MONITORING THE IMMATURE ATHLETE

– Written by Amanda Johnson, Qatar

HOW MUCH SHOULD WE MONITOR IMMATURE ATHLETES?

Screening and profiling athletes in sport has been well represented in the literature. It is considered standard practice with mature athletes but there is still debate regarding the degree of monitoring required for immature athletes who have yet to reach their full physical development.

Screening can take two formats:

1. A pre-participation medical to ensure fitness to train and compete from a health prospective.
2. Physical screening for the purpose of identifying potential problems which may prevent or hinder performance at a later date.

But with immature athletes when should you start, what should you do and how often?

PRE-PARTICIPATION MEDICAL SCREENING

General health pre-participation medicals (PPMs) are represented in the literature and despite the fact there are only a few studies which have discussed the benefits or problems with the process it has become standard practice when looking after any athlete, whatever their age. Carek and Mainous[1] carried out a systematic review regarding the effectiveness of the PPM and identified 176 papers that satisfied the basic requirements for medical screening, but not one paper matched the full criteria. This shows the diversity of thought regarding what a PPM should consist of and what it hoped to achieve.

Although there is still debate regarding the relevance of the medical screening, many sports governing bodies, such as FIFA and UEFA, have made it mandatory, but essentially only at the elite level. In the USA, screening is regarded as a basic standard of care for high school or college students involved in sports activities. For them the main purpose of the screening process is to identify athletes who have medical conditions which may put their health at risk during participation, to identify conditions that may predispose to injury and to meet legal and insurance requirements. The medical examination usually covers all aspects of general medicine, including biochemistry and an orthopaedic screening.

In the literature there is a particular emphasis on cardiovascular issues, for both mature and immature athletes. Corrado[2] reported that a number of non-symptomatic heart conditions could be detected at a basic screening session, although Wen[3] commented that the positive predictive value of the procedure was very low. Despite the conflicting evidence, some countries, such as Italy, still require mandatory cardiac screening for all sports participants.

Much of the argument surrounding PPE was not regarding its usefulness, but seemed to originate from who carried it out and who was responsible for the cost. It appears that medical officers of sporting governing bodies feel it is an integral part of their role[4] while primary care doctors (with no direct affiliation with a sport) were less positive in their regard of the PPM[1]. This may well be due to the financial and

time restraints faced in general practice. Many governing bodies, sports clubs and associations expect the medical staff to carry out some type of physical assessment of its athletes particularly at the elite level even though there is little scientific evidence that backs up the process. The available evidence in support of the efficacy of screening and profiling is essentially anecdotal and clinical, which does carry some weight but it is an area which needs to be researched more to provide the professionals with a more evidenced-based approach[5].

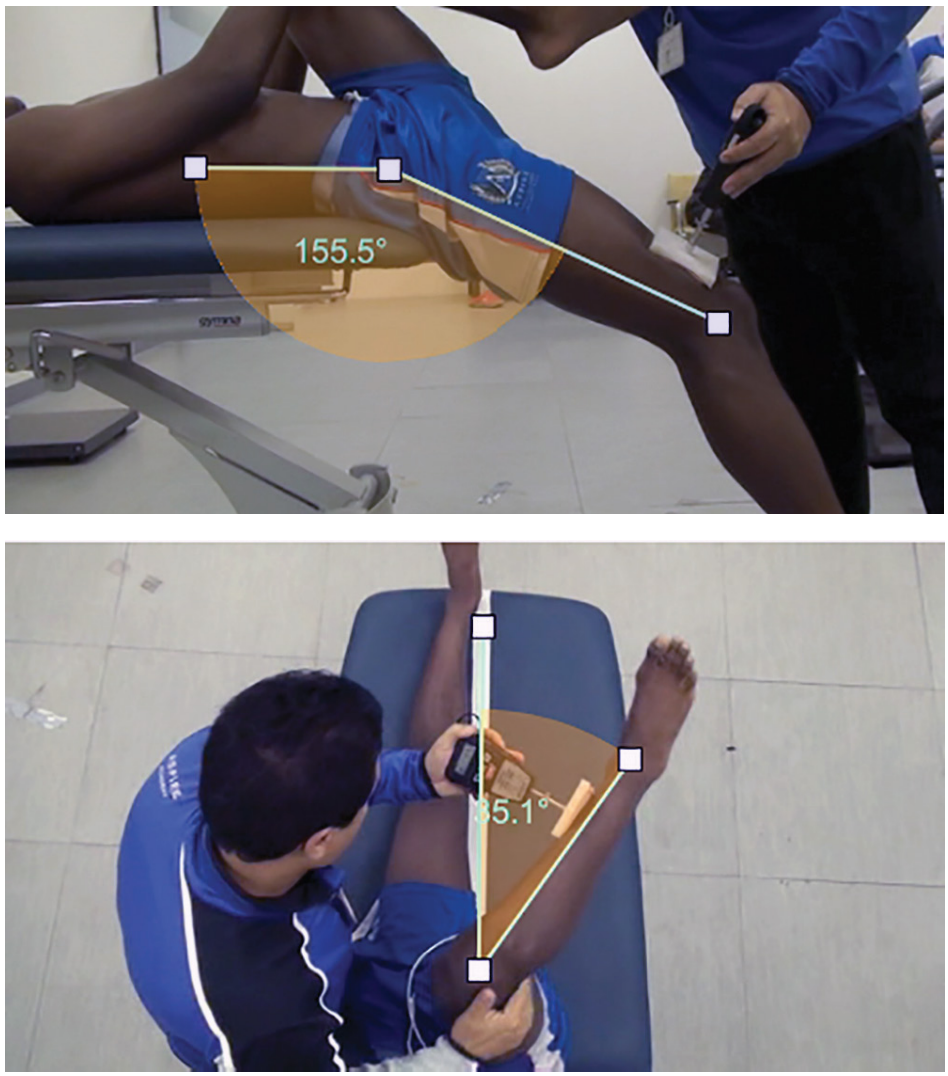

Figure 1: Measuring flexibility and joint range.

PHYSICAL SCREENING

Physical screening is carried out to monitor the progress of an athlete, with the information gathered being used to implement training strategies, to set goals and evaluate future performances. When considering physical screening, the age of the athlete plays a huge part in what is relevant in this monitoring process and the extent to which interventions should be made, if at all. The most challenging aspect of screening immature athletes is what is understood to be an abnormality. There is a lack of consensus in what is regarded as abnormal in a mature athlete, which becomes even more complex when monitoring immature athletes. This confusion is mainly due to the sudden rapid changes that can occur during the adolescent growth spurt which vary with each individual. MacAuley[6] expressed concern about the areas not investigated at a physical examination, such as core stability, muscle imbalances and inflexibility. Another consideration is that different sports demand different parameters for these elements and it is almost impossible to generalise for all sports, to what degree constitutes an abnormality (Figure 1).

MATURITY STATUS

As far back as 1997, Bratton[7] reported that a PPM was important for immature athletes, not only to determine their general health but also their maturity status. The assessment of maturity status of a growing athlete is probably one of the most important tools when monitoring progression, as it establishes the position the athlete has reached on the biological maturity pathway.

There are a number of methods used to establish maturity status, some invasive others non-invasive. Different methods for establishing maturity status use different time criteria to describe the maturity status. Non-invasive methods tend to use a 6-month time band, pre- or post-chronological age to describe early or late developers, with normal developers falling within the 6-month band either side of actual chronological age. Invasive methods tend to use a 12-month band before and after chronological age. After it has been established if an athlete is an early, normal or late developer the coach can use this information to tailor more specific training programmes to better match the biological stage of development each athlete has reached.

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Many of the non-invasive methods are related to the onset of puberty which is highly individual and occurs at different chronological and skeletal ages[8], with the age of menarche being a more specific tool used for the maturity assessment of girls. Other non-invasive measures include the assessment of various maturity indicators, including the development of sexual characteristics. This is a commonly used method in clinical practice to evaluate maturity status. Criteria have been established for each change in sexual characteristics such as the development of pubic hair, breasts and genitalia, but this system is obviously limited to the pubertal stage of growth. Tanner's indices are described as being the 'gold standard' method with validity being reported as high as 86%, if carried out by physicians. However, in today's environment where child protection issues are at the forefront of clinical practice this method has restricted application due to the invasion of the individual's privacy and the unacceptable nature of the assessment to youngsters and their parents. Self-assessment has been advocated in some studies where the child involved would compare their own progress against pictures and illustrations but validity studies have not fared particularly well, with results as low as 27%[9].

Morphological age has also been used although some critics would argue that maturity cannot be measured using anthropometric data as body size in itself is not an indicator[8]. The onset of the adolescent growth spurt is a useful non-invasive method to help identify the stage of maturation and is used in many sports-club environments. The age at peak height velocity can be used for both girls and boys although serial data needs to be taken at least twice a year, for four or more years rendering accuracy and availability of the child over a length of time difficult to achieve[10]. Some would argue that the maturity offset method, described by Mirwald[11] is adequate. Just a single measurement session is required, but this has shown to be reliable only around the time of the growth spurt, proving far less reliable for pre- and post-pubertal athletes.

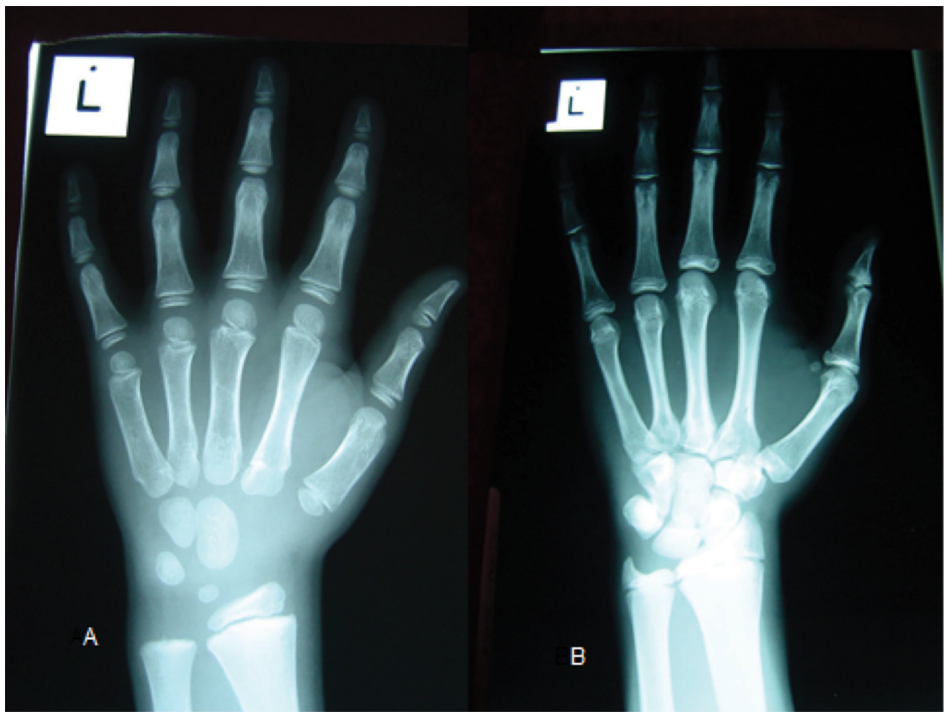

Figure 2: Two players with chronological birthdates within 1 week. Player A has a skeletal age of 6.3 years and player B 12.1 years, using the Fels method of X-ray assessment.

SKELETAL SCREENING

Skeletal age has been described as being the single best maturational index[8,12]. It can be assessed using a number of techniques including ultrasound, magnetic resonance imaging, dual-energy X-ray absorptiometry and plain X-ray. All these methods are classified as invasive and have costs. Plain X-ray of the wrist and hand is probably the most easily accessible and a relatively inexpensive method The ethical dilemma of exposing a child to radiation for non-clinical reasons certainly needs to be considered, but the dose is minimal; the equivalent of sitting for 2 hours in front of a television or walking around a city centre for 1 hour, which are normal activities for most of the adolescent population worldwide. Skeletal age assessment can be done at any age before complete fusion of the growth plates and the accuracy is not affected by puberty.

The information gained from an annual plain X-ray of the wrist and hand can be used in a number of ways. It accurately expresses the level of biological maturity that each individual has reached at a particular time, which is a more accurate measure than chronological age, but it also shows to parents, coaches and all other involved staff, the huge discrepancies (up to 5 years) that may exist between athletes within one chronological age-group[13]. This information can put athletic achievement into perspective, when comparing one young athlete to the next (Figure 2). With only approximately two thirds of adolescent athletes falling within the 'normal' status band it is almost impossible for a coach to pitch a training session which will benefit all athletes in the same group. Knowledge of skeletal age allows closer monitoring of training loads for certain individuals, particularly athletes who are outside the 'normal' age-band, giving the coach the option of holding back the late developers if required or pushing the early developers harder. It has been established in the literature that the measurement of skeletal age is not accurate in verifying chronological age but with some children from countries

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where there is no mandatory registration of birth it can guide clinical intervention if the skeletal age differs from the chronological age by more than 3 years.

A measurement of skeletal maturity can also yield an estimation of end height. An end height prediction in some sports and/or positions can be critical in the potential success of the athlete as an adult. If this is done for a minimum of 2 but preferably more consecutive years, this can be accurate within approximately 2 cm. For long term athlete development purposes, if you have this information, surely it is better to inform a child of 12 or 13 that they are not tall enough to play in a particular position. You then have the possibility of directing them into another more suitable position or even an alternative sport, rather than keeping them in the programme until they are 16 or 17 and then telling them they are not tall enough. There is then the possibility that the athlete will drop out of sport completely as they feel too old to start something new.

ANTHROPOMETRIC SCREENING

The measurement of anthropometric criteria with immature athletes takes on a completely different perspective to fully mature athletes due to the continual changes occurring. There is a huge difference in the timing or rate of progress towards the fully mature state between different children of the same chronological age; this is especially applicable during the pubertal years[14]. There should be a general understanding from all involved and agreement of why specific measures are taken; for interventional or monitoring purposes. If conducted for interventional purposes, musculoskeletal evaluation has more relevance to the mature rather than the immature athlete, as any discrepancies are likely to be real rather than apparent. Some practitioners ask why they should spend time measuring various parameters with immature athletes, such as height, weight, posture, flexibility, strength and limb length discrepancies if, two months later the individual has changed completely due to a growth spurt. Some literature has suggested that the immature athlete is most vulnerable to injury at this time, particularly during heavy training periods. For this reason height and weight should be taken if possible on a monthly basis from the age of approximately 10 years of age, to monitor any changes. The changes can then be brought to the attention of the coaches, as they occur. The coaches may then decide to monitor training loads more closely during this period of change for individual athletes. Accuracy is important when taking these measures as it is well documented that there are many errors associated with the monitoring of growth, particularly if the measures are only taken over a limited period of time, which makes the errors more significant[8,15].

Anthropometric measures such as individual leg length, muscle mass and flexibility measures can be useful in an academic setting or as markers of talent identification. They may help direct the scouting process but great caution should be taken if these measures are used to guide clinical intervention due to the fluctuating rates of growth at different chronological ages. This can lead to difficulties with the interpretation of results in a meaningful way[16]. The information gathered can be compared with further assessment sessions and the data analysed over time, allowing the practitioner to establish various normative values for specific groups of athletes. If used for intervention purposes the effectiveness should be monitored closely over time and appropriate changes made quickly if indicated. It is not always necessary to interfere with discrepancies that are discovered in a young athlete particularly if they are asymptomatic, as these may be anomalies of growth at that specific time. The introduction of orthotics or other remedial interventions may well be counterproductive and create more problems than they help prevent.

FUNCTIONAL MOVEMENT SCREENING

As a consequence of a change to a more sedentary life style, with the increasing use of video and computer games and reports of an onset of early obesity, there is a move by many practitioners towards the assessment of functional movement skills (FMS) in the growing athlete. FMS form the building blocks on which the more complex sports-specific skills are developed but the reduction of physical activity has resulted in the fact that many children do not master these skills in comparison to previous generations[17]. If these skills are not developed, it is thought to lead to a potential breakdown in performance at a later stage and could be a precursor to injury. FMS is reliant on the neurological system which is essentially established in most children by 6 to 7 years of age and it is around this age, through to puberty, that it is thought to be critical for the development of movement

skills, if a child is to be an elite athlete[18]. It is thought to be much harder for an athlete to learn a new skill post-puberty. A number of assessment protocols allow the practitioner to assess the athlete in different sports and to grade their performance in a logical and practical way with a number of validity and reliability studies to verify these tests[19].

Whichever assessment protocols are used to monitor the young athletes, it is vital that there is communication between the medical staff and coaching staff to discuss the results and the impact this might have on training loads and activities. If interventions for poor flexibility or movement skills are required, the coaches can play a significant role in ensuring that the remedial programme is followed, therefore teamwork is essential if monitoring is to have maximum effect with the most beneficial outcomes for the developing youth athlete.

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General monitoring recommendations for skeletally immature athletes

- *Annual PPM as directed by physician.*
- *Maturity status examination (hand and wrist X-ray if available).*
- *Flexibility screen minimum twice annually.*
- *Musculoskeletal screen twice annually.*
- *Height and weight monthly from 10 years of age.*
- *FMS screen with reference to specific sport.*
- *Performance testing as directed by physiologist.*

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Amanda Johnson Ph.D., M.Phil., M.C.S.P, Grad.Dip.Phys.

Lead Physiotherapist

Aspire Health Centre

National Sports Medicine Programme

Aspetar – Orthopaedic and Sports Medicine Hospital

Doha, Qatar

Contact: amanda.johnson@aspetar.com