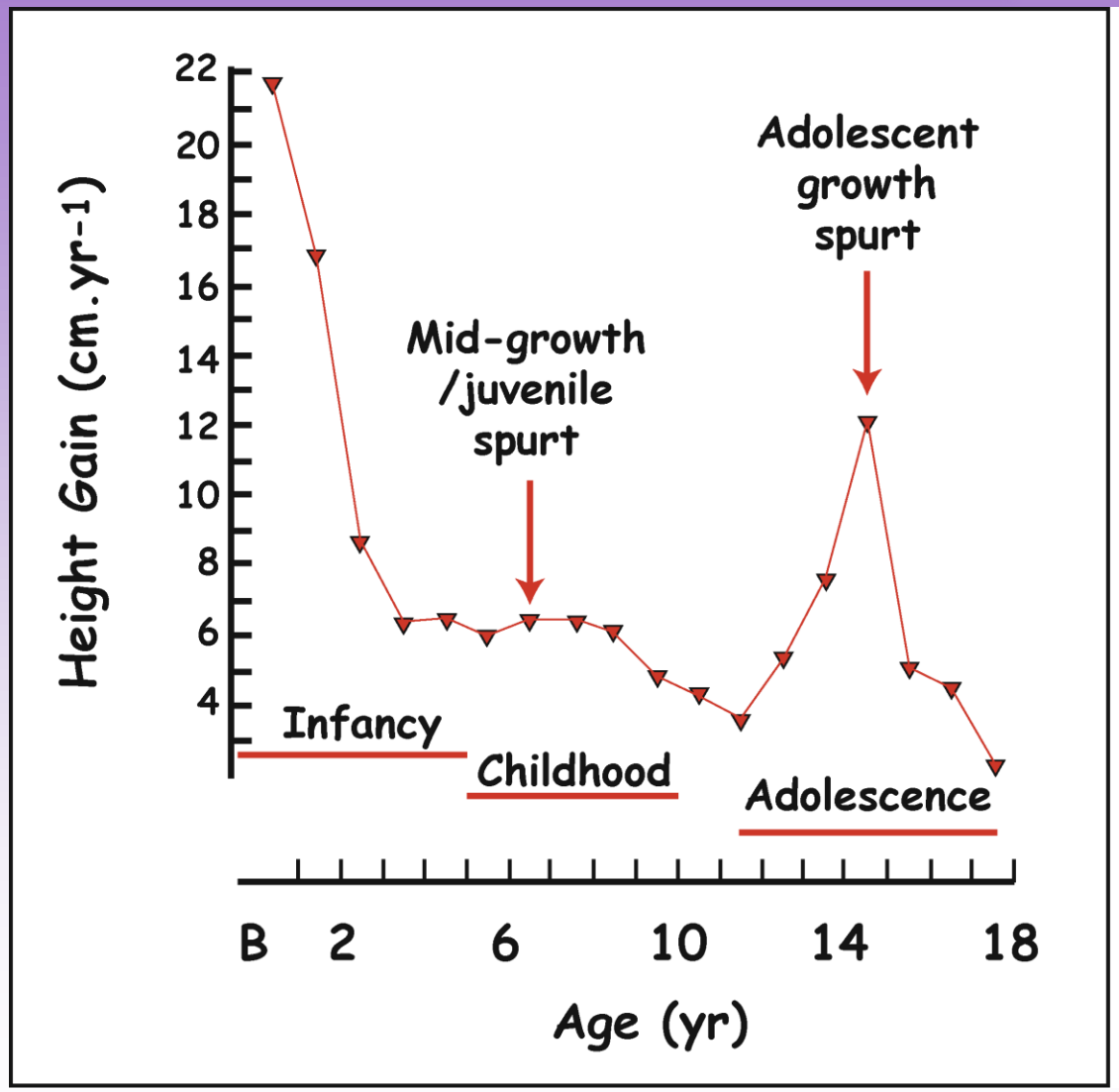
Growth and Maturation



Bogin (2002)

Infancy: Month 2 - End lactation

Childhood: Years 3-7

Juvenile: 7-10 girls; 7-12 boys

Puberty: An event of short duration at the end of the Juvenile stage - dramatic increase sex hormones

Adolescence: 5-10 years after onset of puberty

Adulthood

Growth and Maturation

- Growth: can be defined as an increase in size until we attain adulthood (e.g. height - growth rates of <1 cm.yr^{-1})

  [Cameron, N. (2002). Human growth curve, canalization, and catch-up growth. In: Human Growth and Development, Academic Press]

- Growth: "measurable changes in size, physique and body composition, and various systems of the body,…"

  [Beunen, G. and Malina, R.M. (2008). Growth and Maturation: Relevance to Athletic Performance. In: The Young Athlete, Blackwell Publishing pg. 3.]

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Growth and Maturation

- Maturation: "…progress toward the mature state."

[Beunen, G. and Malina, R.M. (2008). Growth and Maturation: Relevance to Athletic Performance. In: The Young Athlete, Blackwell Publishing pg. 3.]

- Maturation (or Development): is an increase in functional ability - the endpoint can be defined as the point when an individual is able to successfully procreate (biological, behavioural and social maturity)

[Cameron, N. (2002). Human growth curve, canalization, and catch-up growth. In: Human Growth and Development, Academic Press]

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Growth and Maturation

- Growth and Maturation are related
- Physical performance will be influenced: by changes in size, physique and body composition, and by the timing and tempo of the progress toward the adult state
- Chronologic age serves as our typical reference point
- KEY - Among a group of adolescents, growth, maturity and performance may be very different

Puberty / Adolescence

- Puberty: " the onset of adult reproductive capacity" (Ellison, P.T. (2002). Puberty. In: Human Growth and Development, Academic Press.)

- 'Adolescence' - a psychological / behavioural phenomenon occurring at 'puberty' - terms used inter-changably (Tanner, J.M. (1989). Foetus into Man, Castlemead Publications.)

Assessment of maturation

Peak height velocity - requires longitudinal measurements and retrospective.

Skeletal age (gold standard?) - using x-rays of the left hand and wrist, an estimate of skeletal age is made.

Indirect cross-sectional methods: Tanner scales (Tanner, 1962); Anthropometric methods e.g Mirwald and colleagues, 2002.

Skeletal Maturity

[Tanner et al. (2002). Assessment of skeletal maturity and prediction of adult height (TW3 Method). Saunders]

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'Tanner' Scales

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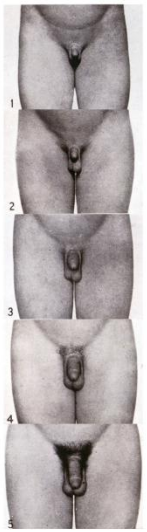
TANNER STAGES:
MALE GENITAL DEVELOPMENT

The pictures on this page show different stages of development of the genitals of boys (i.e. the testes and scrotum, and penis). A boy passes through each of the five stages shown by these pictures. Please look at each of the pictures and read the sentences next to the picture. Then choose the picture closest to your stage of development and mark an **A** on the picture. Then choose the picture that is next closest to your stage of development and mark a **B** on the picture. In choosing the right picture, look only at the size and shape of the genitals not at the pubic hair.



Stage 1
The testes, scrotum and penis are about the same size and shape as they have always been since you were a child.

Stage 2
The testes and scrotum have become a little larger. The feel of the skin of the scrotum has changed and it is slightly darker. The scrotum, the sack holding the testes, has lowered a bit.

Stage 3
The penis has grown a little in length. The testes and scrotum have grown bigger and dropped lower than in stage 2.

Stage 4
The penis has grown larger and is wider. The glans (the head of the penis) is bigger than before. The testes have grown bigger and are darker.

Stage 5
The penis, scrotum and testes are the size and shape of that of an adult male.

Once you have completed the form, fold it and put it in the envelope provided and seal the envelope.

Your results are completely private and will be treated in complete confidence. No one will know who has filled out the form, as your name will not be on it.

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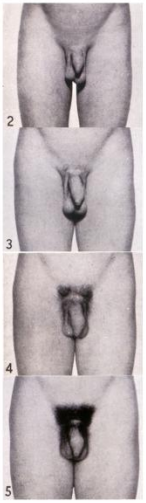
TANNER STAGES:
MALE PUBIC HAIR DEVELOPMENT

The pictures on this page show different stages of development of male pubic hair. A boy passes through each of the five stages shown by these pictures. Please look at each of the pictures and read the sentences next to the picture. Then choose the picture closest to your stage of development and mark an **A** on the picture. Then choose the picture that is next closest to your stage of development and mark a **B** on the picture. In choosing the right picture, look only at the pubic hair and not at the size of the testes, scrotum and penis.

Stage 1
(No picture)



Stage 1
There is no pubic hair at all.

Stage 2
There is a little soft hair. Most of the hair is at the base of the penis. This hair may be straight or a little curly.

Stage 3
The hair is darker in this stage. It is coarser and more curled. It has spread out and thinly covers the area around the penis.

Stage 4
The hair is now as dark as that of an adult man. However, the area it covers is not as large as that of an adult man. The hair has not spread out to touch the thighs.

Stage 5
The hair has spread out to touch the thighs. The hair is now like that of an adult man. It also covers the same area as that of an adult man and has the shape of a triangle (V).

Once you have completed the form, fold it and put it in the envelope provided and seal the envelope.

Your results are completely private and will be treated in complete confidence. No one will know who has filled out the form, as your name will not be on it.

Tanner, J.M. (1962). Growth at Adolescence, Blackwell Scientific Publications.

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Anthropometric methods

Maturity offset (e.g. -4, -3, -2, -1, 0, 1, 2, 3, years from PHV)

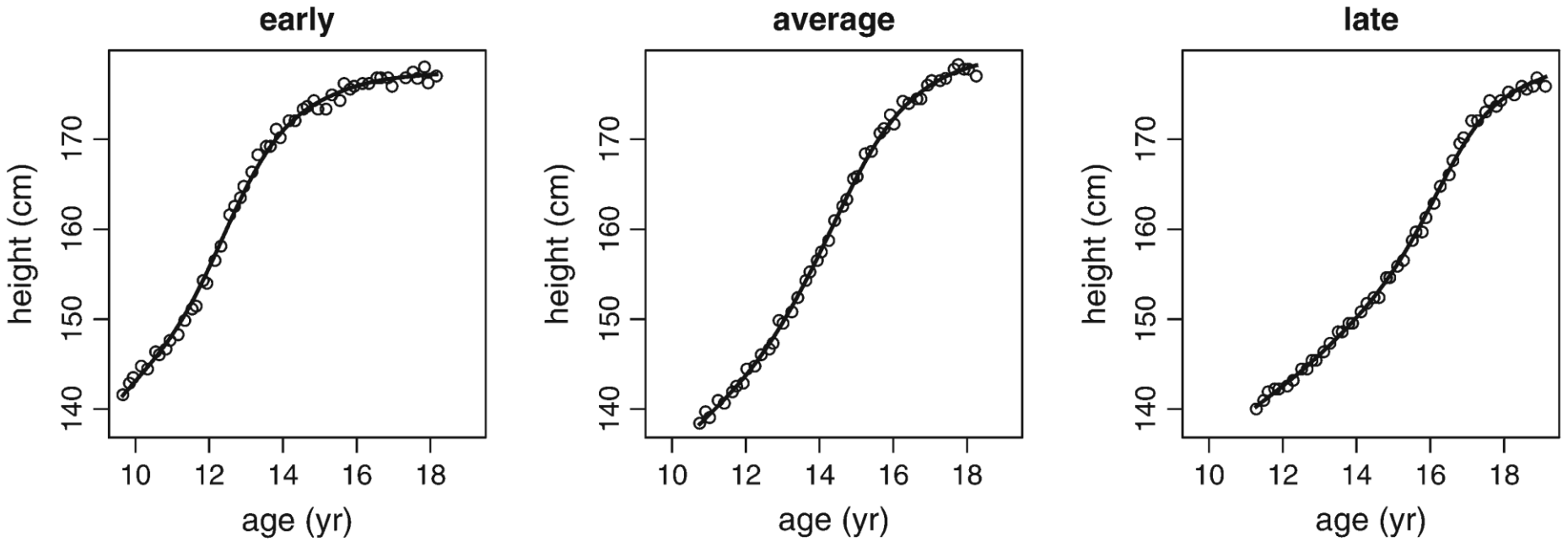
Females:

= -9.376 + 0.0001882*leg length and sitting height interaction + 0.0022*age and leg length interaction + 0.005841*age and sitting height interaction – 0.002658*age and weight interaction + 0.07693*weight by height ratio

$R = 0.94$, $R^2 = 0.890$, and SEE = 0.569

Mirwald, R.L. et al. (2002) Med. Sci. Sports Ex. 34: 689-694

Maturation - Peak Height Velocity



Cole et. al. (2008) Biostatistics. 9(1): 159-171

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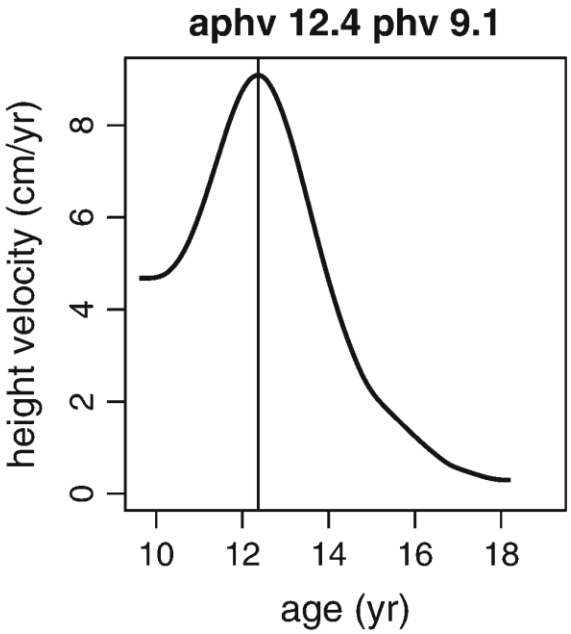
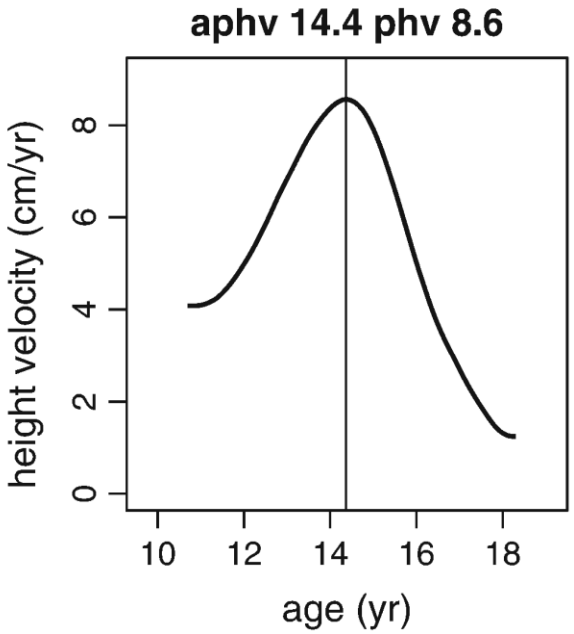
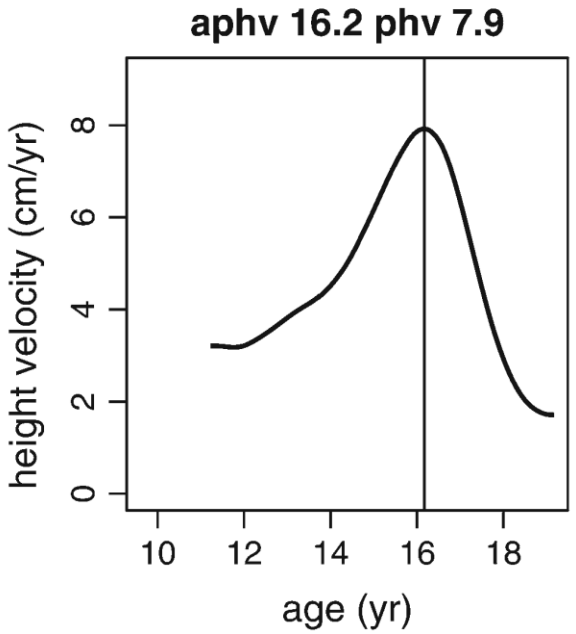
Maturation - Peak Height Velocity







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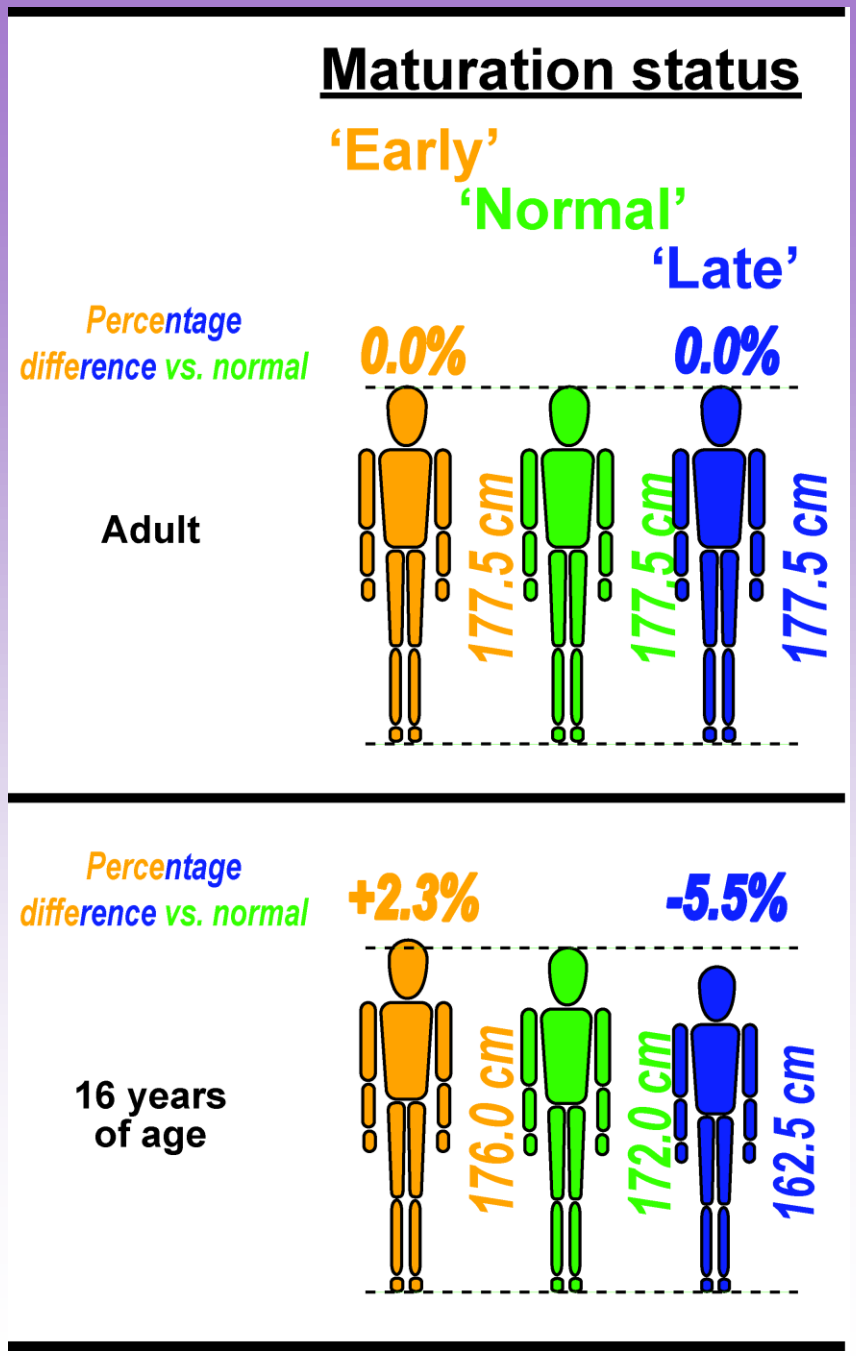
The impact of maturity



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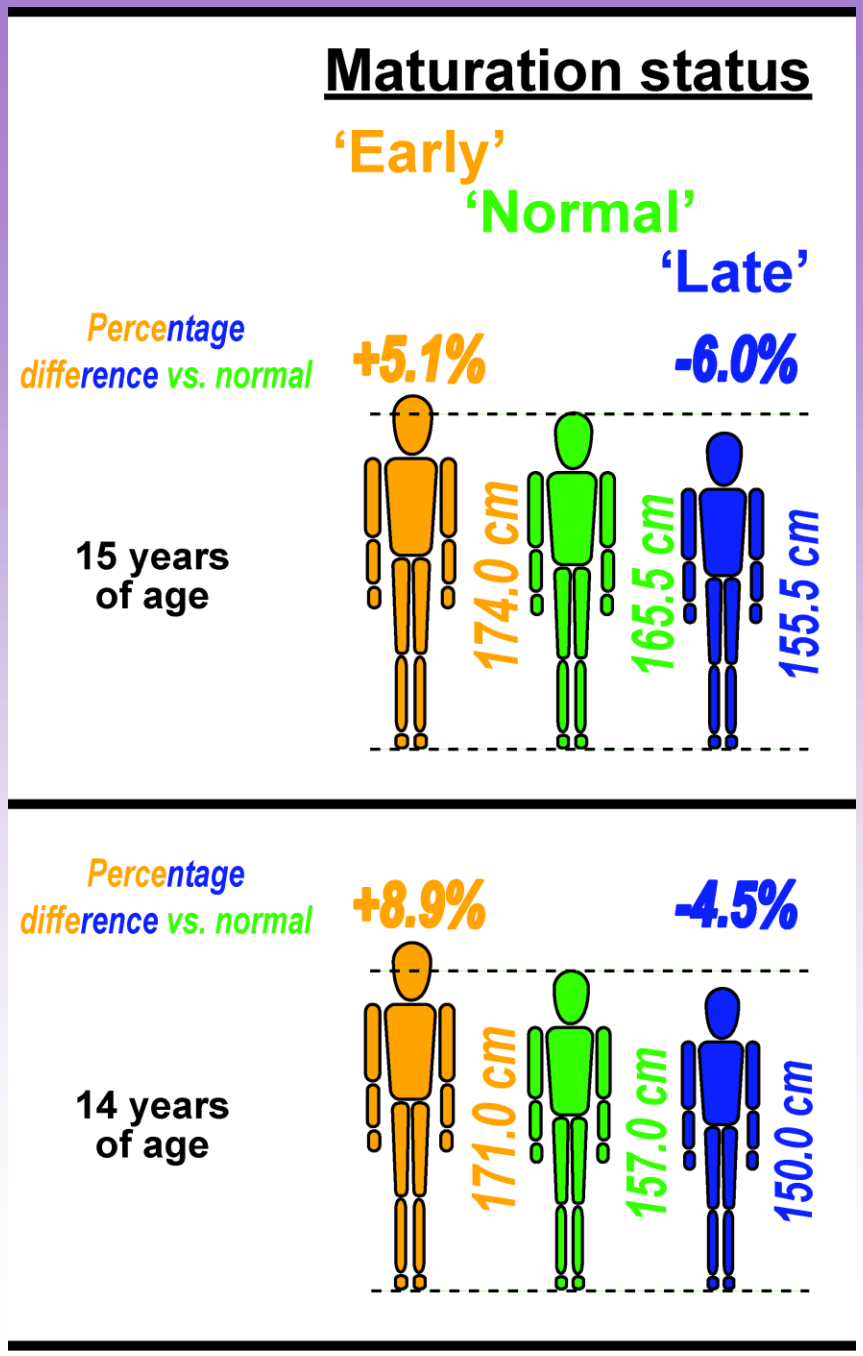
The impact of maturity



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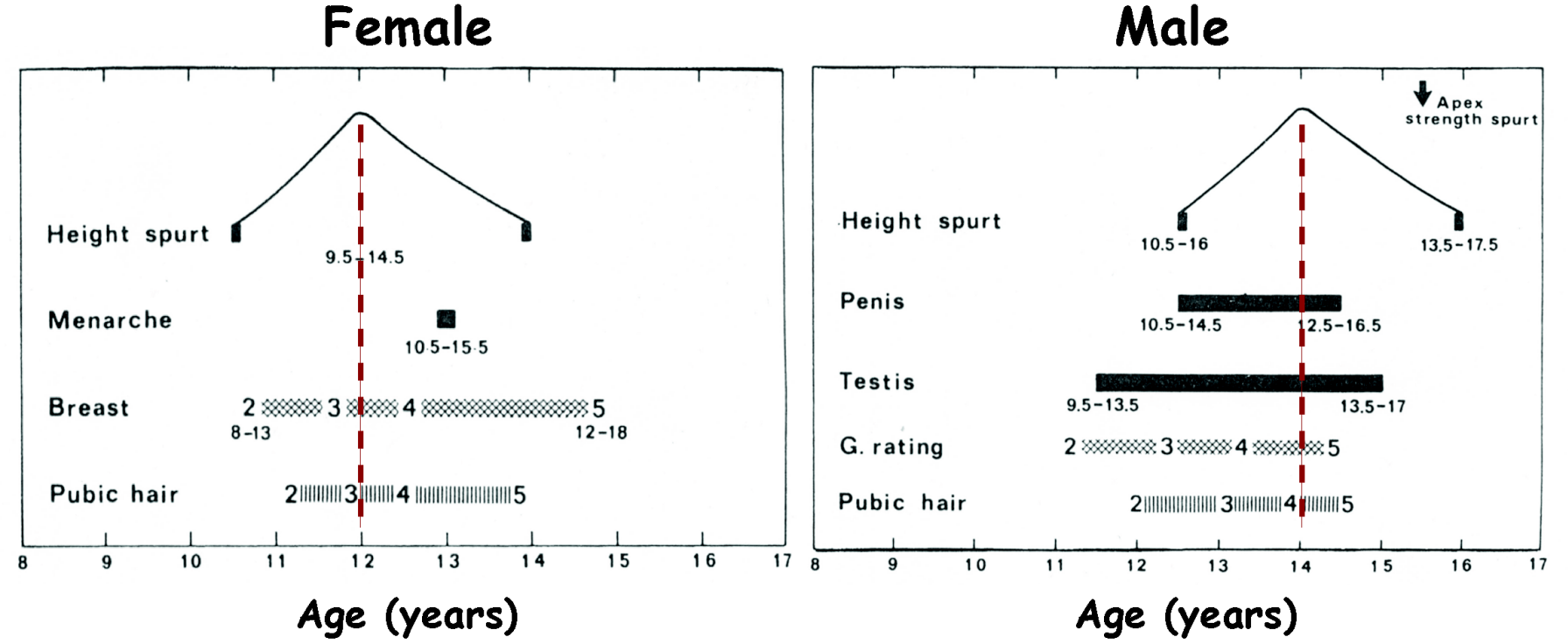
Growth and Maturation - Changes



Marshall, W.A. and Tanner, J.M. (1969 & 1970). Arch. Dis. Child. 44 & 45: 13-23 & 291-303 op. cit: Tanner, J.M. (1989). Foetus into Man, Castlemead Publications.

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Maturation - Timing and Tempo

- Average boy:

  beginning G2 to beginning G3 = 1 year; G2 to G5 = 3 years; BUT some boys G2-G5 = only 2 years; Possible among a group of boys all starting equal at G2 for some to reach G5 before others reach G3

- Clearly 'speed of development' varies
- Age of onset of puberty varies also
- "For the most part independent of each other"

Tanner, J.M. (1989). Foetus into Man, Castlemead Publications.

Maturation - Timing and Tempo

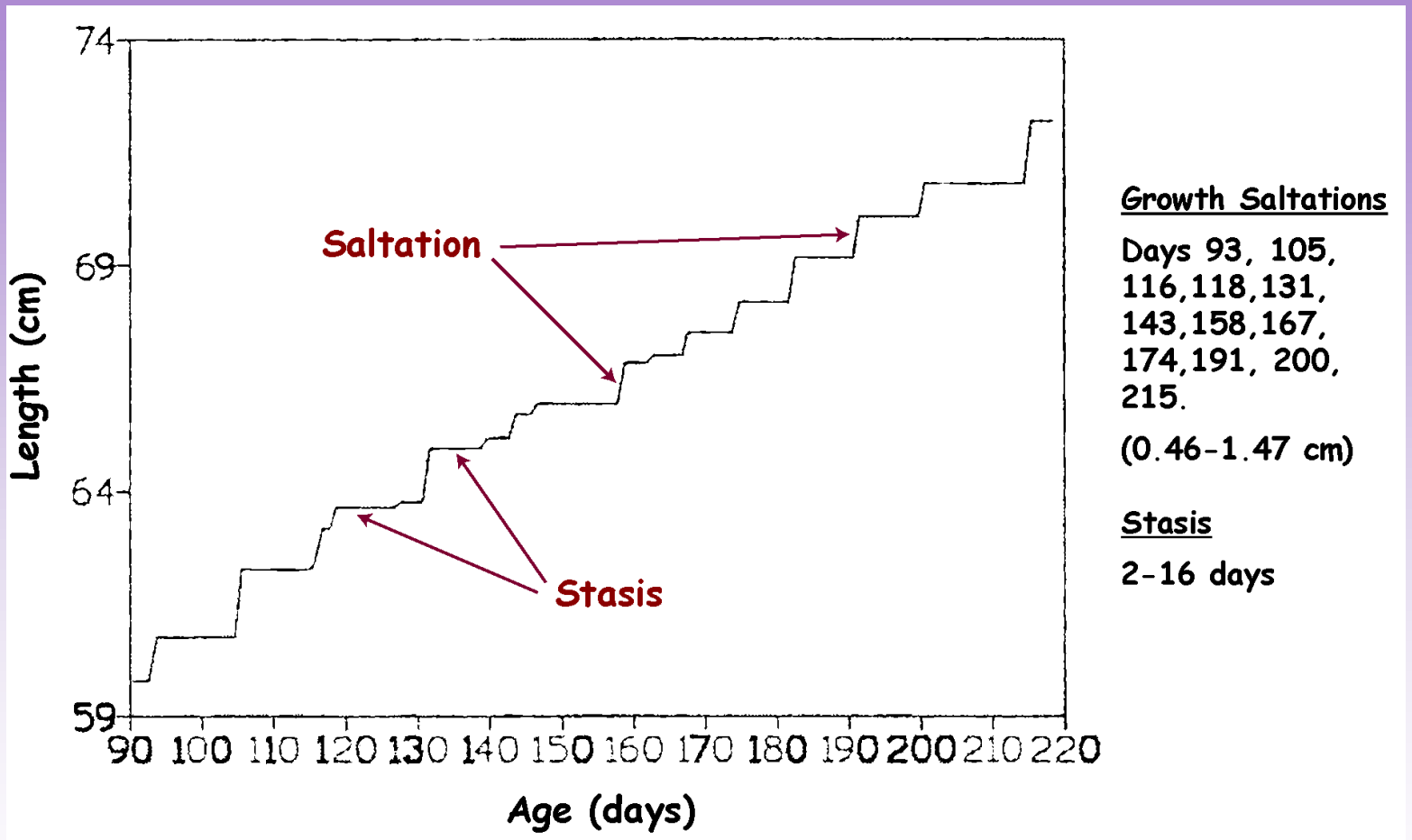
- Average girl:

  beginning B2 to reach B3 = 1 year; B2 to B5 = 4 years; BUT some girls only 1.5 years B2-B5 - others may take 5 years or even more to move from B2-B5

- Clearly 'speed of development' varies
- Age of onset of puberty varies also
- "For the most part independent of each other"

Tanner, J.M. (1989). Foetus into Man, Castlemead Publications.

Saltation and stasis



Growth Saltations

Days 93, 105, 116,118,131, 143,158,167, 174,191, 200, 215.

(0.46-1.47 cm)

Stasis

2-16 days

Lampl, M. (2002). Saltation and Statsis. In: Human Growth and Development, Academic Press.

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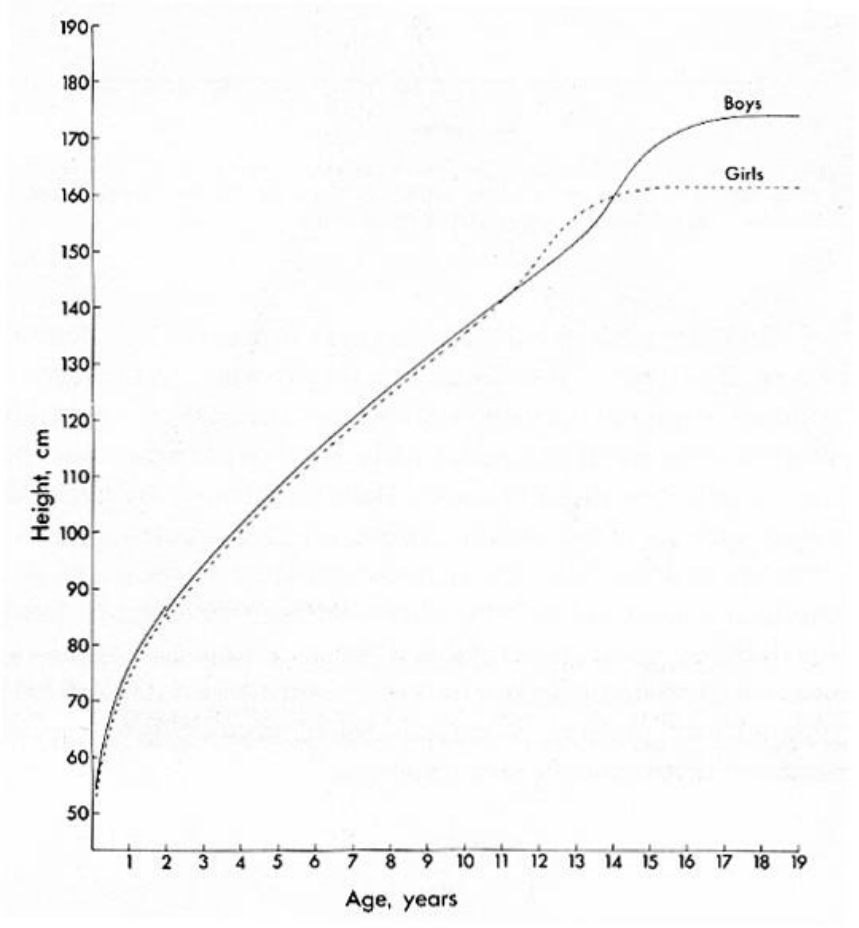
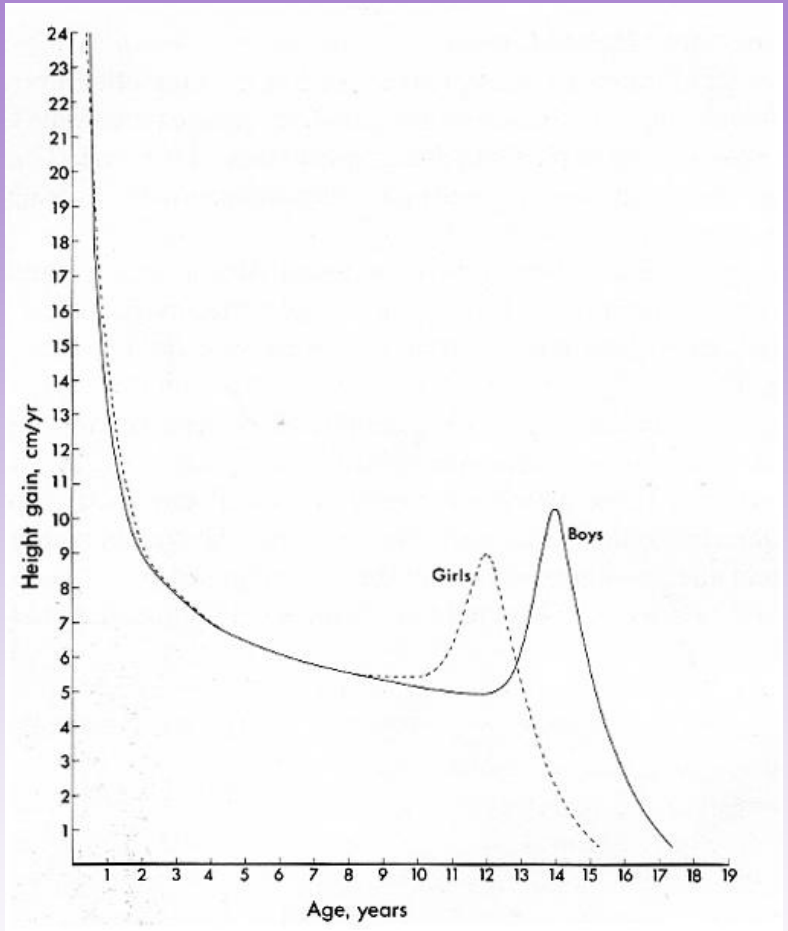
Sexual Dimorphism - Height





Tanner et al. (1966). Arch. Dis. Child. 41: 454-471 op. cit:
Tanner, J.M. (1989). Foetus into Man, Castlemead Publications.

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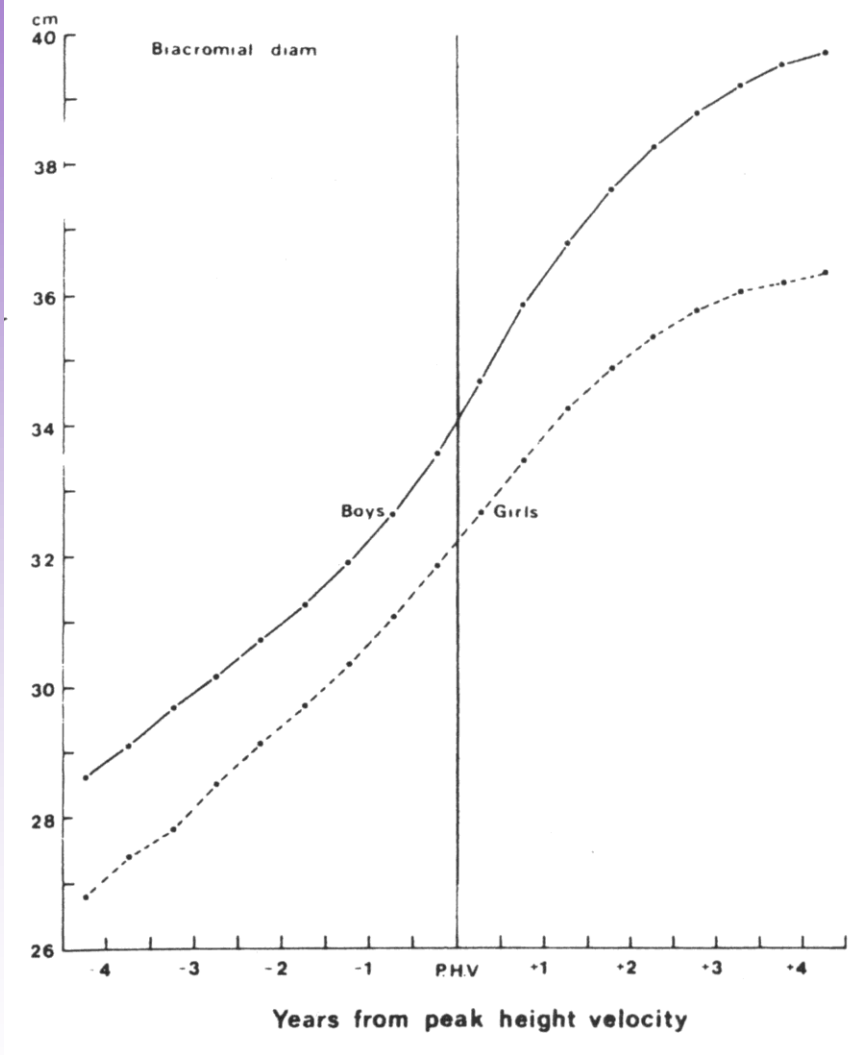
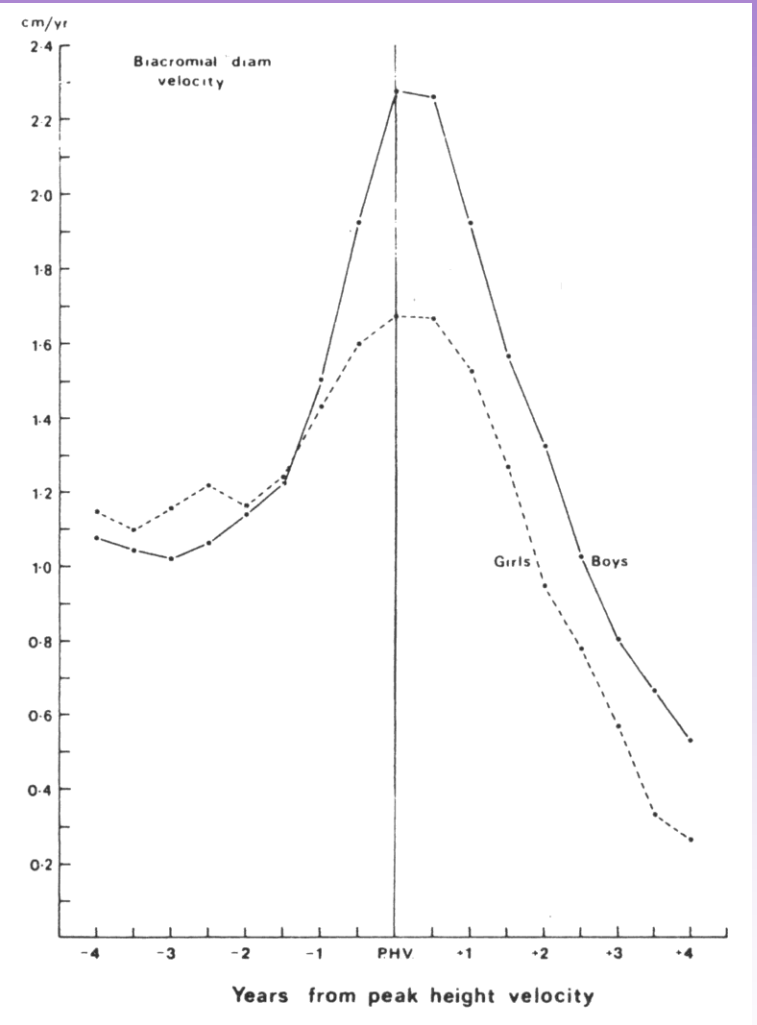
Sexual Dimorphism - Shoulder Width





Tanner, J.M. (1989). Foetus into Man, Castlemead Publications.

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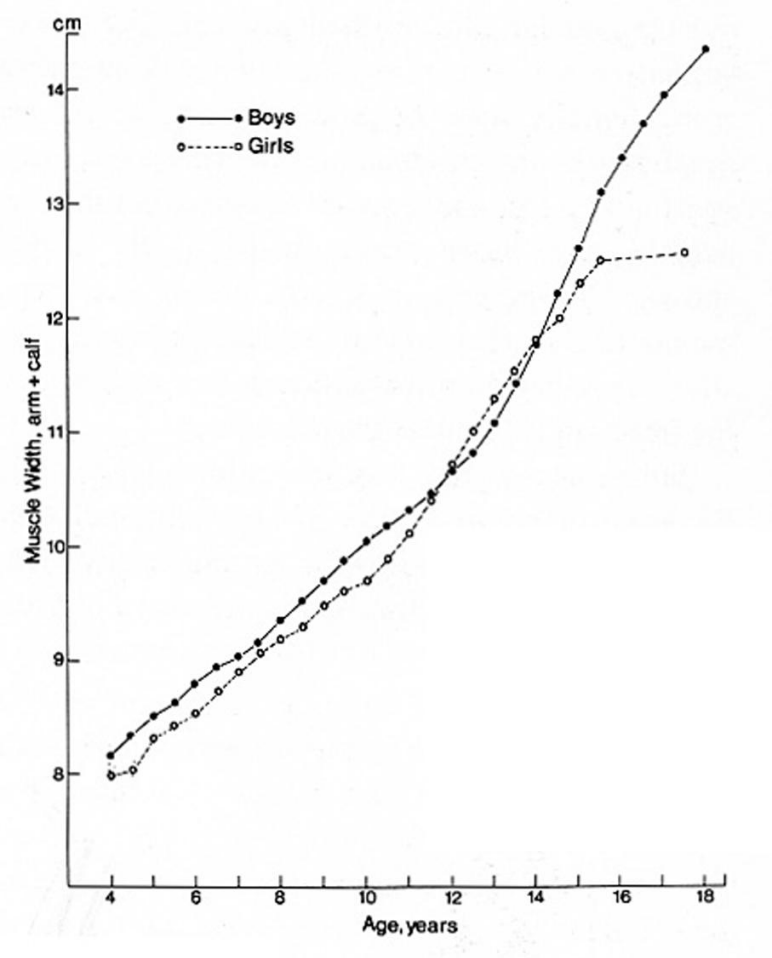
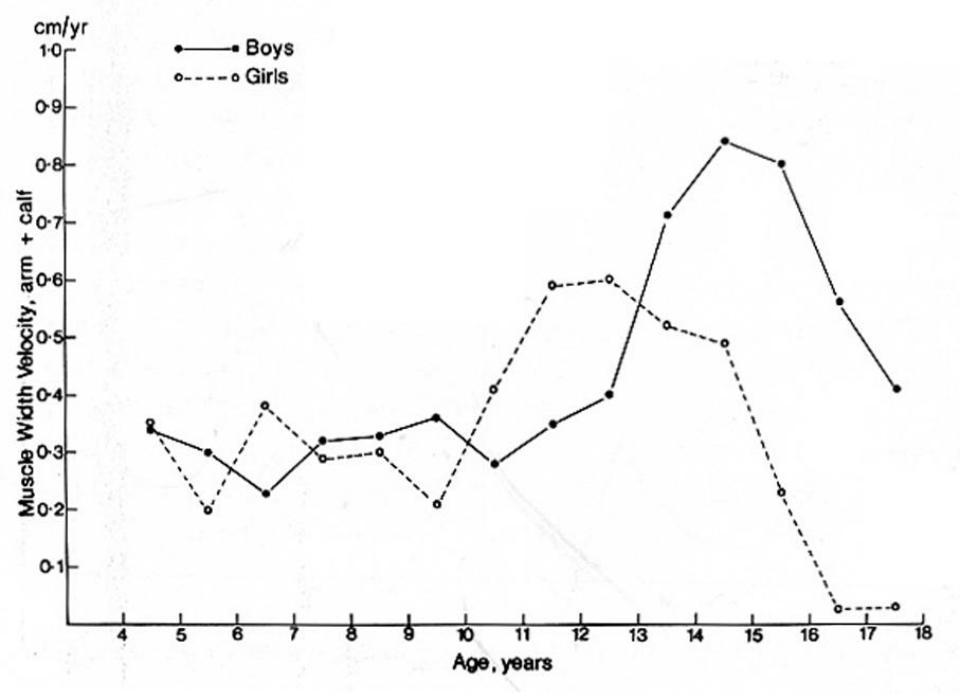
Sexual Dimorphism - Muscle Mass





Tanner, J.M. (1989). Foetus into Man, Castlemead Publications.

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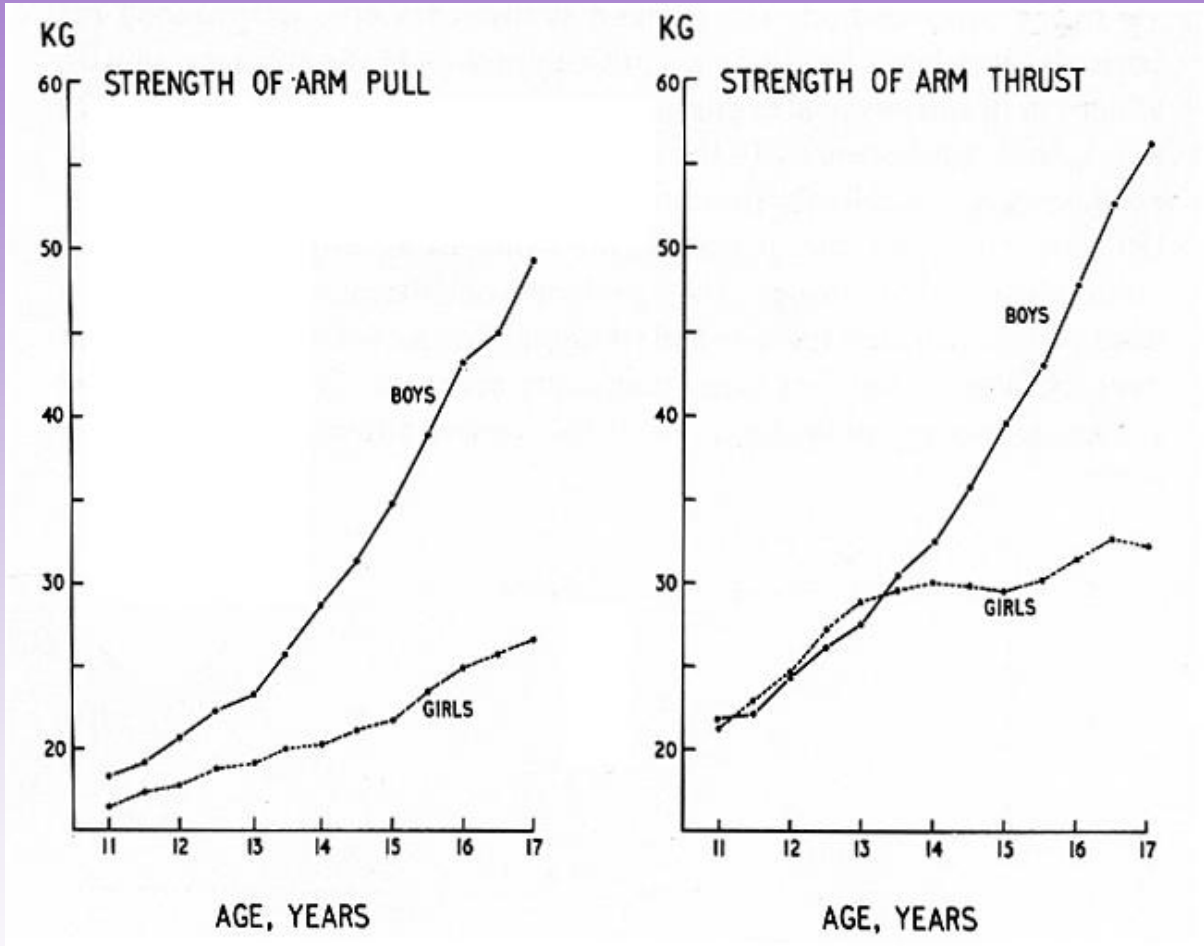
Sexual Dimorphism - Strength



Jones, H.E. (1949). Motor Performance and Growth op. cit:
Tanner, J.M. (1989). Foetus into Man, Castlemead Publications.

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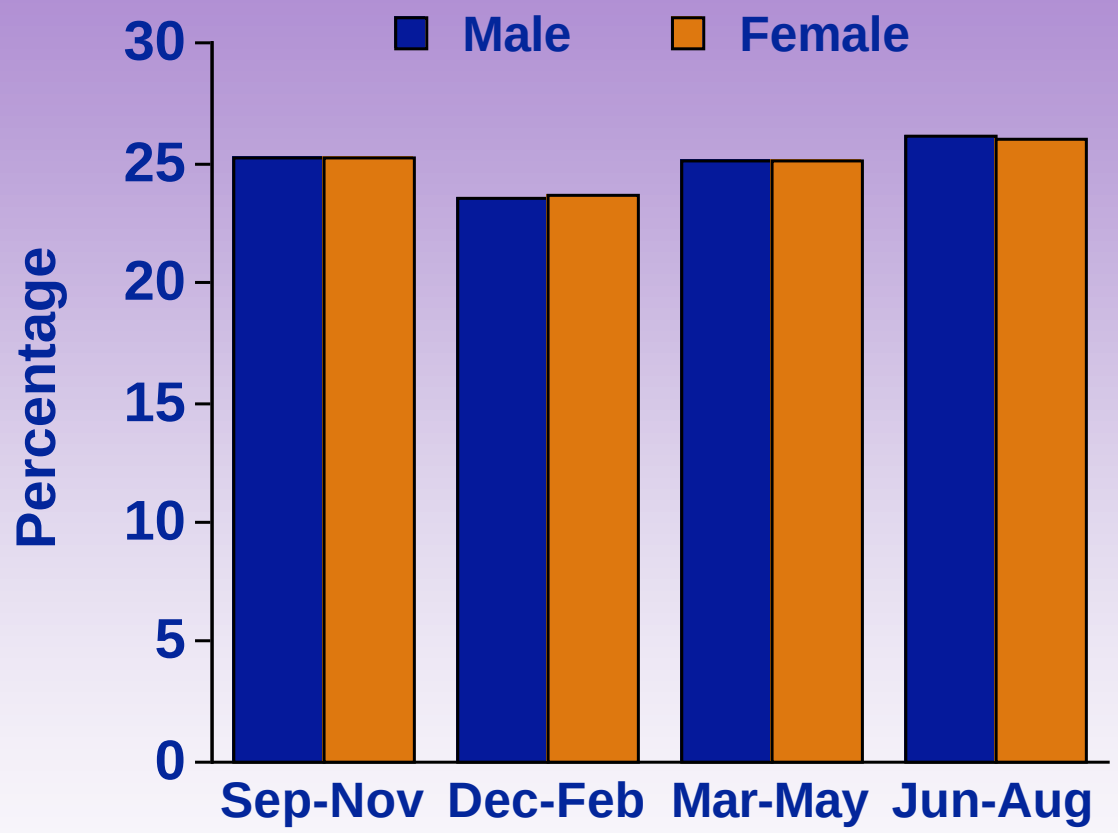
Hormonal stimulation of growth

- In utero and in the first 6 months of life growth is largely GH independent
- From the second year of life until puberty the majority of growth in infancy / childhood seems to be explainable by the amount of growth hormone secreted by an individual
- The pubertal growth spurt is the result of the interaction / effect of the sex steroids (predominantly estrogen in females and testosterone in males) coupled with growth hormone

Hormonal stimulation of growth

- **Estrogen and testosterone: only in very low concentrations until puberty**
- **Large increases in these hormones stimulates the development of secondary sexual characteristics, sexual dimorphism and an increased secretion of growth hormone**

The Relative Age Effect in Sport



Proportion of male and female births per quarter

What is the 'relative age' effect?

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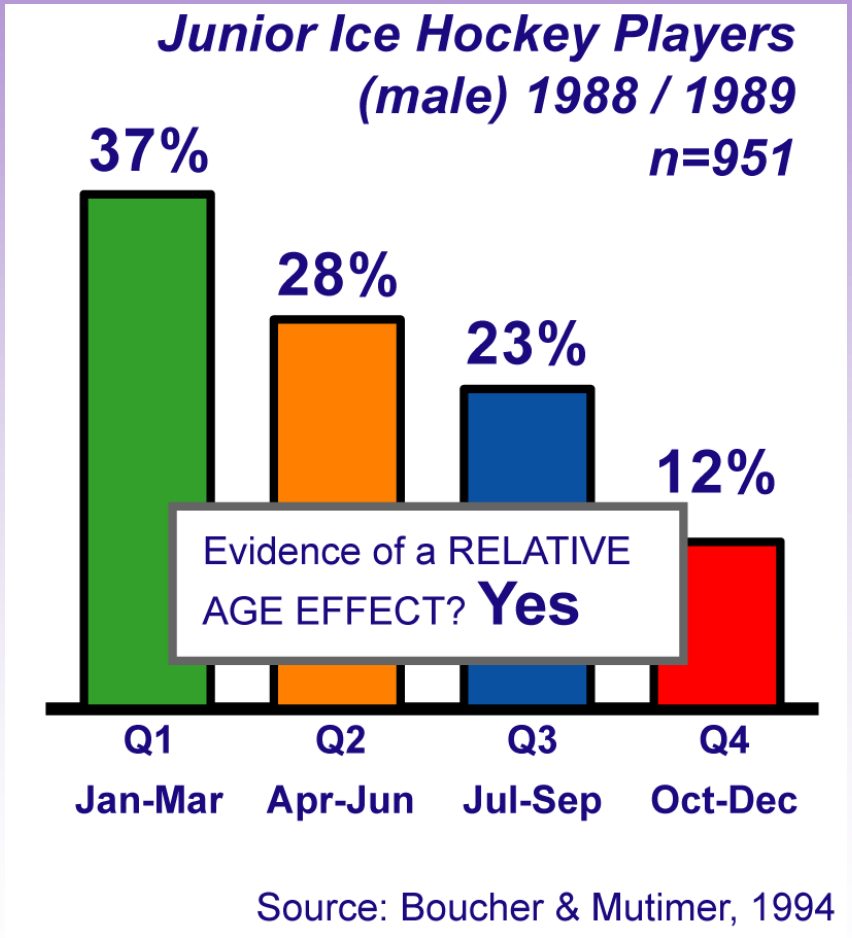
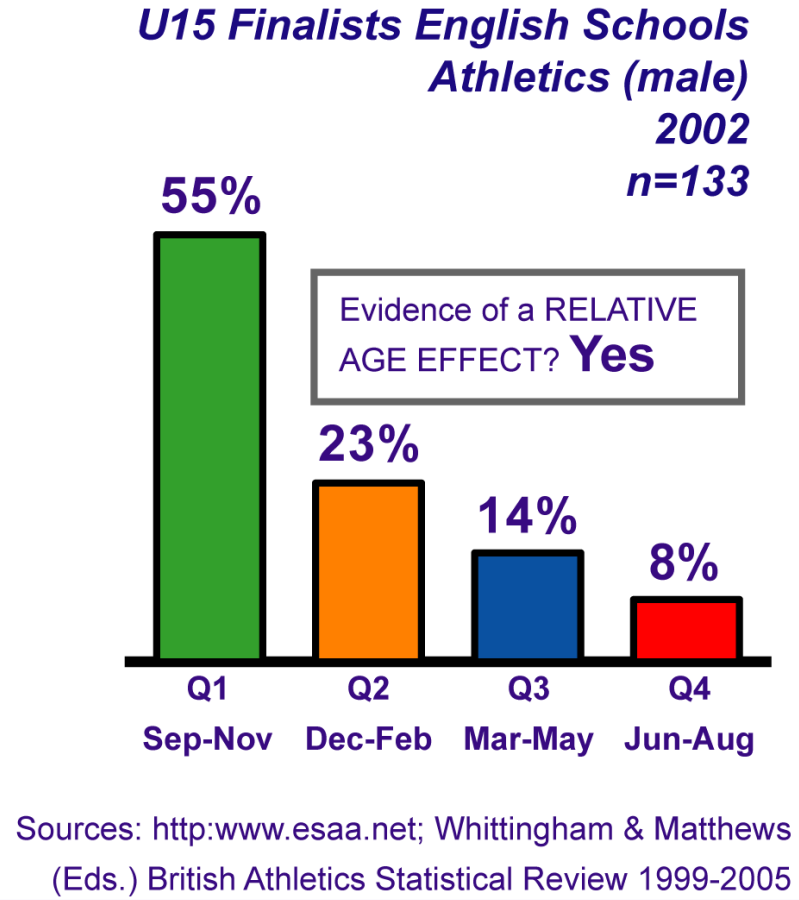
The Relative Age Effect in Sport: Evidence?

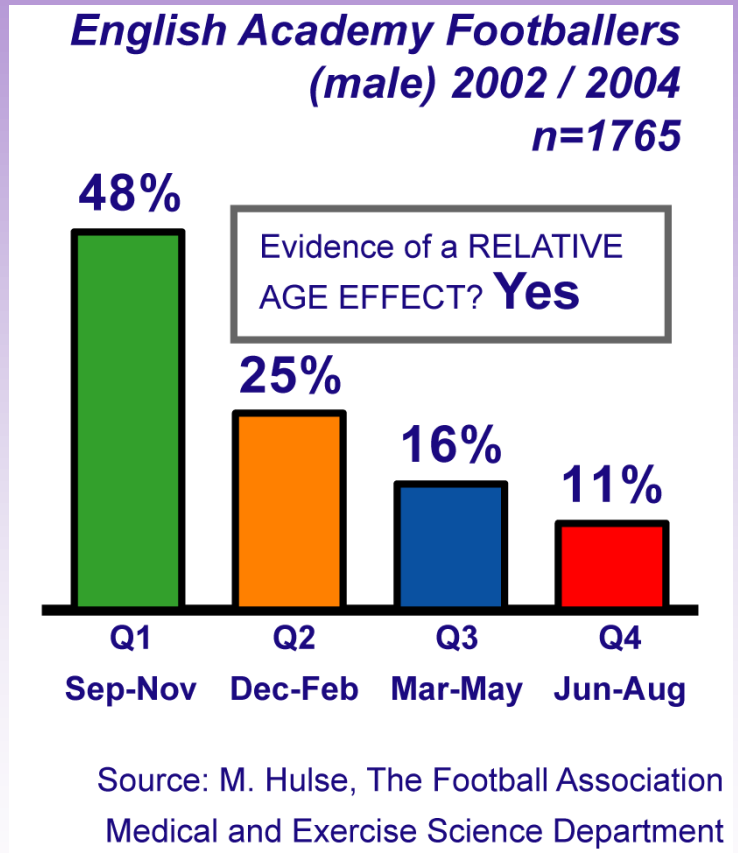
- **Observation that performers born early in a selection year are over-represented in junior and senior sports squads compared with that expected**



The Relative Age Effect in Sport: Evidence?



Sources: http:www.esaa.net; Whittingham & Matthews (Eds.) British Athletics Statistical Review 1999-2005



Source: M. Hulse, The Football Association Medical and Exercise Science Department

The Relative Age Effect in Sport: Evidence?

Sport	Sex	Age	Evidence of a Relative Age Effect
Athletics	Male	Junior	√ √ √
	Male	Senior	√ √
Baseball	Male	Senior	√ √
Cricket	Male	Senior	√
Football	Male	Junior	√ √
	Male	Senior	√ √
Ice Hockey	Male	Junior	√
	Male	Senior	√
Judo	Male	Junior	√ X
	Male	Senior	X
Rugby Union	Male	Senior	√
Swimming	Male	Junior	√ X
	Male	Senior	√
Tennis	Male	Junior	√
	Male	Senior	√

Sport	Sex	Age	Evidence of a Relative Age Effect
Athletics	Female	Junior	X X √
	Female	Senior	√ √
Football	Female	Junior	X
	Female	Senior	X
Gymnastics	Female	Elite	X
Judo	Female	Junior	X X
	Female	Senior	X
Swimming	Female	Junior	√ X
	Female	Senior	X
Tennis	Female	Junior	√
	Female	Senior	√

The Relative Age Effect in Sport: Hypothetical Example

Boy 2 is identical to Boy 1 except for being 11 months younger.

Entry to Year 9 Secondary School 1st September 2004

	Born	Age	Height	Weight	Selected for School Football Team?
'Boy 1'	1st September 1990	14 years 0 month			Yes
'Boy 2'	1st August 1991	13 years 1 month			No
Difference between boys at time indicated.		11 months	7.0 cm	5.7 kg	

The Relative Age Effect in Sport: Hypothetical Example

Boy 2 is identical to Boy 1 except for being 11 months younger.	Born	Selected for School Football Team?	Selected for Professional Club Academy Team?	Adult Characteristics: Age	Height	Weight	Adult Football Experience
'Boy 1'	1st September 1990	Yes	Yes ✓	21 years			Professional player
'Boy 2'	1st August 1991	No	No ✗ "Good player but too small"	21 years			Dropped out of competitive football at 15. No longer plays football at all.
Difference between boys at time indicated.					0 cm	0 kg	

The Relative Age Effect in Sport: Possible Solutions

- Rotating cut-off dates / Reduced age ranges / Establish current and potential squads / "Winning is not everything!" / Age on date of competition / Altered competition structure - Several competitions throughout year / Education package / New success criteria
- Tennis in England recently altered their age structure

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In Summary

- **Growth and maturation clearly influence performance**
- **‘Adolescence’ is a time of huge change: growth spurts, sexual development and sexual dimorphism**
- **The timing and tempo of the changes which occur can vary hugely between individuals**
- **Some, if not much, of the variation in performance in adolescence may be a function of growth and maturation**

Possible Solutions

- Use of other factors in talent ID, rate of improvement, norms for exact age
- Attitude to training, lack of injury and 'hardiness in training'
- Technique and focus on technique
- Judgements on performers post-puberty
- More performers retained at an early age

Acknowledgements

- Dr. Mary E. Nevill (Affiliation?)
- Dr. Caroline Sunderland
- Dr. Mark Hulse
- Dr. Vikki Leslie
- Mr. Matt Sedgwick
- Mr. James Dorling
- Ms. Sophie Hobson
- Study participants

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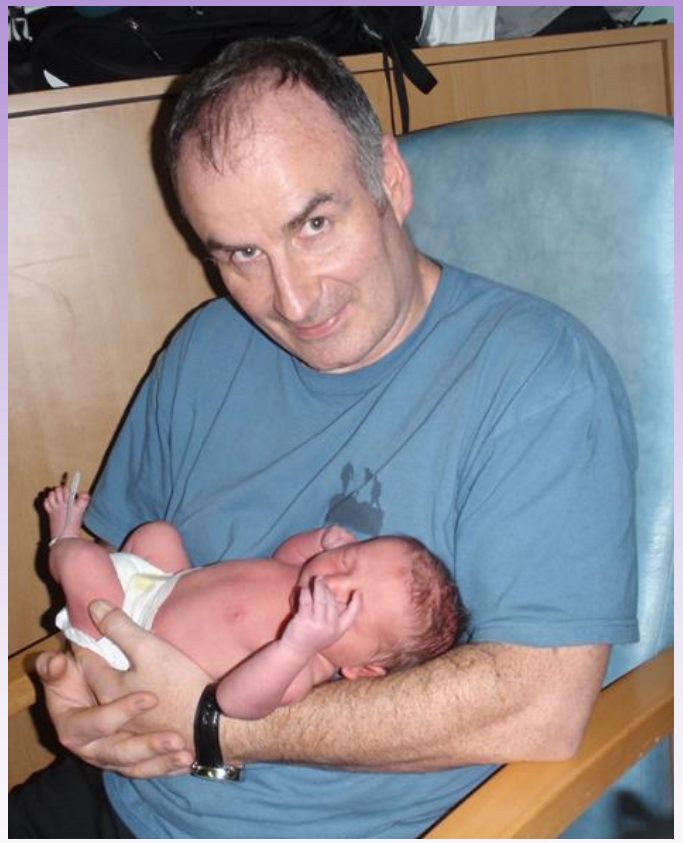
A lot can happen in year when you are young!

November 2011

- Presenter Age 21+!
- Height – 1.74 m
- Weight – more than it should be!
- Son: 0 months
- Height: 0.49 m
- Weight: 3.43 kg



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A year is a long time when you are young!

May 2012 (6 months later)

- Presenter – still 21+
- Height – still 1.74 m
- Weight – Still more than it should be – a little too much pasta!
- Son 6 months
- Height: 66 cm – 35%
- Weight: 7.70 kg – 124%

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