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Practical Case Study of Assessing Growth and Maturity in the Premier League

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Elite Player Performance Plan (EPPP)

- Long-term strategy to increase number and quality of home-grown players
- Improve coaching provision; implement system of effective measurement and quality assurance
- Collective platform for clubs to share ideas/concerns

Academy concerns

1. Limited understanding of growth and maturation & how to assess & monitor it

2. Assessments, training & competition based upon chronological age groups – blanket approach

3. Selection bias towards males who are advanced in age and/or maturation

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Premier League Growth Study: Aims

1. Establish a systematic and shared set of procedures for the measurement of growth & maturation across 29 clubs

2. Educate practitioners on growth, maturation & measurement

3. Adapt existing database (PMA) to capture and present growth and maturation information

4. Help clubs develop strategies to account for individual differences in growth & maturation

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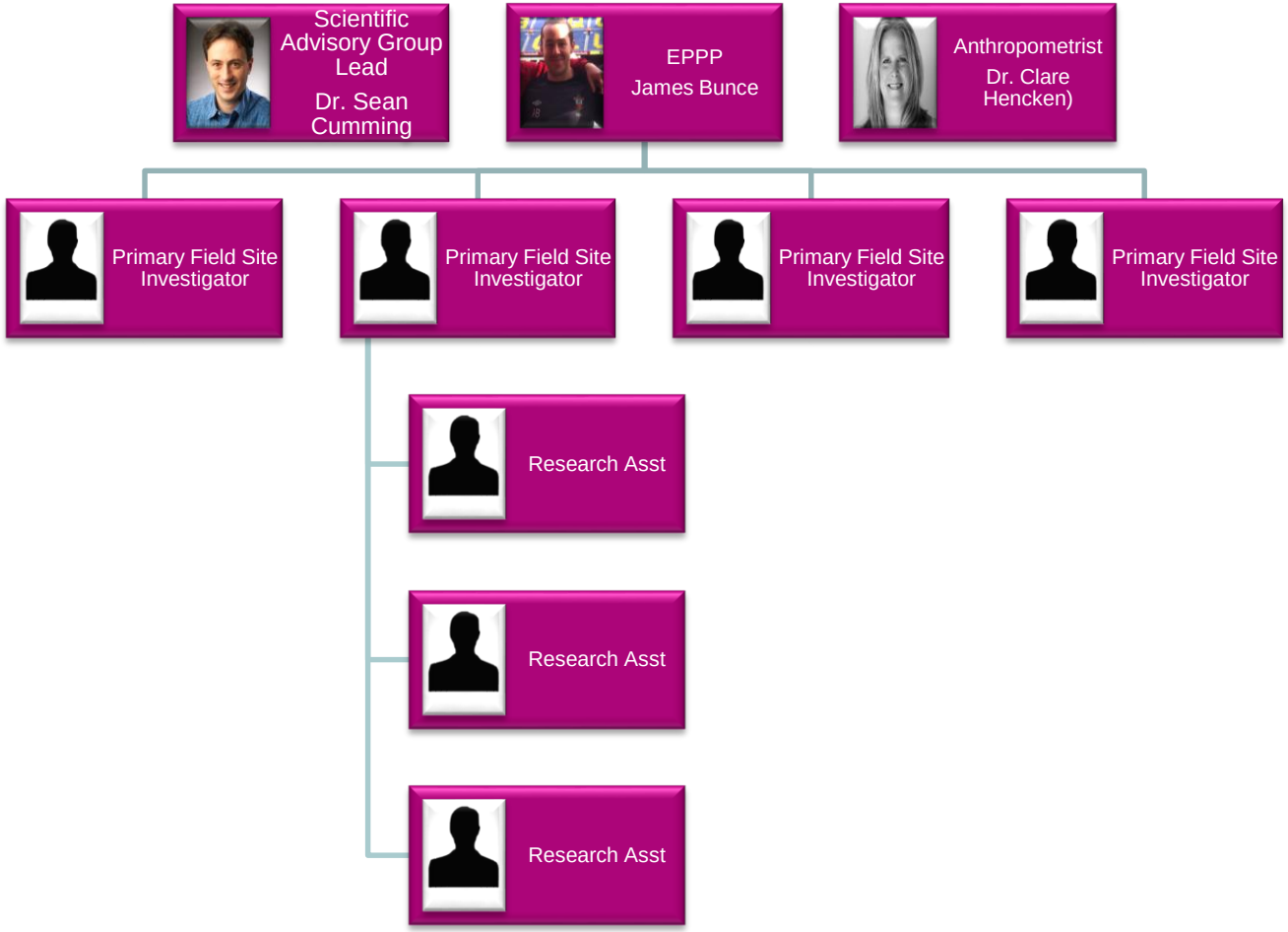
PLGS Organizational Structure



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PLGS Scientific Advisory Group

Professor Robert Malina, University of Texas

Professor Adam Baxter-Jones, University of Saskatchewan,

Professor Joey Eisenmann, Michigan State University

Dr Manuel Coelho e Silva, University of Coimbra

Dr Thomas Dompier, Datalys Center for Sports

Dr Lauren Sherar, University of Loughborough

Dr Amanda Johnson, Aspire Academy

Dr Marije Elferink-Gemser, Rijksuniversiteit

Dr Roel Vaeyen, Club Brugge K & Ghent University

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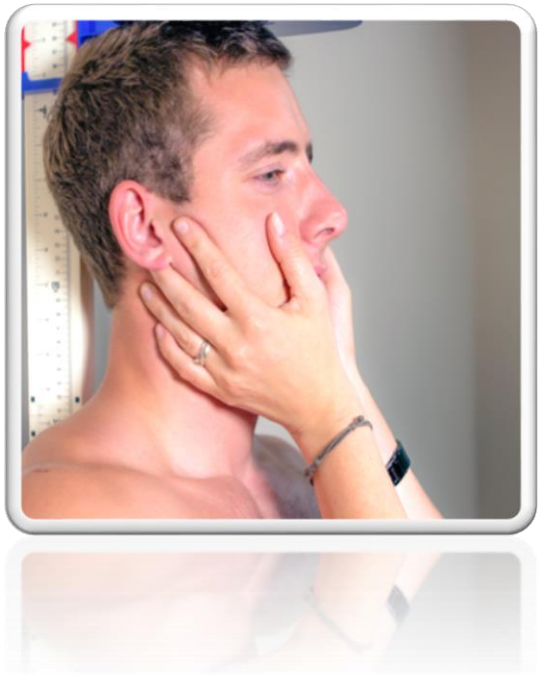
PLGS Measurement protocol

- Baseline player/parent demographic questionnaire
- Anthropometric measurements taken every 3-4 months (or at clubs discretion)
- Non-invasive methods of maturity assessment



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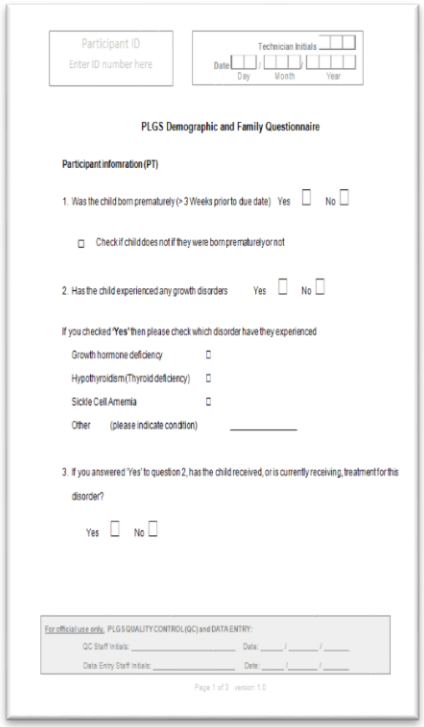
Baseline demographics

- Birth history/ethnicity
- Medical history
- Parents heights (meas./self-reported)
- Player history (e.g., position, training age, multi-sport)



Participant ID
Enter ID number here

Technician Initials
Date: Day / Month / Year

PLGS Demographic and Family Questionnaire

Participant information (PT)

1. Was the child born prematurely (> 3 Weeks prior to due date) Yes ☐ No ☐

☐ Check if child does not if they were born prematurely or not

2. Has the child experienced any growth disorders Yes ☐ No ☐

If you checked **'Yes'** then please check which disorder have they experienced

Growth hormone deficiency ☐
Hypothyroidism (Thyroid deficiency) ☐
Sickle Cell Anemia ☐
Other (please indicate condition) _____

3. If you answered 'Yes' to question 2, has the child received, or is currently receiving, treatment for this disorder?

Yes ☐ No ☐

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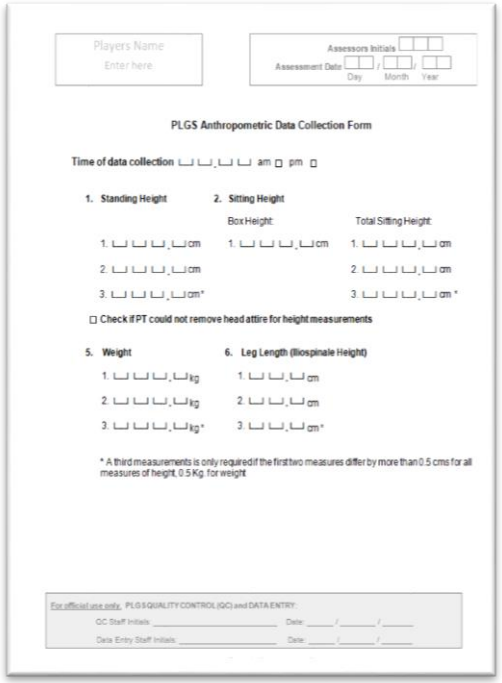
Anthropometrics

- Height, weight, seated height, (iliospinale, chest depth)
- Taken every 4 months (or at clubs discretion)
- Repeat measures with 3rd measure if +- .5 (cm./Kg.)



Players Name
Enter here

Assessors Initials
Assessment Date Day / Month / Year

PLGS Anthropometric Data Collection Form

Time of data collection ☐☐:☐☐ am ☐ pm ☐

1. Standing Height
1. ☐☐☐.☐cm
2. ☐☐☐.☐cm
3. ☐☐☐.☐cm *

2. Sitting Height
Box Height:
1. ☐☐☐.☐cm
Total Sitting Height:
1. ☐☐☐.☐cm
2. ☐☐☐.☐cm
3. ☐☐☐.☐cm *

☐ Check if PT could not remove head attire for height measurements

5. Weight
1. ☐☐☐.☐kg
2. ☐☐☐.☐kg
3. ☐☐☐.☐kg *

6. Leg Length (Iliospinale Height)
1. ☐☐.☐cm
2. ☐☐.☐cm
3. ☐☐.☐cm *

* A third measurements is only required if the first two measures differ by more than 0.5 cms for all measures of height, 0.5 Kg for weight

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Data Entry Staff Initials: _____ Date: ____/____/____

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Quality control

- Competency and reliability of measures assessed
- Intra- and inter-investigator reliability
- Technical Error of Measurement calculated (absolute & relative)

$$\text{Absolute TEM} = \sqrt{\frac{\Sigma\, d_i^2}{2n}}$$

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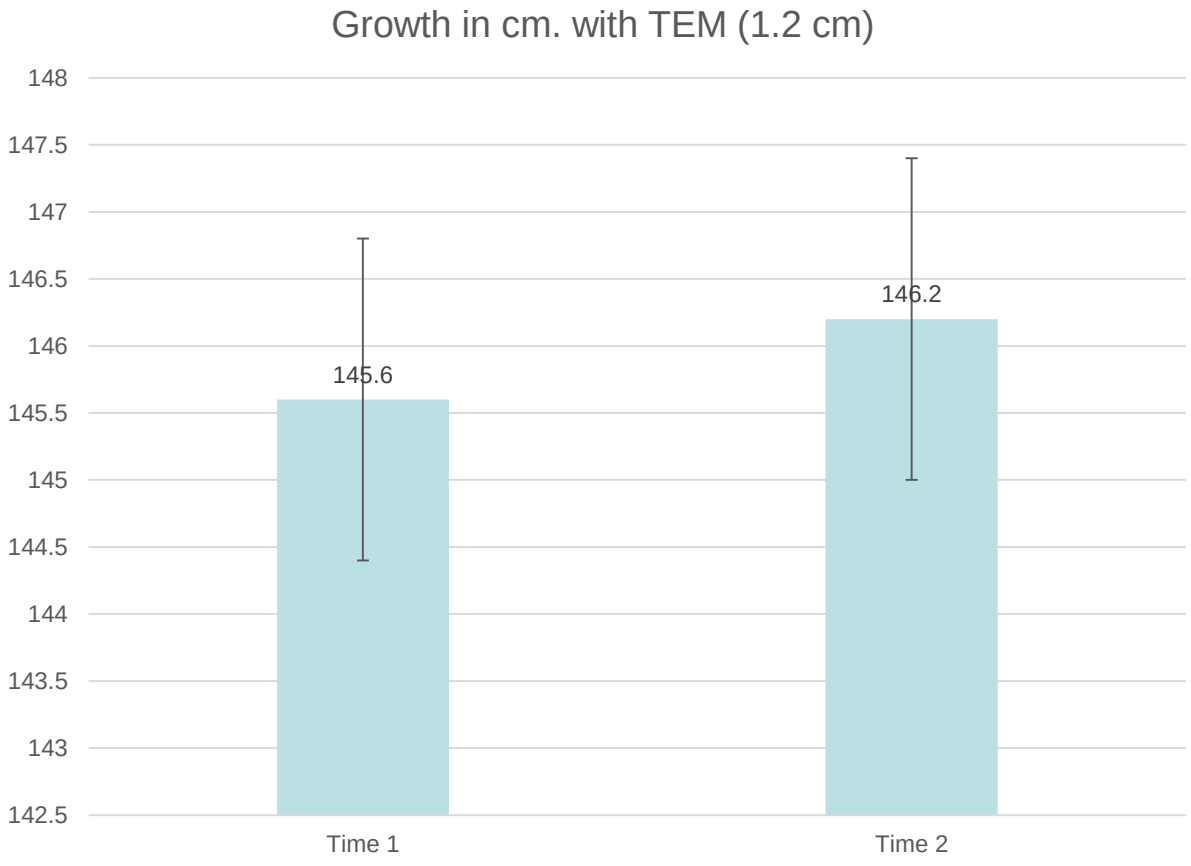
Application of TEM (absolute)



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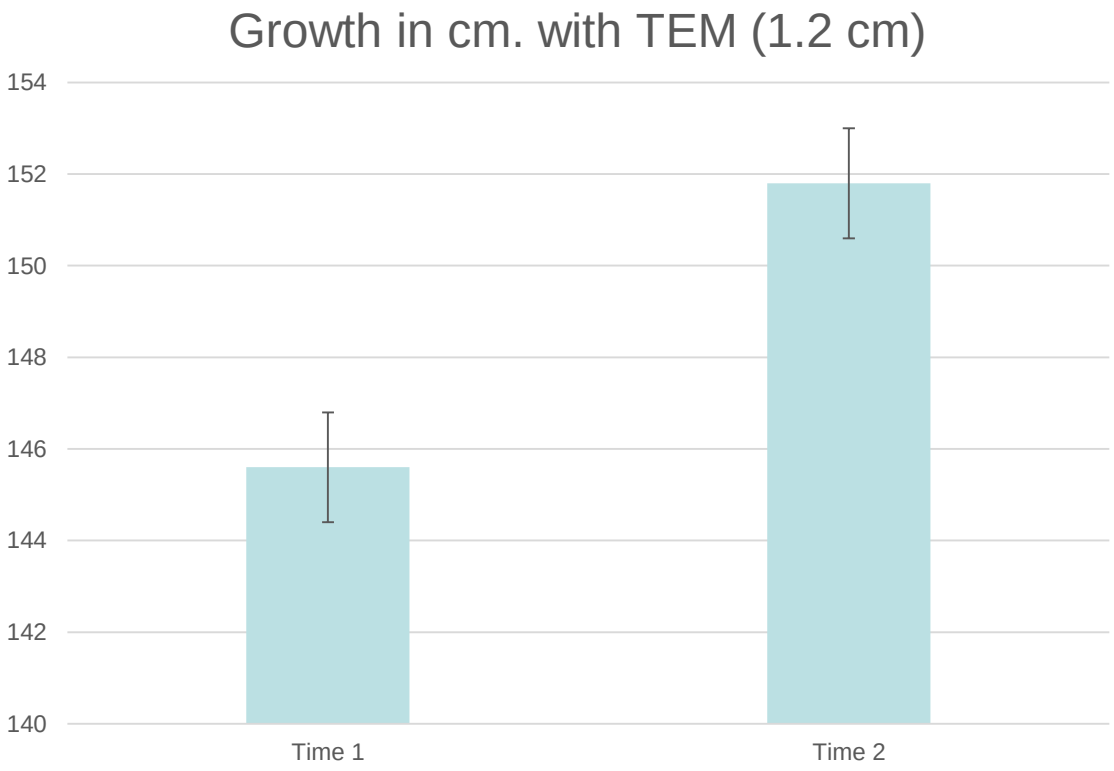
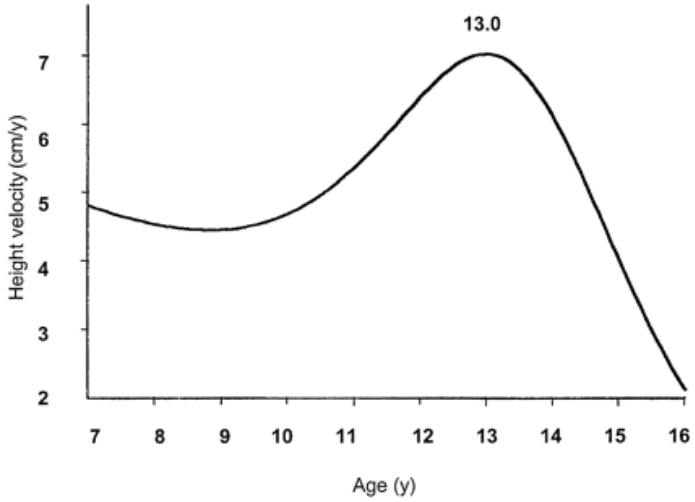
Application of TEM (cont.)



Assessments of maturation

- PMA provides three indices of maturation
  - Khamis-Roche method (% Predicted Adult Height) *
  - Maturity Offset Method (age at/from peak height velocity)
  - Growth velocity curve



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Khamis-Roche method *

- Predicts adult stature from age, height, weight, mid-biological parent height (adjusted for overestimation) **
  - Maturity status expressed as percent of adult height attained at measurement (PAH)
  - Maturity timing (early, on-time, late) expressed as age and sex specific Z score

* Khamis & Roche (1994) Pediatrics, 94, 504-507 ** Epstein (1995) Obes Res, 3 (5), 411-417

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Khamis-Roche Equation

- Predicted Adult height =
  - Intercept + (β1 x height) + (β2 x weight) + (β3 x mid-parent height)
  - Sex and age specific intercepts and coefficients available for imperial (inches, lbs.) and metric (cm./Kg.) measures

* Khamis & Roche (1994) Pediatrics, 94, 504-507 ** Epstein (1995) Obes Res, 3 (5), 411-417

A worked example: Bob

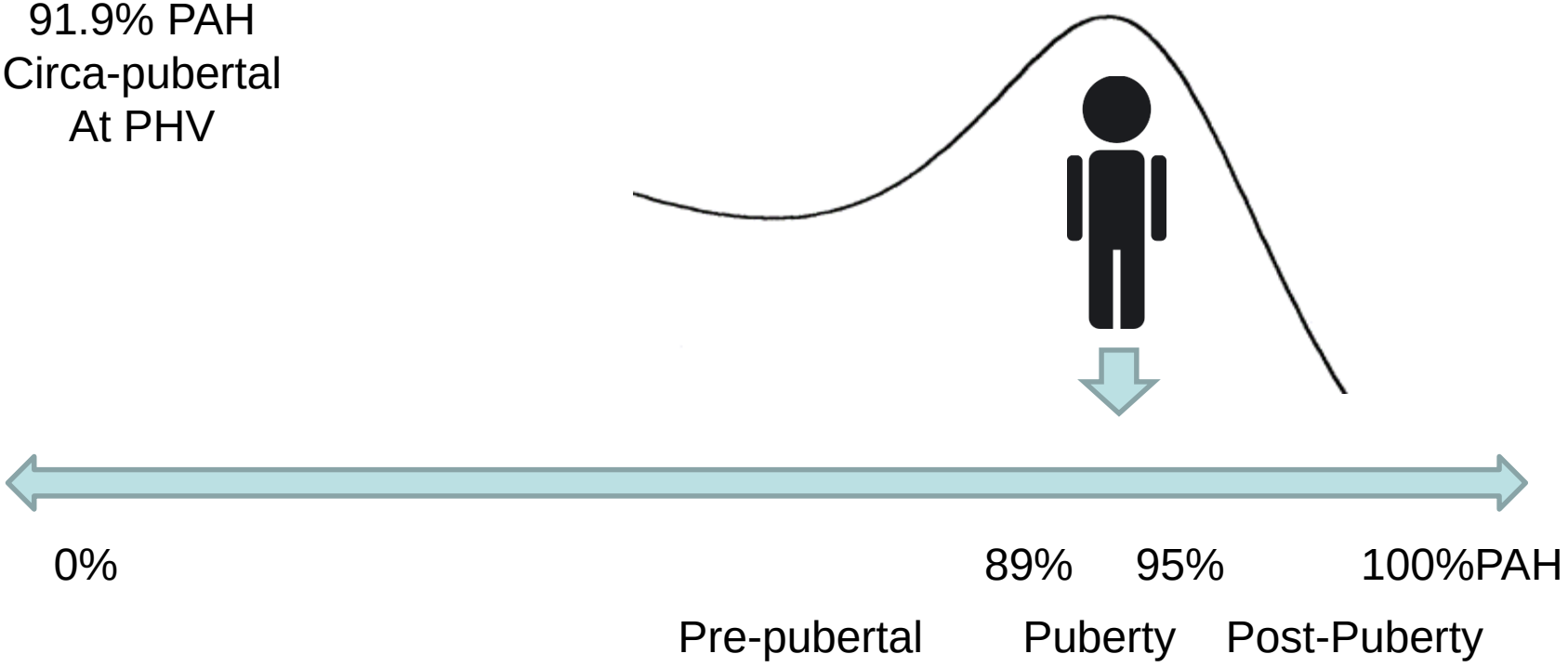
Bob
13.5 years
172.5 cm
55.0 Kg.

Adult Bob
187.6 cm
50% CI +2.2 cm.

Parents
Mum = 5’9
Dad = 5’10

Maturation status: (%PAH)

Bob
91.9% PAH
Circa-pubertal
At PHV



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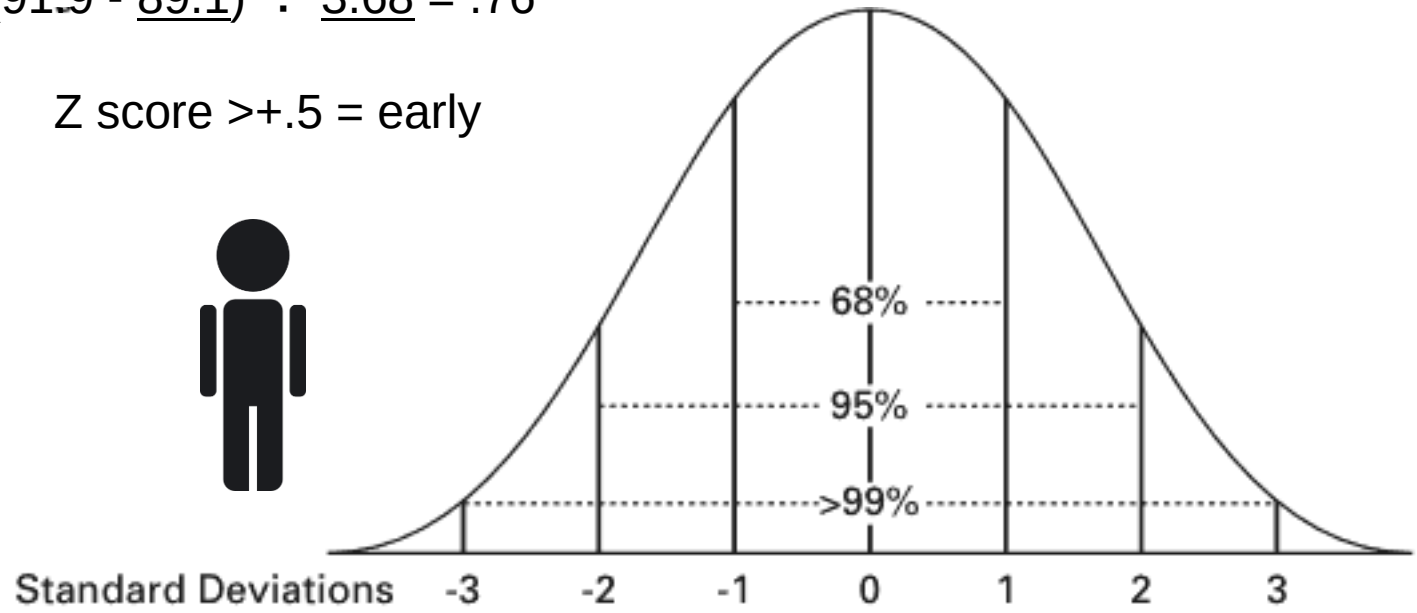
Maturity timing: Z Score

Z Score for 13.5 years

(91.9 - 89.1) ÷ 3.68 = .76

Z score >+.5 = early



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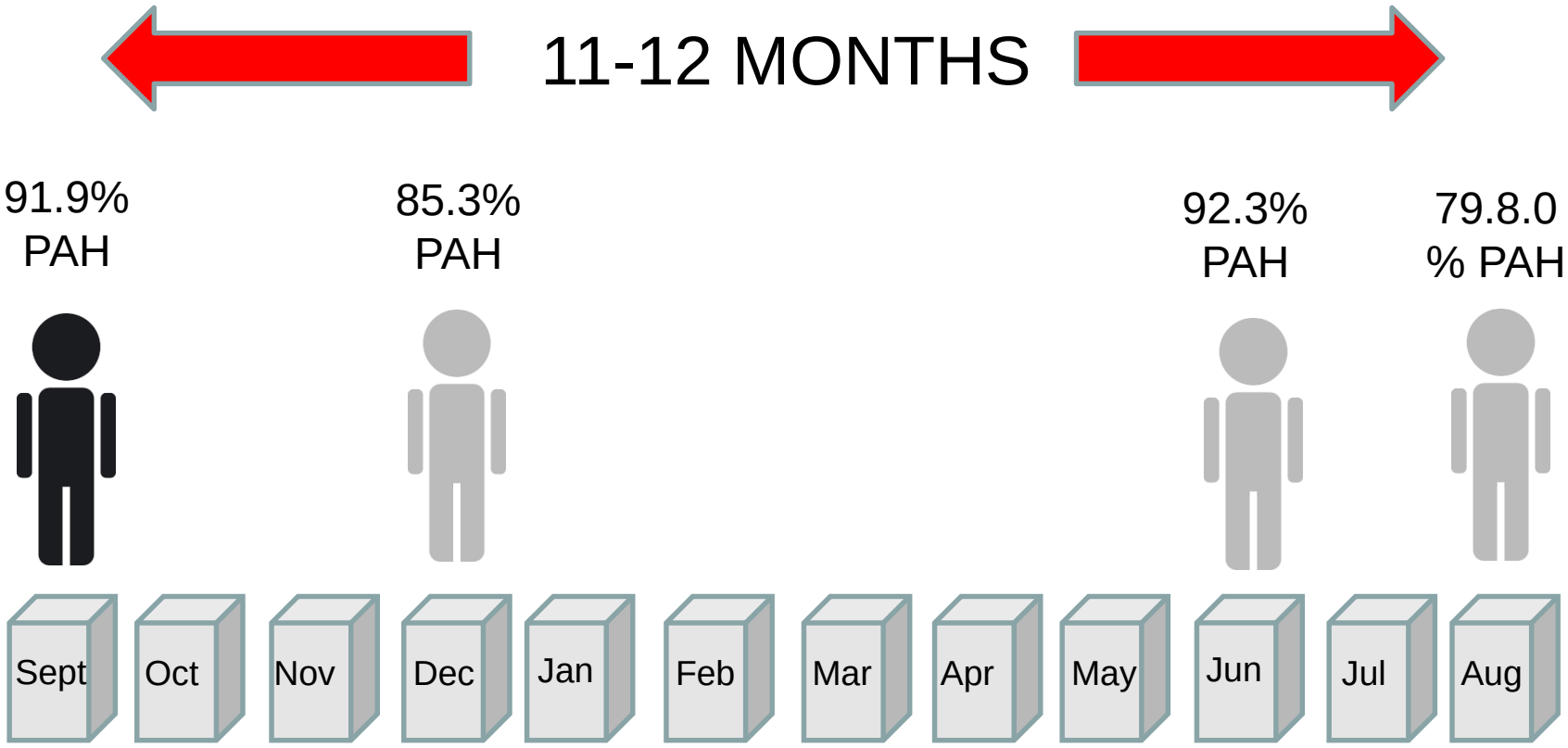
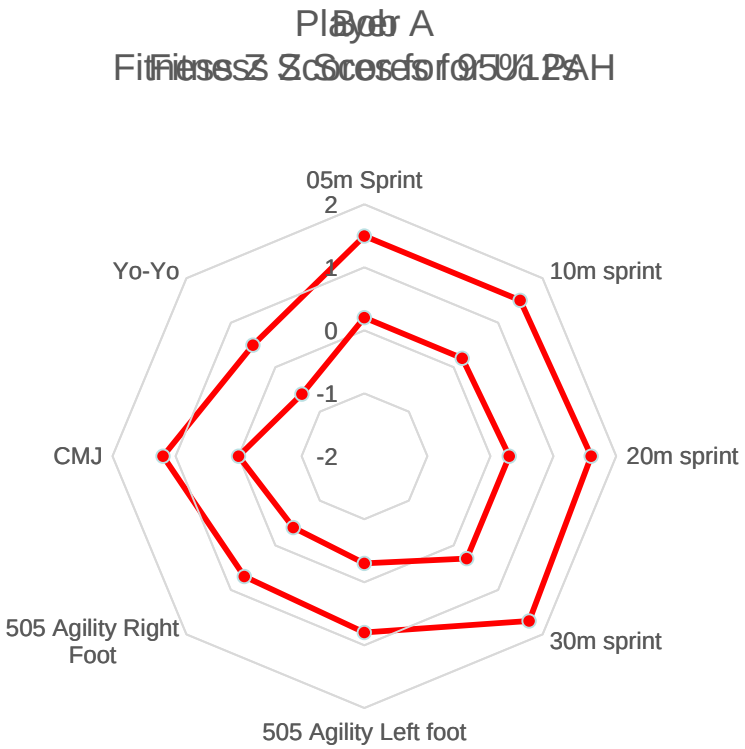
Maturation and relative age



Maturation and performance

- Allows athlete's fitness to be judged relative to maturity standards (%PAH) pooled from 29 clubs
- Identifies strengths and weakness from a developmental perspective



Maturation and measurement

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Maturation status and training

91.9%
PAH

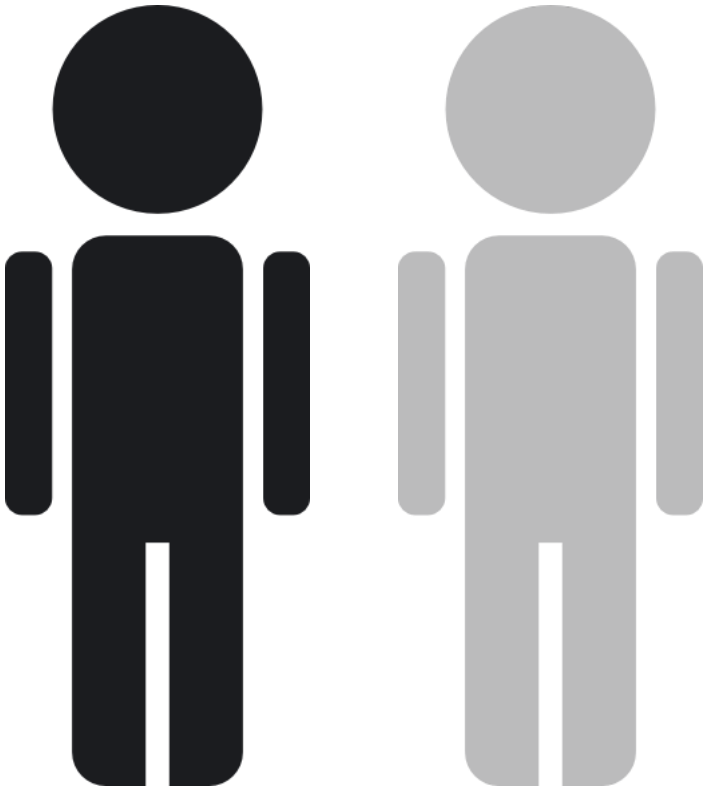
YOUTH PHYSICAL DEVELOPMENT (YPD) MODEL FOR MALES																			
CHRONOLOGICAL AGE (YEARS)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21+
AGE PERIODS	EARLY CHILDHOOD			MIDDLE CHILDHOOD							ADOLESCENCE									ADULTHOOD
GROWTH RATE	RAPID GROWTH ↔			STEADY GROWTH							↔ ADOLESCENT SPURT				↔ DECLINE IN GROWTH RATE					
MATURATIONAL STATUS	YEARS PRE-PHV ←												PHV		→ YEARS POST-PHV					
TRAINING ADAPTATION	PREDOMINANTLY NEURAL (AGE-RELATED) ↔												COMBINATION OF NEURAL AND HORMONAL (MATURITY-RELATED)							
PHYSICAL QUALITIES	FMS			FMS				FMS							FMS					
	SSS			SSS				SSS							SSS					
	Mobility			Mobility											Mobility					
	Agility			Agility								Agility				Agility				
	Speed			Speed								Speed				Speed				
	Power			Power								Power				Power				
	Strength			Strength								Strength				Strength				
	Hypertrophy										Hypertrophy		Hypertrophy							Hypertrophy
	Endurance & MC			Endurance & MC								Endurance & MC					Endurance & MC			
TRAINING STRUCTURE	UNSTRUCTURED			LOW STRUCTURE							MODERATE STRUCTURE			HIGH STRUCTURE				VERY HIGH STRUCTURE		

Figure 1. The YPD model for males. Font size refers to importance; light blue boxes refer to preadolescent periods of adaptation, dark blue boxes refer to adolescent periods of adaptation. FMS = fundamental movement skills; MC = metabolic conditioning; PHV = peak height velocity; SSS = sport-specific skills; YPD = youth physical development.

Maturation and training (cont.)

Donald

- 13.5 years
- Curr. 165cm
- 89% PAH
- Circa PHV
- Z Score = -0.2
- On time



Craig

- 13.5 years
- Curr. 165cm
- 97% PAH
- Post PHV
- Z Score = 2.2
- Early

Implications for Donald

Donald

- 89% adult ht.
- Circa PHV
- Z Score = -0.2
- On time

- Entering pubertal growth spurt; greater risk of epiphyseal injuries
- Closer monitoring of training load, FMS and sport specific skills
- Stay within age group for training/competition

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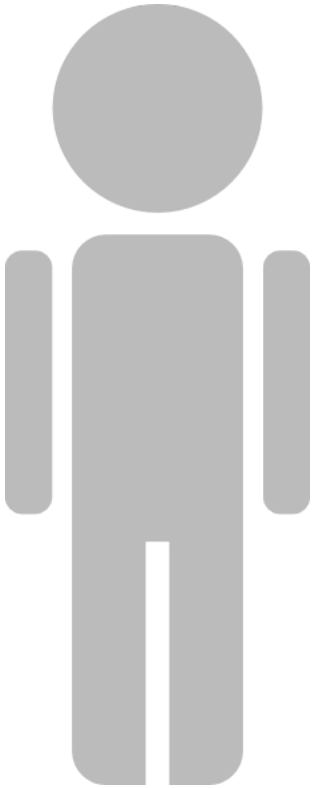
Implications for Craig

- Post-growth spurt; reduced risk of epiphyseal injury
- Benefits from combined training (neural & structural adaptation)
- Could train/play up an age; if technically / emotionally competent



Craig

- 97% adult ht.
- Post PHV
- Z Score = 2.2
- Very Early

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Bio-banding for competition

80-85%

85-90%

Under 12s

Under 13s

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Thank You

Any Questions?