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Estimation of bone age by MRI of footballers under 17 years of age at CNHU-HKM of Cotonou in Benin

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Abstract
Introduction: Age fraud in top-level sport is a topical issue, particularly for footballers under the age of 17, and especially in countries where birth registration is not systematic. Magnetic resonance imaging (MRI) is often used to detect the bone age of footballers.
The objective of this study was to describe the role of MRI in determining bone age.
Materials and Methods: retrospective and descriptive study over a 4-month period from April to July 2024. All players who underwent MRI of the left wrist to detect bone age were included. The protocol consisted of a T1 SE coronal sequence of the left wrist
Results: 54 male players of Beninese nationality were examined. They had no known pathology. According to their administrative documents, they were all aged 17 or under. The average age declared was 14.18 ±1.04 years with extremes of 12 and 16 years. The distribution of players according to the stage of fusion of the radial physis was as follows: I (11.11%), II (20.37%), III (22.22%), IV (18.51%), V (22.22%) and VI (5.55%). As a result, 53.7% of players were aged < 17 years. The concordance between the declared civil age and the age detected on MRI was 29.63%.
Conclusion: MRI contributed to the estimation of bone age in players, thereby limiting fraud in this area.

Keywords: CNHU-HKM, Cotonou, Benin, MRI, bone age, wrist, footballer

1. Introduction
Age fraud in top-level sport is a topical issue, particularly among footballers under the age of 17. The age recorded on official documents (passports, birth certificates), which determines a player's eligibility, is often not the player's real age. This situation is exacerbated in countries where registration at birth is not compulsory or systematic. Bone age determination is often requested to guarantee equal opportunities [1].
There are several reliable methods for an appropriate assessment of real age [2, 3].
Standard X-rays of the left wrist have been widely used to assess skeletal age. Magnetic resonance imaging (MRI) of the wrist of the left upper limb has replaced standard X-rays of a part of the skeleton as being imprecise and irradiating [2, 4]. MRI has become the reference technique with good inter-observer reproducibility and correlation between skeletal age and civil age [5].
The objective of this study was to describe the role of MRI in determining bone age.

2. Material and Methods
This was a descriptive with retrospective collection study conducted in the MRI unit of the CNHU-HKM university medical imaging clinic over a 4-month period from April to July 2024.
All players who underwent MRI of the left wrist to detect bone age were included
All examinations were performed with a SIEMENS MAGNETOM AMIRA 1.5 Tesla MRI according to the protocol, which consisted of a T1 SE Coronal sequence of the left wrist.
When the players arrived, their presence and identity were checked. Identity and civil age were checked by means of a national identity card or a valid passport.

The preparatory conditions for an MRI examination were met. The technique consisted of placing the subject in the procubitus position, with the arm above the head, the left wrist extended in a surface antenna, and the 3rd metacarpal aligned with the radial axis. The images were read by two separate radiologists, who then compared their results.
The images collected were compared with those of the Fédération Internationale de Football Association (FIFA) reference chart [5], which (Figure 1) is a classification of the stage of fusion of the left distal radial physis as follows:

- **Stage I:** Absence of fusion of the cartilage.
- **Stage II:** Beginning of fusion (PUNCTIFORM).
- **Stage III:** Fusion less than 50%.
- **Stage IV:** Fusion greater than 50%.
- **Stage V:** Residual physis less than 5 mm.
- **Stage VI:** Complete fusion.

The stages of fusion of the inferior radial physis correlated with age. Stage I corresponds to an age of 14 years, then age increases by one year with the stages.

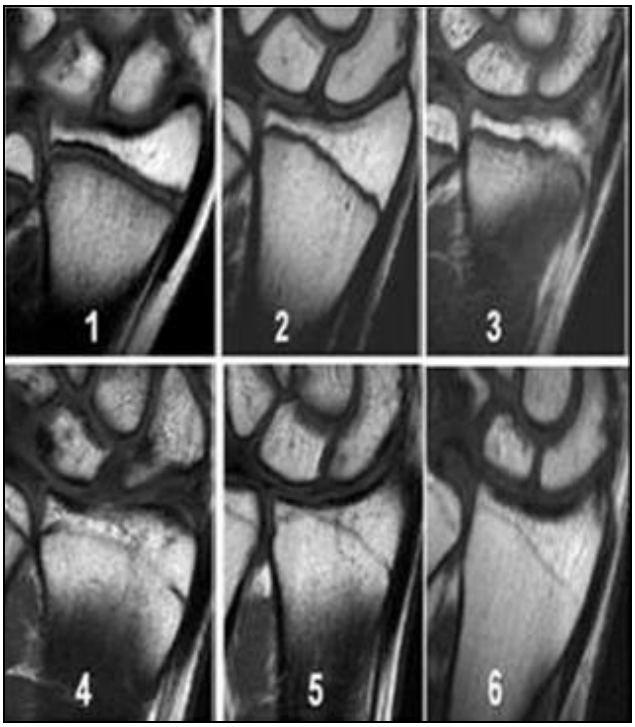

Fig 1: Classification of the stage of fusion of the left distal radial physis

The variables studied were epidemiological data including declared civil age and bone age on MRI.
Data analysis was done using Microsoft Word and Excel 2019 software.

3. Results

We collected 54 male players of Beninese nationality. They had no known pathology. According to their administrative documents, they were all aged 17 or under. The average age declared was 14.18 ±1.04 years with extremes of 12 and 16 years.
Table I shows the distribution of players according to their declared civil age.
Regarding the distribution of players according to the declared civil age, the predominant age was 14 years (35.18%) followed by 15 years (31.48%).

Table 1: Distribution of players according to civil age

	N	%
12 years	3	5.55
13 years	10	18.51
14 years	19	35.18
15 years	17	31.48
16 years	5	9.25

Table II presents the distribution of players according to the stage of fusion of the radial physis

Table 2: Distribution of players according to the stage of fusion of the radial physis

	N	%
Stage I (14 years)	6	11.11
Stage II (15 years)	11	20.27
Stage III (16 years)	12	22.22
Stage IV (17 years)	10	18.51
Stage V (18 years)	12	22.22
Stage VI (19 years)	3	5.55

Stages III and V were the most predominant at 22.22% respectively, followed by stage II (20.27%).
Table III presents the distribution of players according to the FIFA age group

Table 3: Distribution of players by FIFA age group

	N	%
< 17 years (Stages I, II et III)	29	53.7
17 years (Stage IV)	10	18.51
>17 years (Stages V et VI)	15	27.77

Regarding the distribution of players according to the FIFA age group; 53.7% of the players were < 17 years old.
The concordance between the declared civil age and the age detected by MRI was 29.63%. Figures 2 and 3, respectively show an example of concordance and discordance between the declared civil age and the bone age by MRI.

Fig 2: Coronal T_1 MRI of the left wrist in a player whose declared civil age is 15 years. The stage of fusion of the radial physis is estimated at stage II, which corresponds to 15 years suggesting concordance

Fig 3: Coronal T_1 MRI of the left wrist in a player whose declared civil age is 13 years 7 months. The stage of fusion of the radial physis is estimated at stage V, which corresponds to 18 years suggesting a discordance

4. Discussion

In our study, all the players were male. This is the case in most other studies carried out in the context of men's international competitions [6, 7].

All the players in our series, that is 100%, declared a civil age of less than 17 years. In their study in Togo in 2016, Djagnikpo *et al.* [6] noted that 95% of players declared a civil age of less than 17 years.

The average age declared in our study was 14.18±1.04 years. This average age is slightly lower than that reported by Moifo *et al.* [7] in Cameroon in 2023 (15.7 years) and by Sarkodie *et al.* [8] in Ghana in 2013. This suggests that the players in our study are younger, taking into account their declared civil age.

With regard to the stage of fusion of the radial physis, the 16 and 17 age groups were the most predominant, that is 22.22% respectively, followed by the 15 (20.27%) and 17 (18.5%) age groups. Djagnikpo *et al.* [6] in Togo in 2016 found a preponderance of 18 years (30.83%) followed by 15 years (15%) and 16 years (15%). This highlights the fact that many players had a bone age of over 17 years

In our study, 53.7% of the players were under 17 years of age, according to the FIFA age group distribution. Djagnikpo [6] and Moifo [7] reported a lower rate, 44.2% and 25.8% respectively. This means that our players are younger, taking into account their declared civil age and bone age as measured by MRI.

46.3% of the players in this work were aged 17 or over. Moifo *et al.* [7] found a higher rate of 73.1%. This relatively high rate may be explained by the players' ignorance of their true ages or by a falsified declaration of their civil age.

In terms of concordance between declared civil age and bone age, we found 29.63%. Moifo *et al.* [7] found a similar result (25.8%), while Djagnikpo *et al.* [6] found a lower concordance (20%). The relatively low concordance rate highlights the probable lack of knowledge on the part of the players of their true ages or the falsification of the declared civil age.

5. Conclusion

MRI was useful in estimating the bone age of the players. Thus, 53.7% of the players were selected because they were under 17 years of age. This made it possible to limit fraud in this area.

Conflict of Interest
Not available

Financial Support
Not available

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