

# AGE ESTIMATION WITH WRIST MRI; HOW ACCUATE IS MRI FOR YOUNG UGANDAN MALES

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# Learning objectives

- To recognize the need for accurate age estimation in young individuals enlisted for sports competitions.
- To discuss the different methods used for age estimation: x-ray, ultrasound , MRI
- To review the accuracy of MRI of the wrist in estimating bone age in young Uganda African males.

# BACKGROUND

- Accurate biological age determination is needed for various reasons: sports (age-related sports to ensure fair-play), medical and medical legal purposes, immigration
- XRAY has been mainstay in age estimation
- Disadvantage: ionizing radiation in a young age group.
- MRI has emerged as a reliable method and now accepted by FIFA.
- Reliability of available age charts for African black populations not yet published
- This study sought test the reliability of available MRI criteria by Dvorak to our patient population.

# Plain film radiography for bone maturity

Radiography was the mainstay for bone age estimation from the 1950s' using Greulich/Pyle charts.

*Greulich W, Pyle S. Radiographic atlas of skeletal development of the hand and wrist, 2nd edn. Stanford: Stanford University Press, 1959.*

# Ethnicity and bone maturity

Several studies using radiography for age estimation have demonstrated ethnic differences in bone maturity

- Bone age exceeded chronological age in Black Americans and lagged behind in whites.

*Ontell FK et al; Bone age in children of diverse ethnicity. AJR Am J Roentgenol 996;167:1395-8.*

- Pre-pubertal American children of European descent have significantly delayed skeletal maturation when compared with those of African descent;

Moras S et al. [Pediatr Res.](#) 2001 Nov;50(5):624-8. Skeletal age determinations in children of European and African descent: applicability of the Greulich and Pyle standards

# MRI offers an reliable non-ionising alternative to radiographic age determination

Age determination by magnetic resonance imaging of the wrist in adolescent male football players

Jiri Dvorak, John George, Astrid Junge, Juerg Hodler

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*Br J Sports Med* 2007;41:45–52. doi: 10.1136/bjism.2006.031021

**Background:** In football there are established age-related tournaments for males and females to guarantee equal chances within the game for all the different age groups. To prevent participation in the incorrect age group, and owing to the fact that in some Asian and African countries registration at birth is not compulsory, other methods of age determination need to be available. Standard radiographs of the left wrist have been used for assessment of skeletal age for many years. This is, however, not ethical in the sporting environment.

**MRI of the wrist offers an alternative as a non-invasive method of age determination in 14–19- year-old male adolescents.**

# MRI accuracy correlates well with plain-x-ray grading of radial fusion

- MRI has good correlation with plain radiograph fusion ( $r=0.949$ )
- Mean of x-ray grading is higher than the MRI in the 15, 16, 17, 18 and 19 years age-group
- x-rays significantly overrate the grading of fusion in the 15, 16, 17, 18 and 19 years age-group
- X-ray not to be used to exclude players in older age groups because it overrates.

# MRI age estimation is a viable tool for under-17 year males

Application of MRI of the wrist for age determination in international U-17 soccer competitions

Jiri Dvorak, John George, Astrid Junge, Juerg Hodler

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*Br J Sports Med* 2007;41:497-500. doi: 10.1136/bjism.2006.033431

**Background:** To guarantee equal chances for different age groups, age-related tournaments for male and female players have been established in soccer. However, as registration at birth is not compulsory in some countries, other methods of age determination are needed to prevent participation in the incorrect age group.

**Objectives:** To evaluate the age of soccer players of international U-17 competitions from the degree of fusion of the distal radius and to compare the findings with an age-related normative population.

**Methods:** MRI scans of the wrist of a representative sample of 189 players from four U-17 competitions (FIFA U-17 World Cups 2003 and 2005, and Asian (AFC) U-17 championships 2004 and 2006) were analysed

**MRI investigation of fusion of the left distal radius is a viable tool to estimate the age and degree of maturity of players in U-17 soccer competitions.**

# MRI of wrist has moderate correlation with chronological age in young Egyptian players



Contents lists available at [ScienceDirect](#)

The Egyptian Journal of Radiology and Nuclear Medicine

journal homepage: [www.elsevier.com/locate/ejrnrm](http://www.elsevier.com/locate/ejrnrm)



Age determination by MR imaging of the wrist in Egyptian male football players. How far is it reliable?



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Sixty-one football players between 13 and 18-year-old

Three independent raters assessed the degree of fusion of the left radius using 6 category grading system .

Moderate correlation between the MR skeletal age with the chronological age

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# MRI had good correlation in young Iraq males

[Original Article](#)

## Magnetic resonance imaging of the left wrist: assessment of the bone age in a sample of healthy Iraqi adolescent males

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### *Abstract:*

**Background:** Use of magnetic resonance imaging (MRI) to calculate skeletal age is a novel idea. MRI provides excellent soft-tissue contrast and multiplanar cross-sectional imaging capability. It could be used as an alternative method of skeletal age determination.

**Objectives:** To study the value of MRI in estimating the age of healthy Iraqi adolescent males and to

There is high correlation between chronological age and degree of fusion of distal radius.

Most adolescent boys in the age group between 13 and 14 years presented as grade I and II.

Complete fusion was found at the age of 17 and 18 years.

# MRI not recommended in under 17-year female players

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## MRI of the wrist is not recommended for age determination in female football players of U-16/U-17 competitions

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Because of earlier osseous maturity in female adolescents, the grade of fusion of the distal radial epiphysis on MRI is not recommended for pretournament age determination for the age of 17 and younger in female.

*Tscholl et al. Scand J Med Sci Sports* 2016; 26: 324–328

# Ultrasound reported to have acceptable accuracy

- Diagnostic accuracy of US in bone age determination by width of distal radius growth plate (n=82).
- Three age categories: < 16 and > 16 years, < 17 and > 17 years, and < 18 and > 18 years.
- Cut-off point for each category, based on the width of the growth plate
- US showed acceptable diagnostic sensitivity and specificity.
- Disadvantage of US measurements: operator dependant

# Method 1

- Total of 45 Ugandan African males age 13-19
- Scheduled for national and international football games.
- 1 disqualified : age on birth certificate  $> 18$  years.
- Known and certified age by birth
- Consent from those  $>18$  years, and assent  $<18$  years
- Coronal T1W images of LEFT wrist, 3mm thickness
- 1.5 Tesla, dedicated wrist-hand coils.
- 2 radiologists, blinded to the participants age by birth certificate; read independently, then convened together to agree by consensus
- Left wrist reading was used
- Participants 6 months past their birthday were considered as attained the subsequent year

# Methods 2

## *Exclusion criteria*

- No birth certificate excluded from study
- Known h/o disease which could affect bone growth
- H/o bone injury and h/o past surgery on the wrist.

## *Analysis*

- Proportions were used due to small sample size.

## *Classification of age*

- Classification quoted from Dvorak et al was used

# Classification of ossification or fusion of the radial wrist epiphysis (Dvorak)

- Grade I : Completely unfused = **13 yrs**
- Grade II : Early fusion: minimal hyper intensity within the physis = **14 yrs**
- Grade III: Trabecular fusion of <50% of the radial cross-sectional area = **15 yrs**
- Grade IV: Trabecular fusion of >50% of the radial cross-sectional area = **16yrs**
- Grade V: Residual physis, <5mm on any one section = **17yrs**
- Grade VI: Completely fused = **18ys +**

*Dvorak et al: Br J Sports Med 2007;41:497-500. n= 189, MRI overrates in 17-27% in U- 17 players compared to normative population*

# Results

# Category I



Grade/ Category I : Completely un-fused = 13 yrs

# Grade III



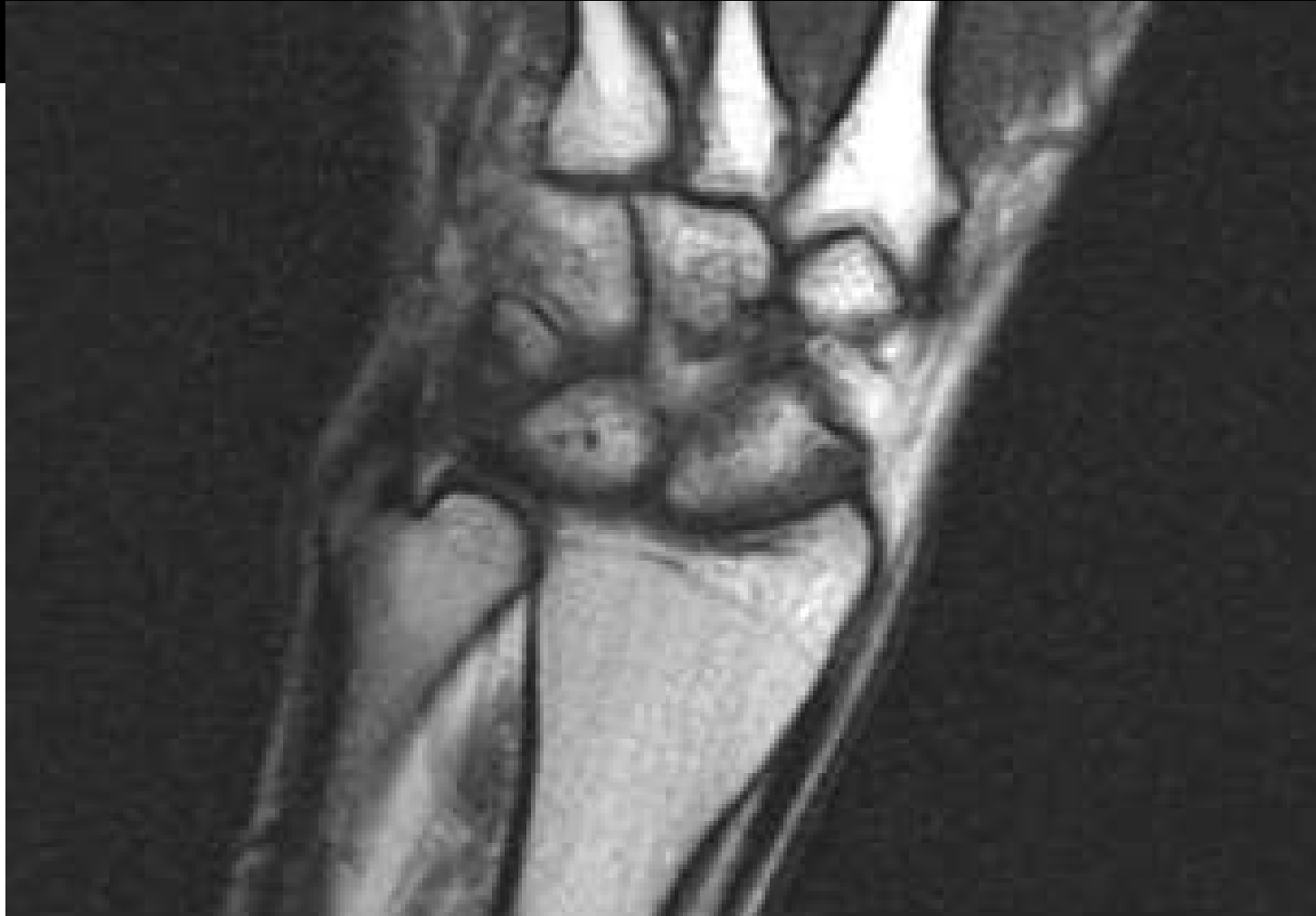
Grade/category II : Early fusion: minimal hyper intensity within the physis  
= 14 yrs

# Grade IV



Grade III: Trabecular fusion of <50% of the radial cross-sectional area = 15 yrs

# Grade V



**Grade V: Residual physis, <5mm on any one section =17yrs**

# GRADE VI



Grade VI: Completely fused =18ys +

# Individuals within the Dvorak grades.

- 9 individuals had MRI grade II (14 years)
- 7 individuals had MRI grade III (15 years)
- 3 individuals had grade IV (16 years)
- 23 individuals had grade V (17 years)
- 3 individuals had grade VI (18 years)
- One individual disqualified because age by birth certificate was 19 years.-not qualify for youth competitions

MRI age grade	Total number (#) in grade	MRI age agrees with birth (#)	MRI age is higher than age by birth (#)	MRI age is lower than age by birth (#)	Comment
Grade II (14 yrs)	9	2	0	7	MRI under-estimates in 77%
Grade III (15 yrs)	7	3	0	4	MRI under-estimates 57%
Grade IV (16 yrs)	3	1	2	0	MRI over-estimates in 60%
Grade V (17 yrs)	23	0	23	0	MRI over – estimates in 100%
Grade VI (18 yrs +)	3	0	3	0	MRI over-estimates 100%
<b>TOTAL</b>	<b>45</b>	<b>6 (13 %)</b>	<b>6 (62%)</b>	<b>13 (24 %)</b>	

# Discussion

- This is a small sample size but we still derive the following:
  - There is lack of correlation between MRI and age by birth in the majority of participants (89%) .
  - Correlation is weakest for grade; VI, V and VI (above 16 years) where MRI tends to over-estimate the age.
  - **MRI tends to over-estimate individuals in older age groups (MRI tends to over-estimate individuals in age category V-VI)**
  - For individuals 15 years or younger, **MRI tends to under the age (MRI tends to und-estimate age in category II and II)I.**

# Conclusion

- Age by MRI does not agree with the age by birth in most of our participants
- MRI under-estimates up to 70% of individuals below 15 years and over-estimates 97% of individuals above 16 years and above.
- There may be need to be cautious while using MRI age estimation especially with grades IV, V and VI.
- Individuals in higher age categories may be unfairly disqualified from participating because of an abnormally higher MRI age estimate.
- There is need for a large sample size for definitive conclusions

# Take home

- Accurate age estimation is important so as not to disqualify deserving young sportsmen from competitions
- X-ray, ultrasound, MRI have been used for age estimation but US is preferred since it is non-ionising, reproducible and fairly accurate for most populations
- MRI may over-estimate age in young African males and should be used with caution for age estimation.
- Larger studies are required to confirm this and re-visit the MRI age-criteria for this population.



*Thank You*