

Biological Maturation in Youth Sports: Breaking Biases



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Maturation in Sports



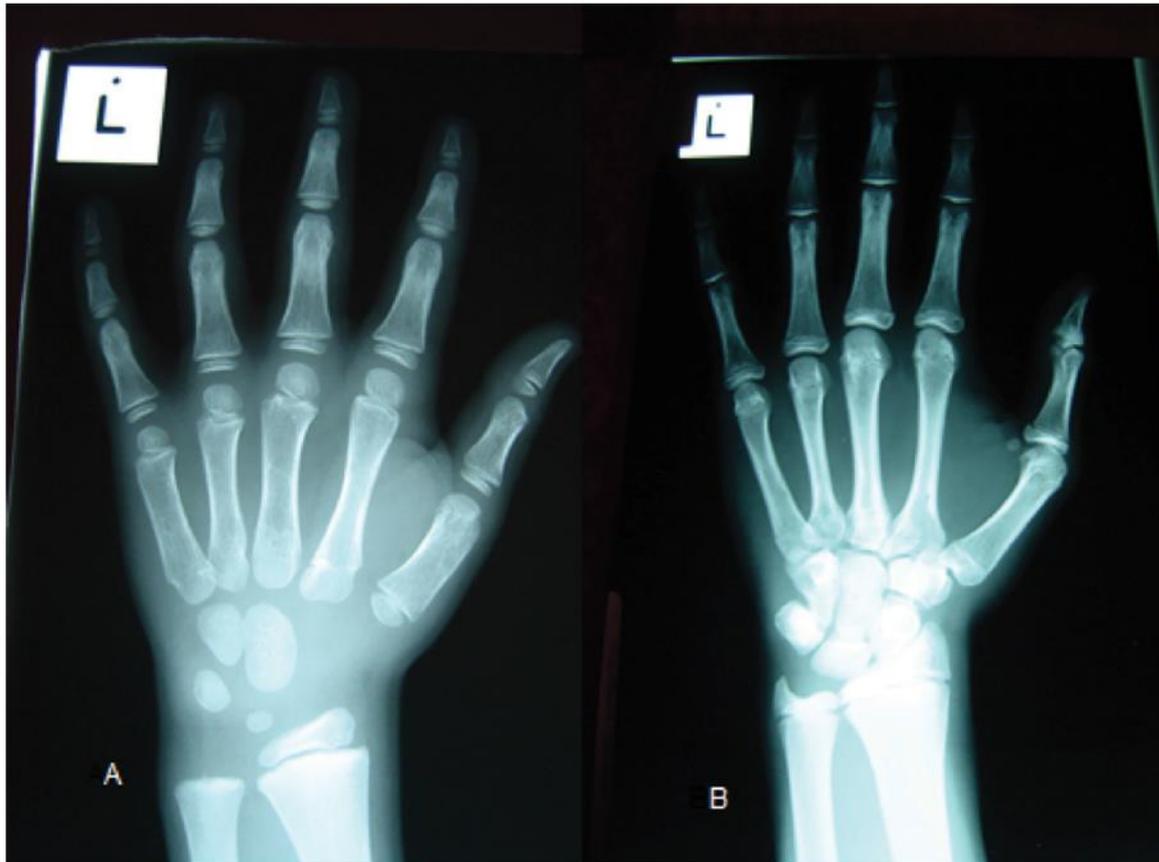
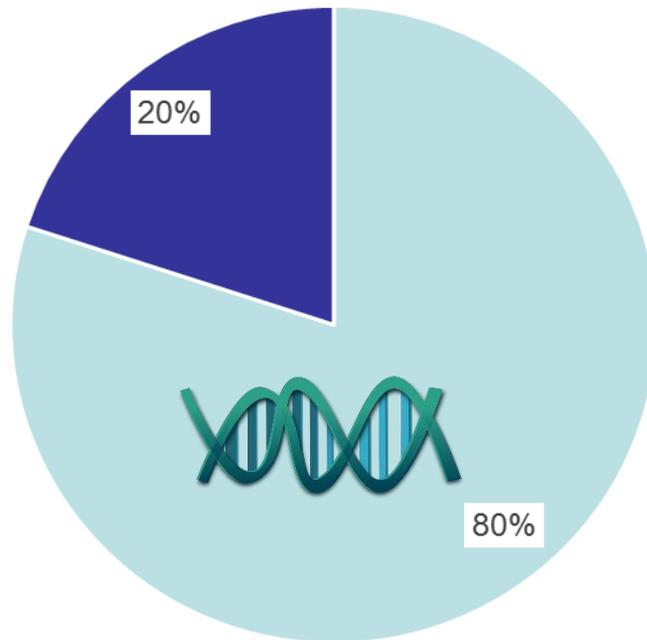


Figure 2: Two players with chronological birthdates within 1 week. Player A has a skeletal age of 6.3 years and player B 12.1 years, using the Fels method of X-ray assessment.

* Johnson et al., (2015) *Aspetar Sports Med J*, 4 (1)

What causes variance in pubertal timing?

Sources of Variance



■ Genetics ■ Environment



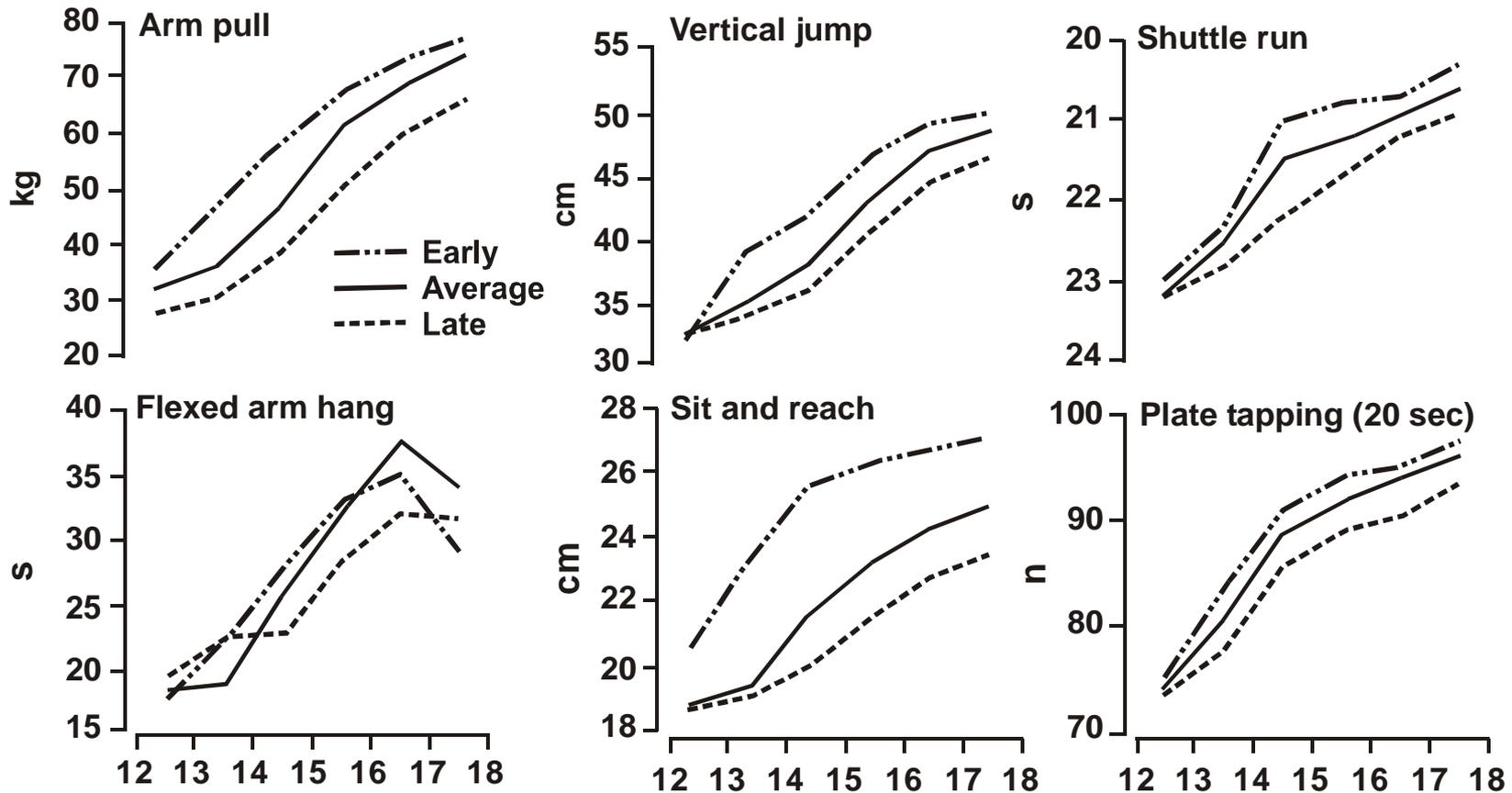
Early versus late developing boys



- **Larger** from 8 years; greater pubertal gains in height, weight, absolute/relative muscle mass
- **Superior** explosive /anaerobic power, strength, speed, agility, and endurance
- More **adaptive** psychological profile

* Malina, Rogol, Cumming et al., (2016) BJSM, 49 (13), 852-859

Pubertal timing and fitness in boys



* Malina et al., (2004) Growth Maturation and Physical Activity

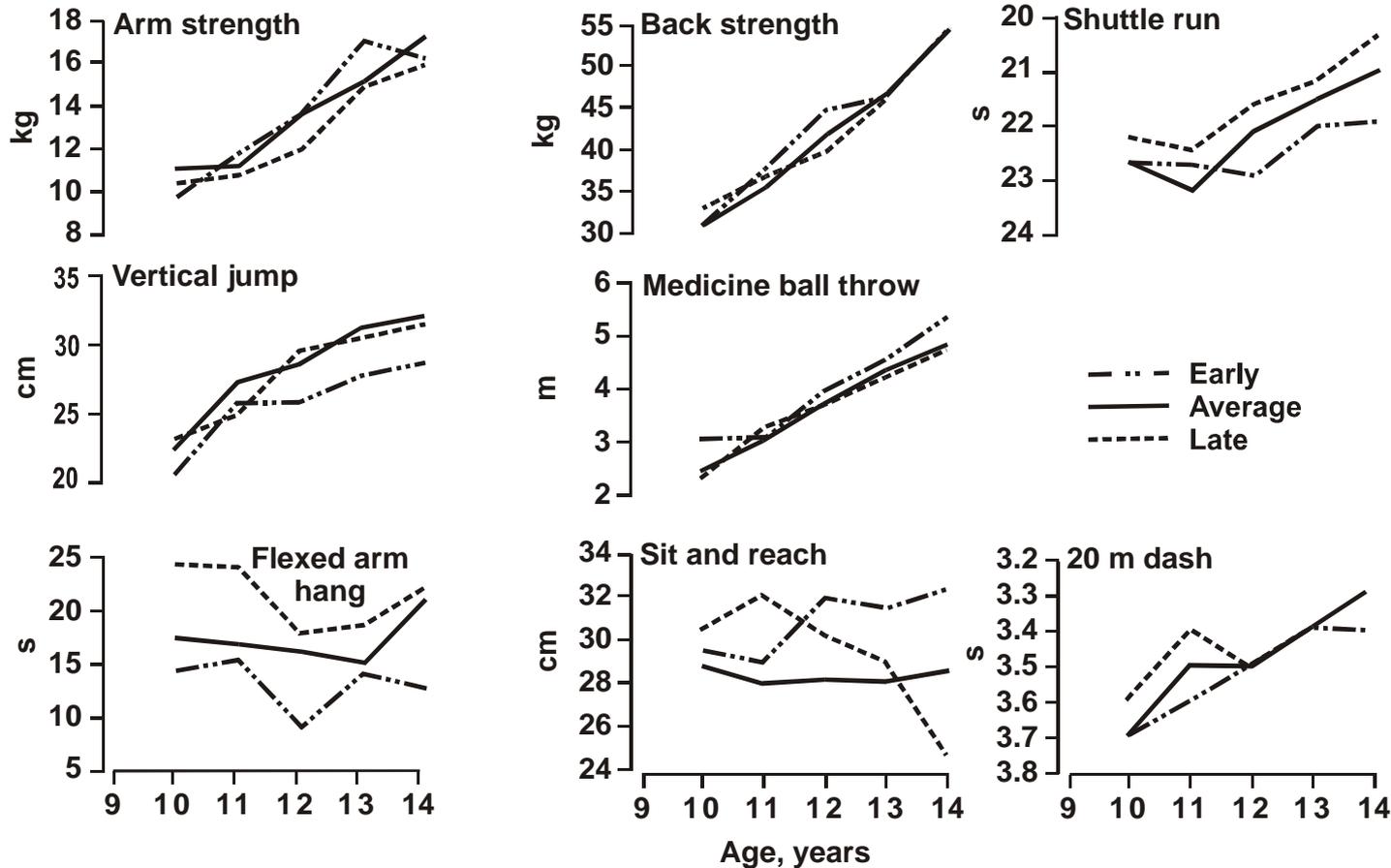
Early versus late developing girls

- Greater pubertal gains in height, weight, absolute/relative **fat mass**
- Superior strength, power; **poorer** endurance, speed, agility
- Less **adaptive** psychological profile;



* Malina, Rogol, Cumming et al., (2016) BJSM, 49 (13), 852-859

Pubertal timing and fitness in girls



* Malina et al., (2004) Growth Maturation and Physical Activity

What are the implications in sport?



Talent
Identification



Competition



Training

Talent ID and competition: Race to the bottom

- Sports **select** for children of varying maturing timing (i.e., early, on time, late)
- Selection **biases emerge at pubertal** onset; increase with age and level of competition



* Malina, Rogol, Cumming et al., (2016) BJSM, 49 (13), 852-859

Selection bias for early developers



American Football,
Soccer & Rugby

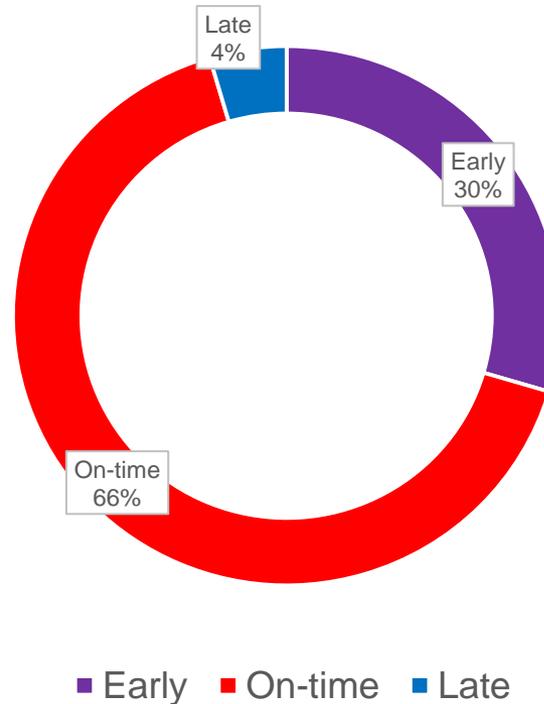


Boys and Girls
Tennis



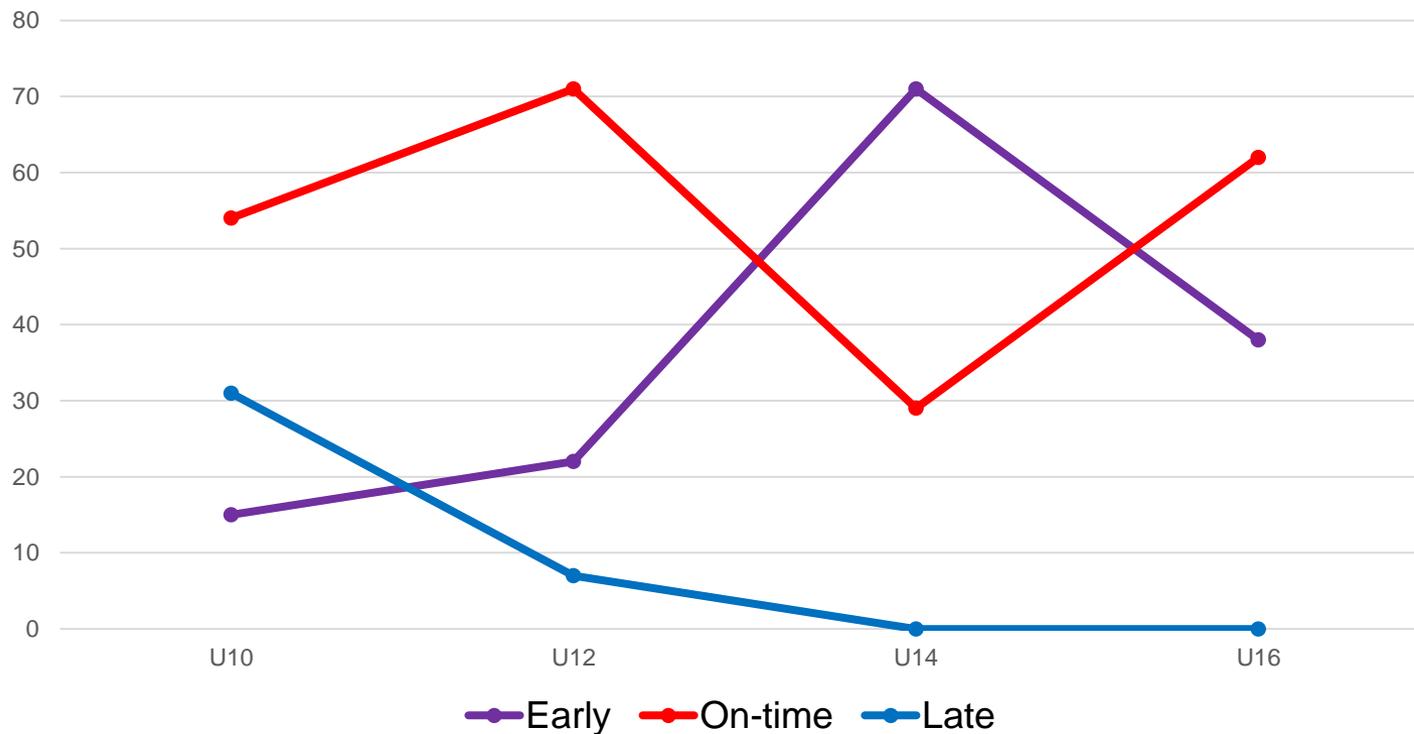
Boy's
Swimming and
Triathlon

The Percentages of Early, On-time, and Late Maturing Girls (10 to 16 years) in British Junior Tennis



* Myburgh et al., (2015) JSS; Myburgh et al., (2016) Ped Exerc Sci

Percentages of Early, On-Time & Late Maturing Boys at the Elite Level in Junior tennis



* Myburgh et al., (2015) JSS; Myburgh et al., (2016) Ped Exerc Sci



Maturation in Sports

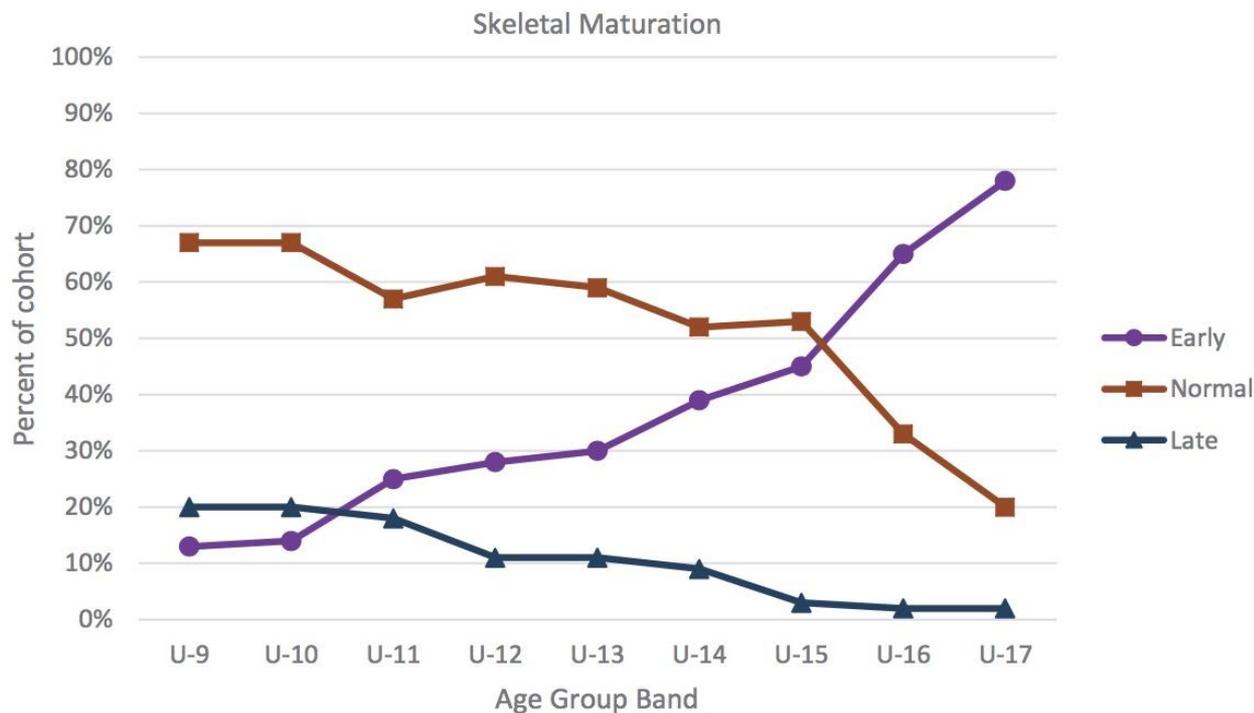


Figure 2. Skeletal maturation status for the entire cohort. Note the increasing prevalence of early maturing athletes as age increases at the expense of normal and late maturing athletes.

* Johnson et al., (2017) *Sci Med Football*, Feb, 1-7

Selection bias for late developers



Gymnastics and
diving

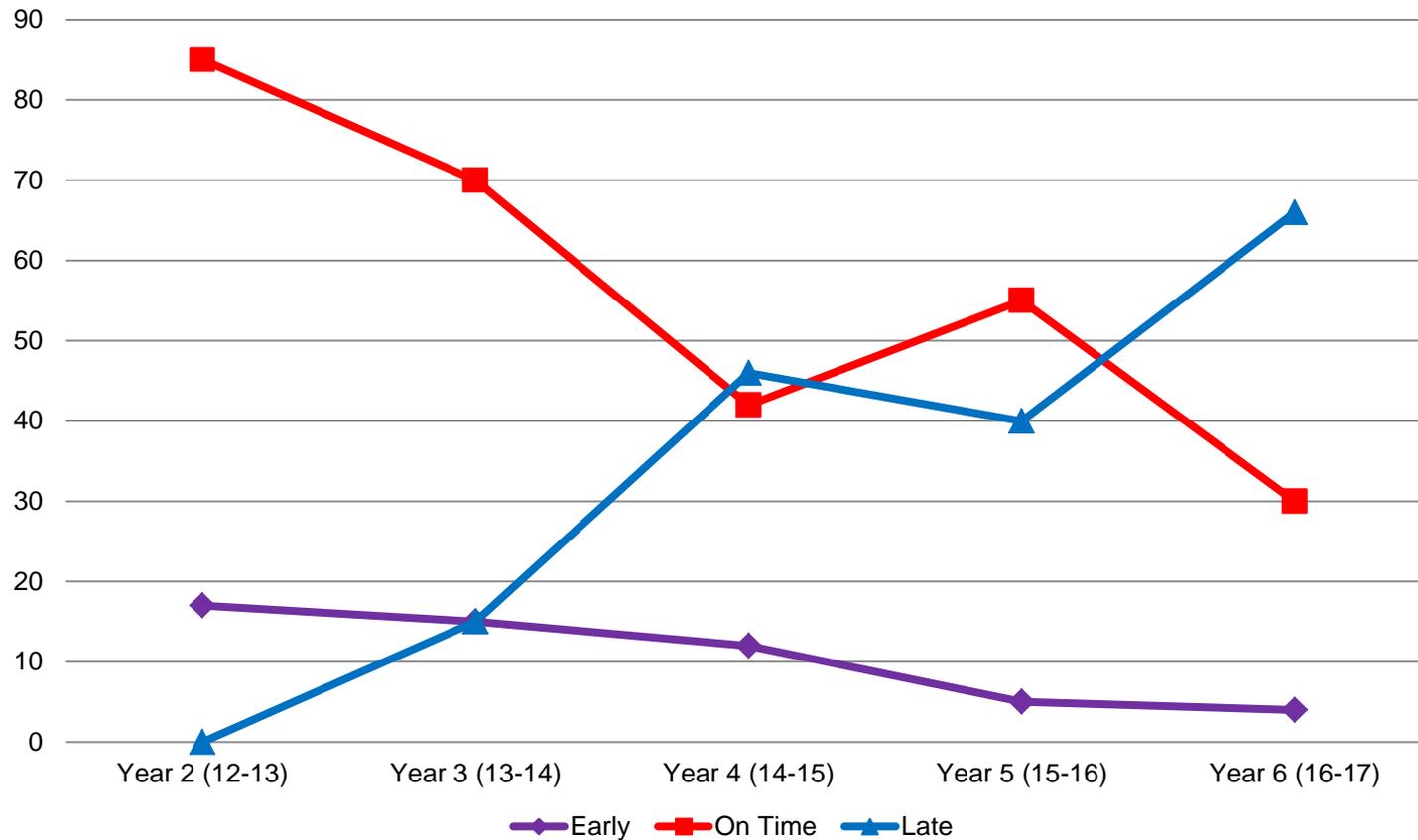


Dance



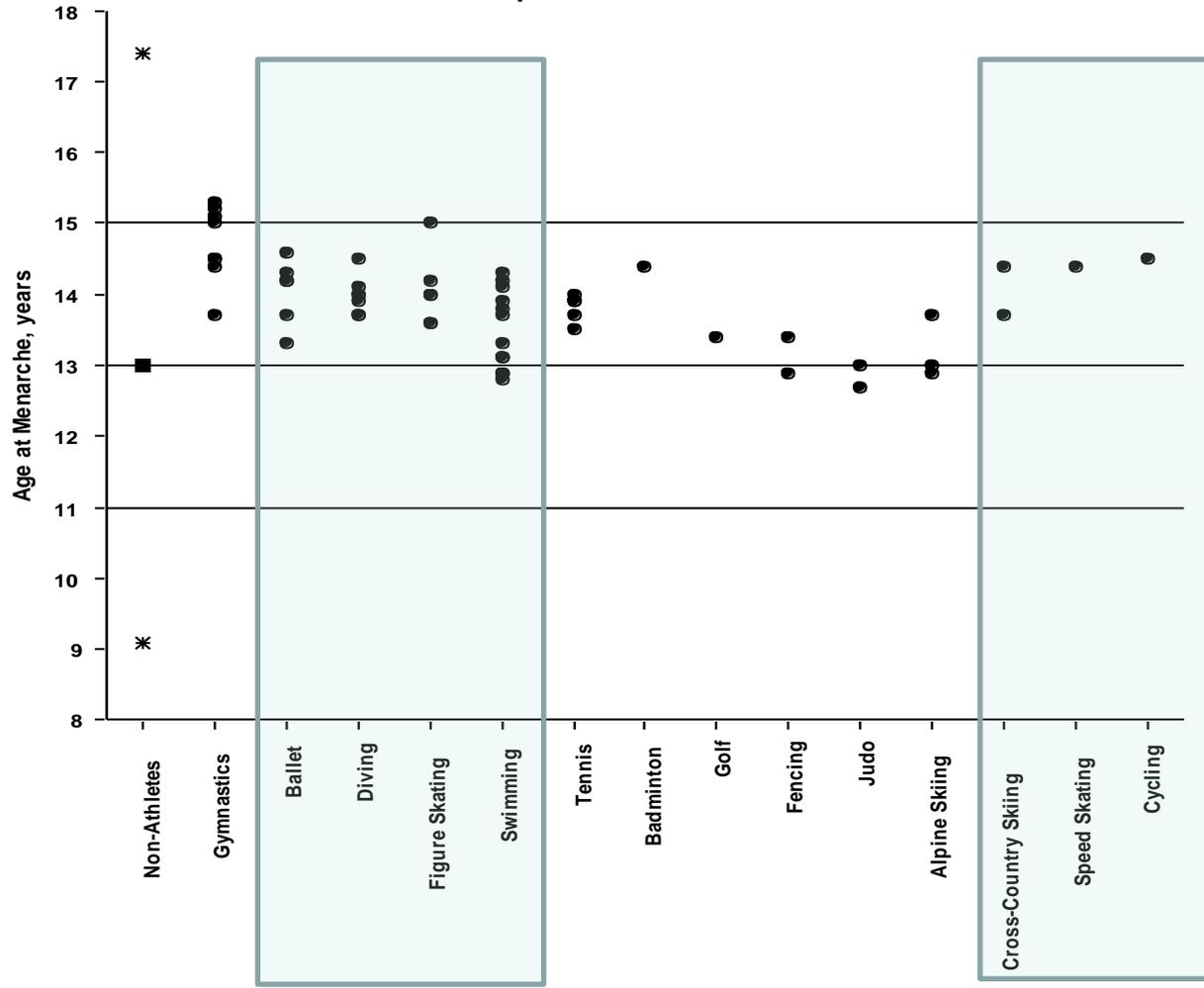
Distance running;
cross country

Pubertal Timing in Elite Female Ballet Students



* Mitchell (2017) University of Bath

Mean age of menarche in female athletes



Societal effects: The rich get richer*

- Most physically able young athletes identified talented; encouraged and **recruited earlier**
- Greater exposure to high level competition; **specialist coaching and training resources**



* Bloom & Sosniak (1985); Wattie *et al.*, (2008)

Growing concerns in youth sports

- Selection strategies **favour athletes** on the basis of physical attributes not realised until adulthood
- Physically gifted athletes play to their strengths; **neglecting** technical/tactical development
- Less physically gifted, yet equally talented, athletes **overlooked** or excluded too early



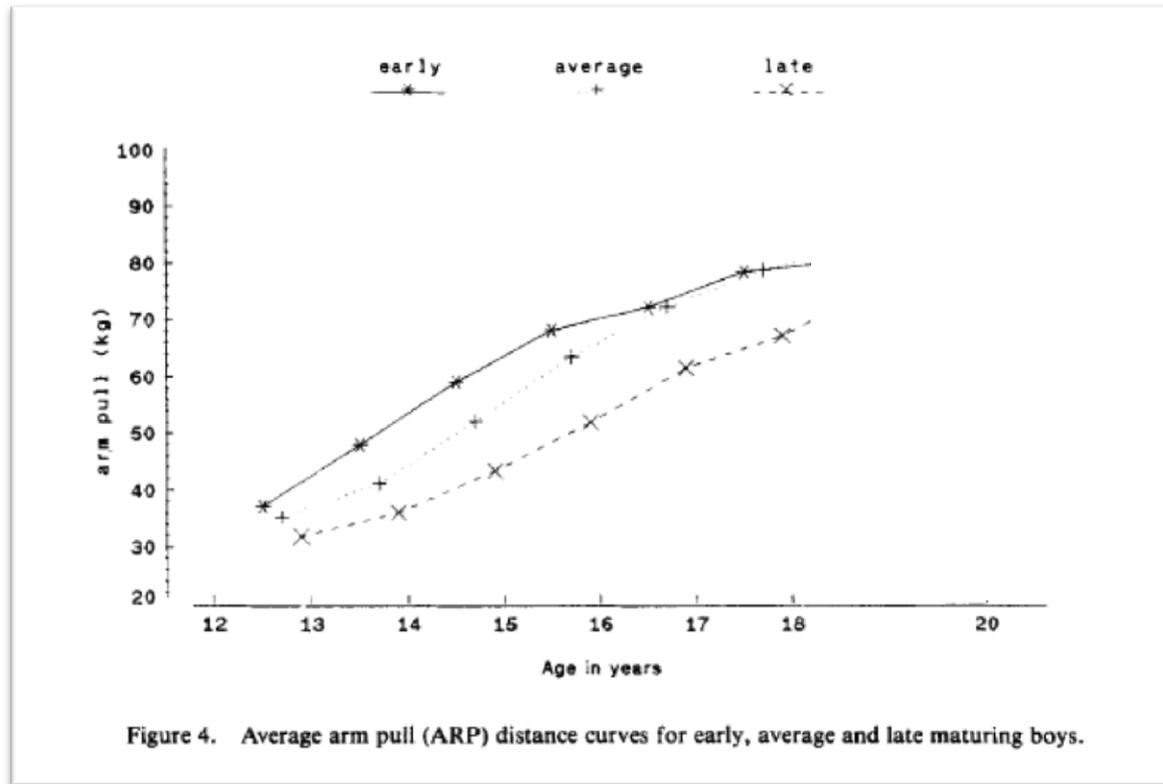
Seeing through the fog of maturation

*“The **biggest risk** was that we had erred in our assessment of a particular boy and could have used his slot to work with a more talented youngster. We had to wait a little longer to see the real potential in some boys, because **not everyone's physique develops at the same rate.**”*

- Sir Alex Ferguson (2015)

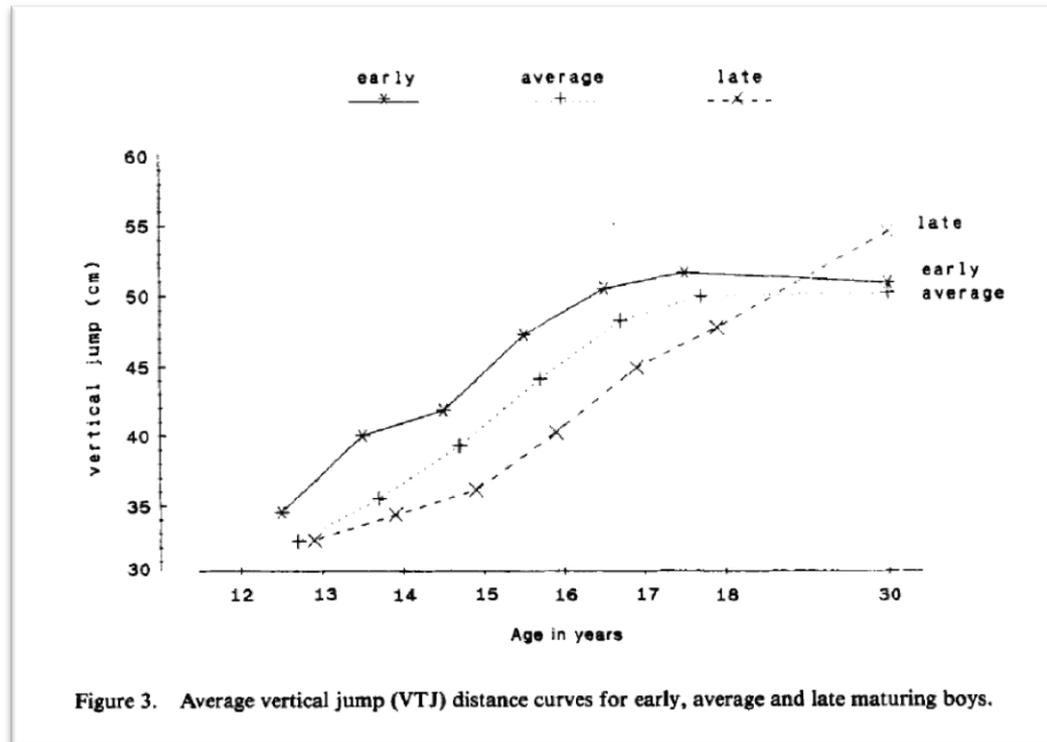


What you see is not what you get (**Strength**)



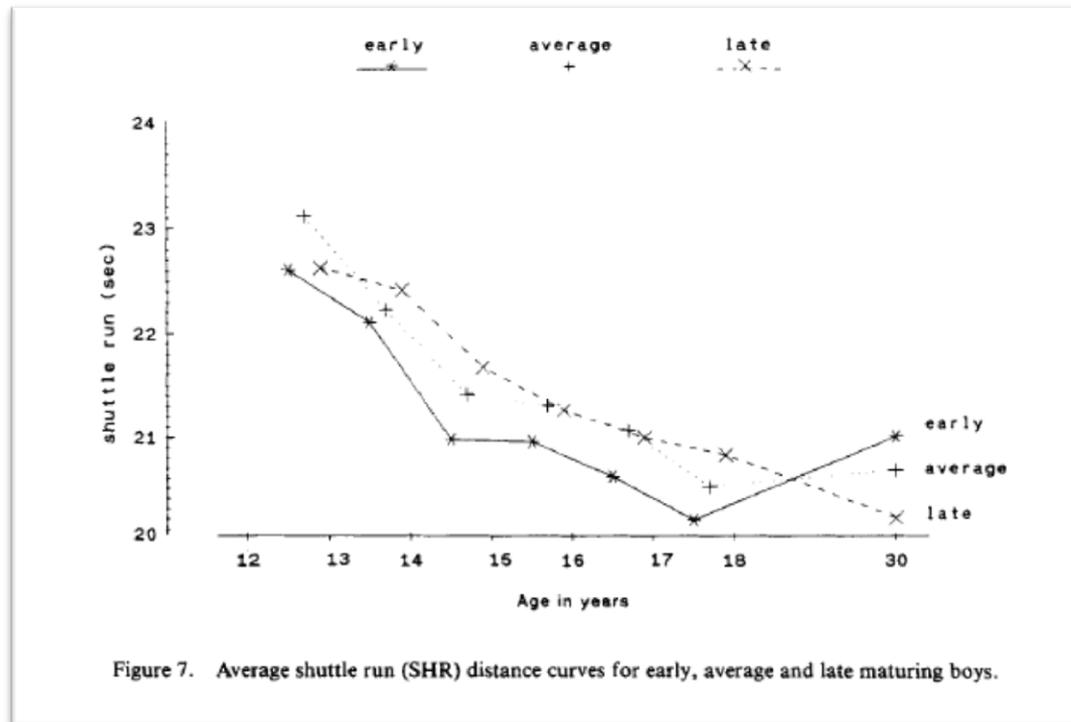
* Lefevre et al., (1990) Annals Hum. Biol., 17, 423-34

What you see is not what you get (**Power**)



* Lefevre et al., (1990) Annals Hum. Biol., 17, 423-34

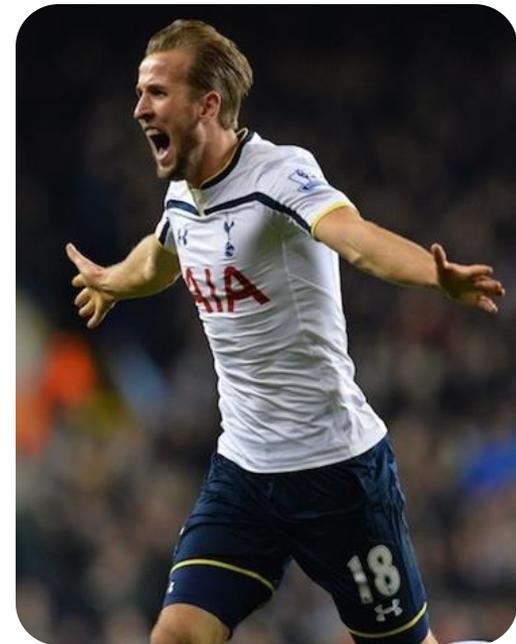
What you see is not what you get (**Speed**)



The haemorrhaging of talent

*"I was **small for my age**. I was a **late developer**.... it's hard to call a player at such a young age. After that I went to Spurs when I was 11. As I got older and older, **I grew up a bit, caught up to the rest** of the players my age and it went from there, really".*

- Harry Kane, Tottenham Hotspur & England



Training and maturation



Neural Adaptation



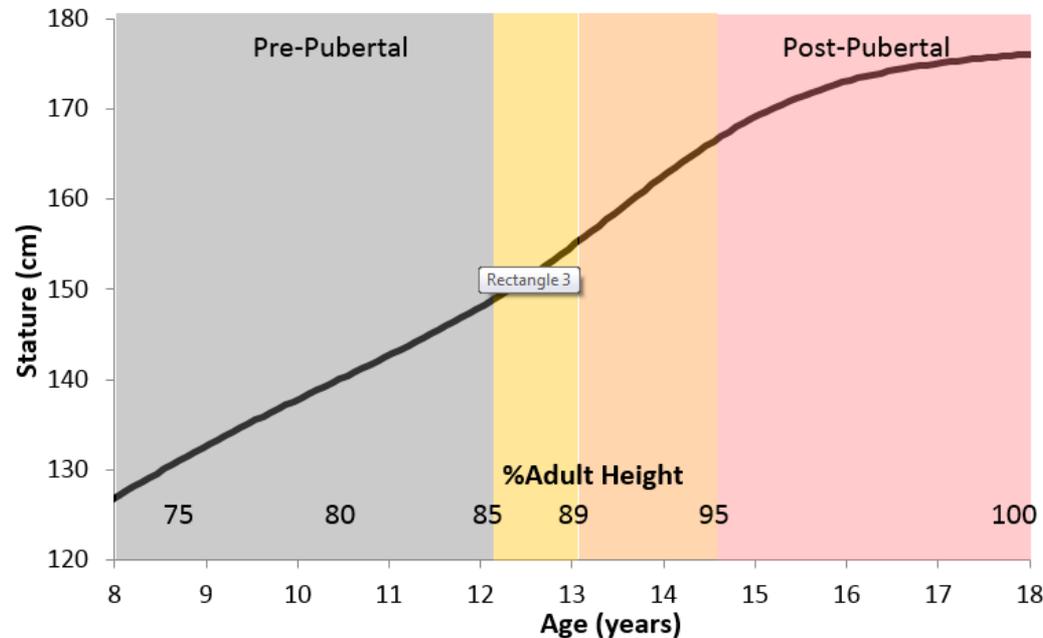
Structural
Adaptation



Metabolic
Adaptation

Matching training to maturational stages

Figure 2. Bio-bands of maturity for an individual male based on cumulative growth and percentage of adult height.



* Cumming, Lloyd, Oliver, Eisenmann, Malina (2017) Str Cond J

Physical Youth Development (Lloyd & Oliver, 2012)

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.

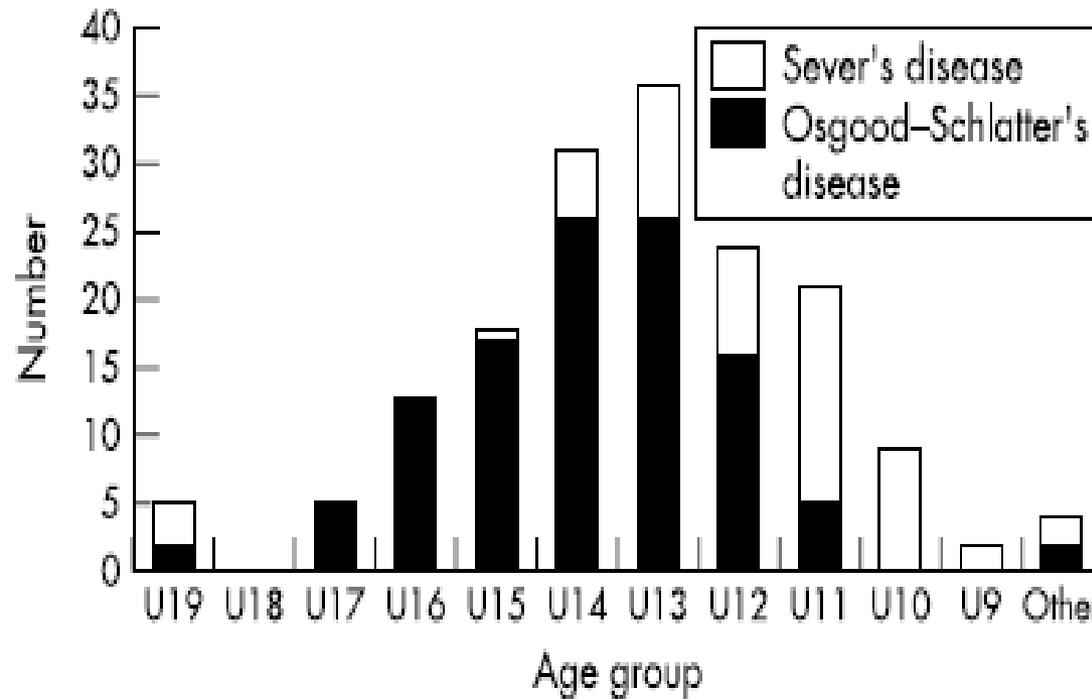
Maturation, training and injury

- Athletes **vulnerable to injury** during growth spurt; especially during heavy training loads (stress fractures, apophyseal injuries)
- Monitor symptomology and concomitant risk factors **adjust training** load/type accordingly to reduce risk; **



* Blanchard (2015) <http://blogs.bmj.com/bjism/2015>; ** Guerra et al., (2016) Acta Ortop Bras

Incidence of OSD and Sever's in Academy football *



* Price et al., (2004) Brit J Sports Med, 38, 466-471

Breaking biases – what are we doing?

- **Education** on growth and maturity
- Systematic **measurement** programs
- Developing maturity sensitive **strategies** for evaluation, training and competition



How do we assess growth and maturation? *

- Players regularly assessed for **height, seated height and weight**; heights of bio-parents
- Data used to **calculate maturity status**, maturity timing, growth velocity, age at PHV, future height

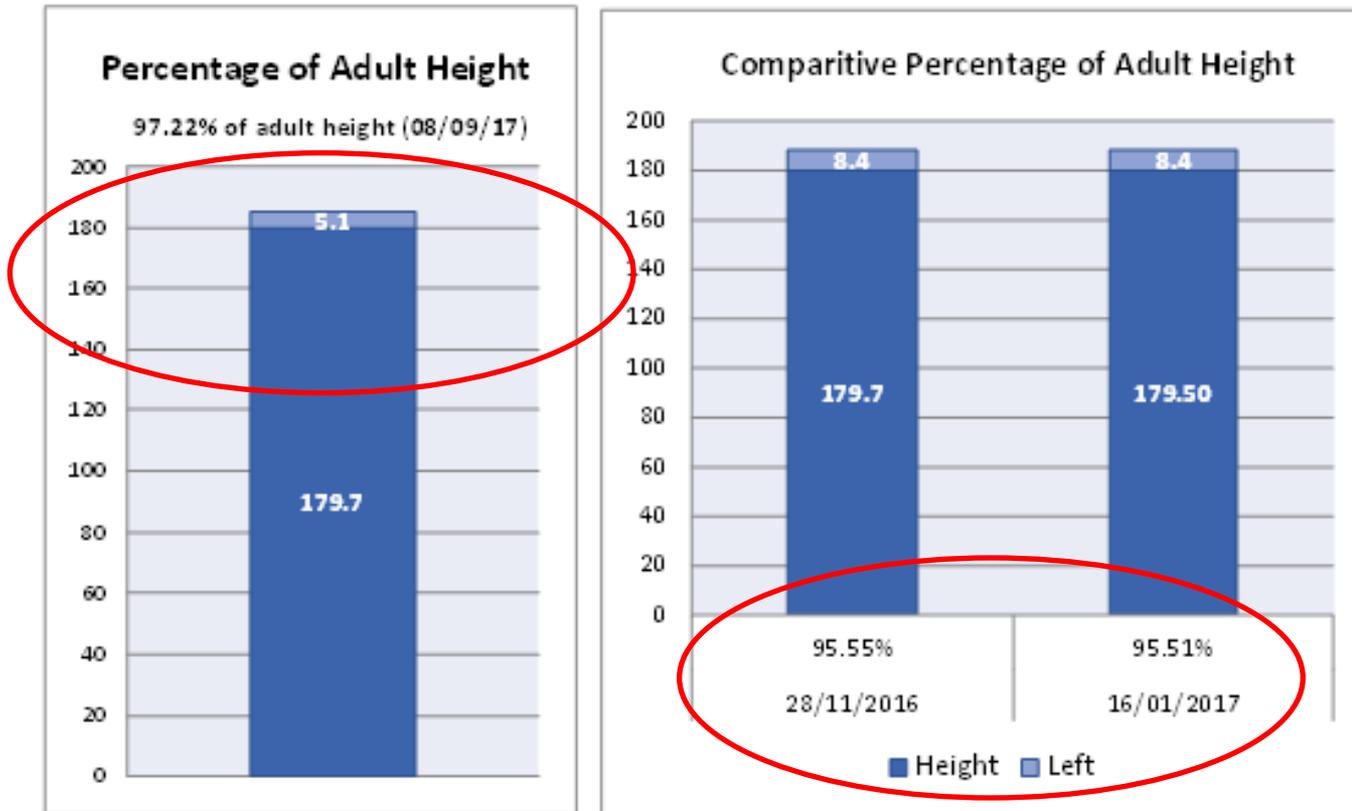


* Cumming, Lloyd, Oliver, Eisenmann & Malina (2017) Strength Cond J

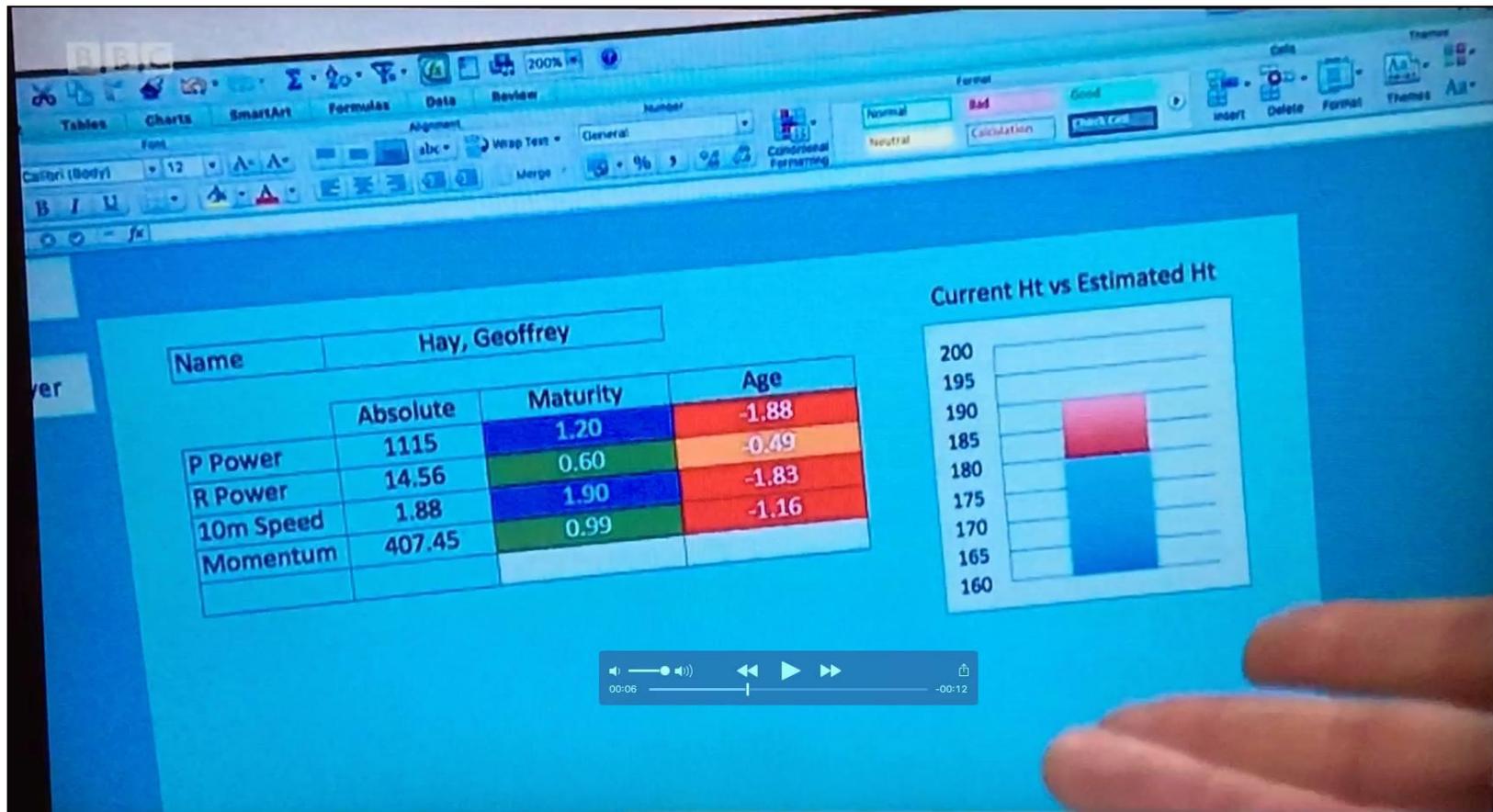
Monitoring growth in players



Assessing maturity (% predicted adult height)



Maturation and fitness testing



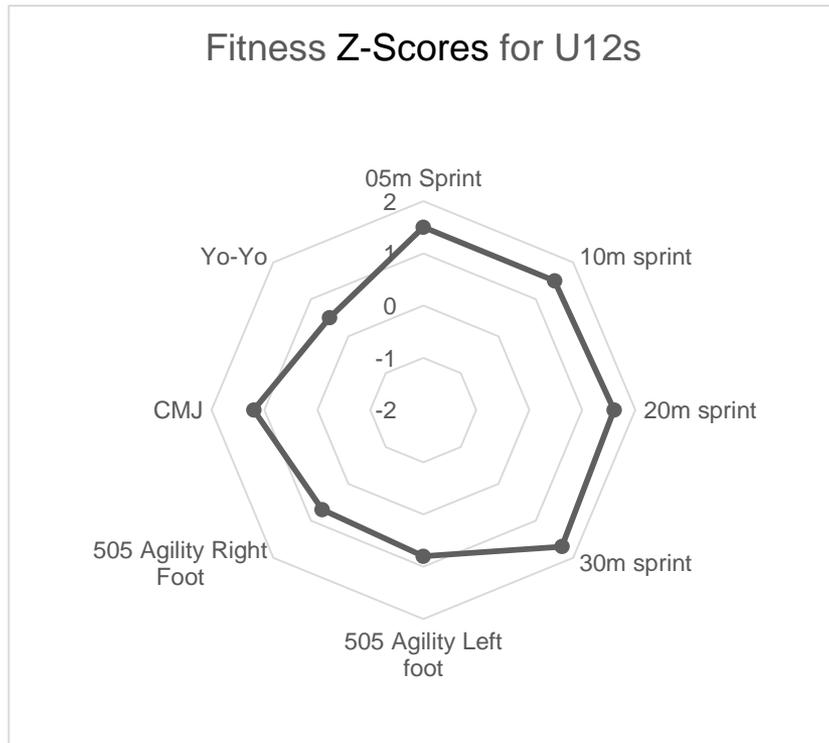
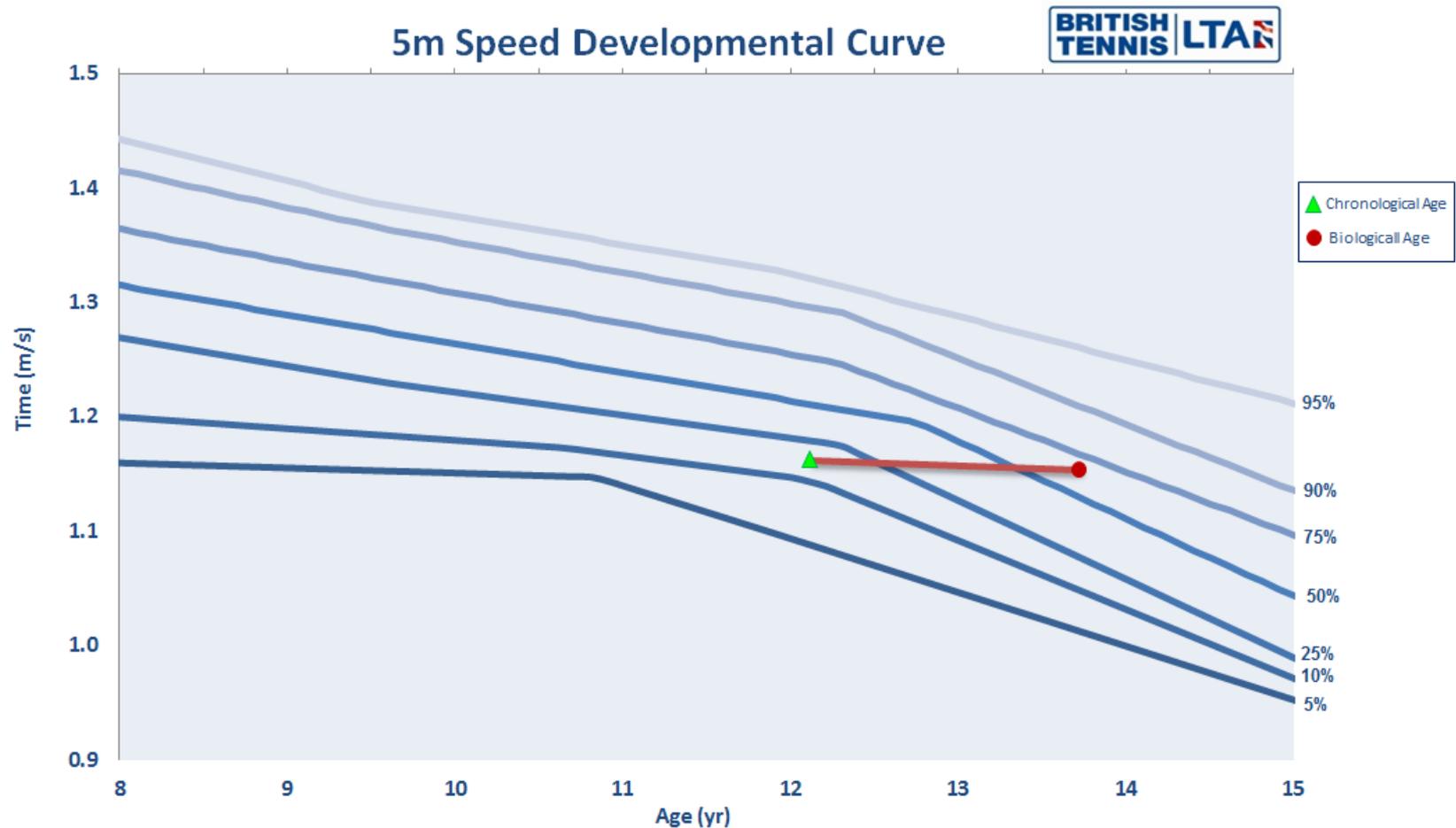


Figure 4: Player A's fitness attributes represented as Z-scores relative to age and maturity specific standards



Growth trajectories for performance



Bio-banded (maturity matched) training groups

Saints (97%+)				
Name	Age Group	% of Predicted Height	Predicted Height	Maturity Status
Harvey Head	U15	100.50(200)	182.21	1.02
Connor Langan	U15	99.65(210)	171.17	0.97
Neal O'Brien	U15	99.91(200)	182.4	1.01
Ben McKeown	U15	99.25(210)	182.03	0.99
Lynke Johnson	U15	99.2	181.3	0.99
Ben Cull	U15	99.76(210)	182.79	0.99
Ben Howarth	U15	99.91(200)	182.41	1.01
Olly Gardner	U15	99.80(200)	179.03	0.99
Oliver Long	U15	99.69(210)	182.4	0.99
Matthew McLaughlin	U15	99.74(200)	179.24	0.99
Jack Higgins	U15	99.05(200)	179.23	0.98
Stash McWhorter	U15	99.10(200)	179.27	0.98
James Shi	U15	97.92(210)	179.73	0.97
John White	U14	97.51(200)	179.23	0.96
Sam Gordon	U15	97.94(200)	179.23	0.97
Henry Woods	U15	97.99(210)	182.4	0.96
Mathew Wood	U15			

Saints (94-97%)				
Name	Age Group	% of Predicted Height	Predicted Height	Maturity Status
Billy Shadman	U15	99.99(210)	179.27	0.99
Adam Parke	U15	99.22(210)	182.4	0.95
Garmon Langan	U15	99.21(210)	179.27	1.01
Harry Hamilton	U15	99.2	182.03	0.99
Liam Doyle	U15	99.29(200)	182.07	0.99
Knutson Jones	U15	99.08(210)	179.23	-0.93
Wall Clowther	U15	99.07(200)	182.79	1.01
Ben Brooke	U14	99.21(210)	182.7	1.01
Louis Nymen	U15	99.29(210)	179.27	0.99
Will Donohoe	U15	99.72(200)	179.27	0.97
Shawn Carmo	U15	99.01(200)	182.7	0.99
George Wilshire	U15	99.01(200)	182.7	0.99
Alex Cull	U15	99.4	179.27	0.97
Tommy Willard	U14	99.91(210)	179.27	0.99
Jack Milton-Jones	U15	99.00(200)	179.27	-0.93
Harriet Hale	U15	97.91(200)	179.27	0.99

Saints (89-95%)				
Name	Age Group	% of Predicted Height	Predicted Height	Maturity Status
Harry Neughton	U14	97.66(200)	182.7	0.95
James Cook	U14	99.21(200)	182.7	-0.74
Ben Mendis	U15	99.29(200)	179.27	0.99
Joe Tomlinson	U15	99.29(200)	179.27	0.99
Liam Jacques	U15	99.08(200)	182.7	1.01
Jack Spence	U14	97.92(210)	182.7	0.97
Dan	U14	97.91(200)	182.7	0.99
Chris Dunbar	U14	97.92(210)	182.7	1.01
Ryan Clough	U15	97.92(210)	182.7	0.97
Josh Dennis	U14	97.92(210)	182.7	0.97
Callum Watts	U15	97.92(210)	182.7	0.99
Lewis Dix	U14	97.92(210)	182.7	-0.93
Joe Cole	U14	97.92(210)	182.7	-0.93
Harry Andrew-Ross	U15	99.01(200)	182.7	1.01
Joe Gubbins	U14	99.02(210)	182.7	0.99
Joel Bevan	U15	99.02(200)	179.27	0.99
Charlie Philpott	U15			

Saints (81-89%)				
Name	Age Group	% of Predicted Height	Predicted Height	Maturity Status
Williammet	U15	99.00(210)	179.27	0.99
Madison Hill	U14	97.92(210)	179.27	-0.97
Thomas Stone	U15	97.91(200)	182.7	0.99
Sam Bell	U15	97.91(200)	179.27	0.99
Seungwoo Park	U15	97.91(200)	179.27	0.99
William Taylor	U14	97.91(200)	182.7	0.99
Samuel Bradshaw	U15	99.01(200)	179.27	-0.93
Alfie Saunders	U15	99.01(200)	182.7	-0.93
James Morris	U15	99.01(200)	179.27	-0.93
Jack Turner	U15	99.00(200)	182.7	0.99
Samuel Jones	U15	99.01(210)	179.27	-0.93
Maxon Harrison	U15	99.01(200)	179.27	0.99
Sam Salmon	U15	99.01(200)	179.27	0.99
Luke Hallett	U15	99.01(200)	179.27	-0.93
Oliver Lovell	U15	99.01(200)	179.27	-0.93
Harvey Sinker	U15	99.01(200)	179.27	0.99
Dylan Morgan	U15	99.01(210)	179.27	-0.93
Madison Green	U15	99.01(200)	179.27	0.99
Sonny Ford	U15	99.01(200)	182.7	0.99
Erwan Clark	U15	99.01(200)	179.27	-0.93
Tommy Bevan	U15	99.01(210)	182.7	-0.93
Neddy De	U15	99.01(210)	179.27	-0.93
Wagdy Obeid	U15	99.01(210)	179.27	-0.93

* DePledge (2015) *Application of growth and maturation at Southampton FC*

Bio-banding for competition

- Athletes **matched by maturity bands** rather than chronological age
- Optimise **challenge and opportunity** for early and late developers, respectively



* Cumming et al. (2017) J Sports Sci



Maturation in Sports



Maturation in Sports



Benefits of bio-banding in soccer

- Early developers **report greater challenge**; rely more on technical and tactical abilities; have to think faster and adjust gameplay
- Late developers experience more success and opportunity to adopt leadership positions, and **use and demonstrate technical skills**



<http://www.premierleague.com/en-gb/news/news/2015-16/sep/170915-premier-league-bio-banding-helping-late-developers.html>



The early developer's perspective

*“it’s definitely made me move the ball quicker than I would and **I don’t use my strength as an advantage** as much as I do with my own age group”
(EM1, P4)*

*“You **learn a lot more** playing like this than you would normally playing with your age group” (EM2, P4)*

*“It made me **more confident**, playing with older boys, and getting used to the pace. Made me quicker on the ball.
” (EM1, P3)*



The late developer's perspective

*“in a normal game you might only be able to do a bit of magic twice, but in here, **every time you get the ball there is a chance** that you can do it” (LM1, P3)*

*“You're also **more composed on the ball**...there's not a massive 6' 5" player running up ...you know that it's somebody your size, you can push off as well as keep the ball” (LM1, P4)*

*“I feel like **it's given us more chance to stay at the club**... Finally, people have been realising that small players are good for the academies” (LM1, P1)*



Thank You

Any Questions?