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Pros and cons for the medical age assessments in unaccompanied minors: a mini-review

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Summary. Unaccompanied minors refer to immigrants who are under the age of 18 and are not under the care of a parent or legal guardian. Age assessment is used in Europe mainly to establish whether or not an individual is under 18 years of age and therefore eligible for protection under the United Nations' Convention on the Rights of the Child (UN - CRC). EU Member States use a combination of techniques to determine the age of a minor and to certify minor status, including interviews and documentation, physical examinations (anthropometric assessment; sexual maturity assessment; dental observation); psychological and sociological assessment; radiological tests (carpal, dental or collarbone x-rays). All such techniques are criticized as they are often arbitrary, do not take into account ethnic variations, and are based on reference materials that are outdated, invasive and may procure harm to the individuals whose age is assessed. They also generate a margin of error that makes them inaccurate to use. There is a debate about the risks and ethics associated with the use of X-rays for non-medical purposes versus the benefits of more accurate age assessments in the interest of justice. It appears that in European countries many individuals carrying out age assessment do not have sufficient training or are not sufficiently independent enough to be carrying out such assessments. Moreover, there is a lack of standardized approach between countries or even within the same country. Only some countries clearly indicate a margin of error in the results of age assessment examinations but there is no consensus – within and among countries – about the width of such margins in relation to each exams applied. It has been advised that the expert report should give the degree of age probability to allow Magistrate to interpret the age assessment results on the 'balance of probabilities' and give the detainee the right to the rule of the 'benefit of the doubt'. It also addresses concerns rested in the convention of the Rights of the Child. (www.actabiomedica.it)

Key words: unaccompanied minors, age assessment, current laws, European Countries

Introduction

In the past 5 to 10 years there has been an increase in migrants to EU and other western countries from regions struggling with poverty, famine, war and natural disasters.

An unaccompanied minor refers to a third-world country national or stateless person below the age of eighteen, who arrives on the territory of the Member States unaccompanied by an adult responsible for them whether by law or custom, and for as long as they are not effectively taken into the care of such a person, or a minor who is left unaccompanied after they have entered the territory of the Member States. Note that, by definition, this means the exclusion of unaccompanied minors who are EU nationals (1). They cross from West

Africa to the Spanish Canary Islands; from Morocco to southern Spain; from Libya to Malta and the Italian islands of Sicily and Lampedusa; and from Turkey to the islands of Greece. Many more enter the European Union by land, via Turkey and the Balkans or from Ukraine and Belarus. Unaccompanied minors may arrive clandestinely for a variety of reasons: escape from poverty, persecution, human rights violations, domestic violence and armed conflict.Therefore, they must be considered as refugees who need special protection.

Often one of the biggest difficulties an unaccompanied minor subject to immigration control faces on arrival or discovery is in proving to the various agencies that will need to know when he/she was born. Checks on an individual, with or without age-related documents, can be complicated if the individual has not given his true identity or nationality (2). Minors might produce documents bearing an adult's date of birth, having carried them for safety reasons and/or because minors would not be able to travel alone. On the other hand, some minors may have been coached to provide the wrong age in order to gain what they believe to be an advantage, and some young people may have documents that can provide age-related information but these documents might have been fraudulently obtained (3).

Furthermore, the immigration services are particularly concerned as to a teenager's age because from 18 years the immigration services will begin to treat him as an adult and may well focus on returning the individual to his originating country.

To prevent abuse of the system and to protect the children many countries have introduced age estimation procedures in cases where the given age is questioned (4). As a consequence, in the EU, the need for accurate age estimation techniques has never been greater than in the last two decades. Member states, however, may have different national legislation as to legal age and age of responsibility.

Aims of the review

This review considers the pros and cons of age assessment in unaccompanied minors subjected to immigration control in the EU States.

Unaccompanied minors: the dimension of problem

There are no reliable statistics on how many unaccompanied migrant children enter Europe every year. In 2009, the statistical office of the European Union (EU - Eurostat), reported that 12,200 minors were registered for asylum status in Europe. In 2011, there were 12,225 asylum applications in the 27 Member States, a number comparable to previous years – i.e. 10,845 in 2010, 12,245 in 2009 and 11,715 in 2008 (Table 1). Most unaccompanied minors who lodged asylum claims in the EU were boys (10,175 male applicants - 2,025 female applicants in 2011) and were primarily from Afghanistan and poor African countries (2).

However, in the last years, Europe has been facing massive flows of this particular category of migrants. In 2014, on the basis of data provided to Eurostat (2) by the Ministries of Interior and official agencies, a total of 16,265 unaccompanied children has been registered as asylum applicants in the countries applying the EU Regulation. These figures, however, were not representative of the real situation because many of unaccompanied minors did not register with the authorities either because they were unable or afraid to do so or because they were advised not to do so by family members, peers or smugglers to keep on the move to another destination.

Table 1. Countries with highest numbers of unaccompanied children in care facilities from 2004 to 2008 (*Source*: European Migration Network Synthesis Report: Unaccompanied Minors; access May 2010)

	2004	2005	2006	2007	2008
Italy	8100	7583	6453	7548	7797
Spain	2004	3160	3064	4497	4916
Belgium	N/A	2040	1702	1558	1878
Netherlands	1626	954	633	1182	1858
Germany	919	602	612	888	1099
Ireland	611	661	537	331	344
Sweden	360	378	629	773	1165
Finland	140	220	112	90	706

Age assessment in the contest of unaccompanied minors

Age estimations may be defined as examinations to detect chronological ages when the children's ages are unknown because the births may never have been registered or they arrive without being able to document their age (4). Many authorities,therefore, use medical tests to verify someone's age and decide whether the person is indeed underage or not, although medical experts repeatedly claimed that an 'objective' test accurately determining age does not exist and using these tests gives doubtful results (5,6). Only in cases of criminal or unlawful actions, it is necessary to find if the child is under or over the age of civil responsibility (usually 14 years for most European countries).

Age assessment it is not necessary if they have a valid documentation and if their age is certainly under 18 years.

Which methods are used for age assessment? A critical review

In the European countries there is currently no consensus on which methods to use for age assessment (7-11). This request has to be done only if it does not represent possible risks for the minor or for his/her family (subjects running away from wars, persecutions, previous exploitations and abuses by the family or other people or institutions).

Several different techniques feature within medical approaches to age assessment including physical examination, the use of X-rays to determine skeletal (bone) and dental maturity, and the use of other methods of imaging bone development. Few countries include psychological evaluation (Table 2).

Professionals conducting age assessment examinations of separated children in Europe include: radiologists, general practitioners, dentists and doctors

Table 2. Overview of methods used for assessing the age of an unaccompanied minor in the Member States (Policies on Reception, Return and Integration arrangements for, and numbers of, Unaccompanied Minors – an EU comparative study produced by the European Migration Network: "This report does not necessarily reflect the opinions and views of the European Commission, or of the EMN National Contact Points, nor are they bound by its conclusions"; principally covering the period up to mid-2009)

	Interview documentation	Assessment by a doctor	Dental analysis	Skeletal assessment	Psychological
Assessment					
1. Austria	x	x	x	x	-
2. Belgium	x	-	x	x	x
3. Czech Republic	x	-	x	x	-
4. Estonia	x	-	-	x	-
5. Finland	x	-	x	x	-
6. France	x	x	x	x	x
7. Germany	x	-	x	x	-
8. Greece	x	-	-	-	-
9. Hungary	x	x	-	-	-
10. Ireland	x	-	-	-	-
11. Italy	x	x	x	x	-
12. Latvia	-	x	-	-	-
13. Lithuania	x	x	-	x	x
14. Netherlands	x	-	-	x	-
15. Malta	x	-	-	x	x
16. Poland	x	x	x	x	-
17. Portugal	-	-	x	x	-
18. Slovak Republic	x	-	-	x	-
19. Slovenia	x	-	-	-	x
20. Spain	x	-	-	x	-
21. Sweden	x	-	x	x	-
22. United Kingdom	x	-	-	-	-

with expertise in forensic medicine. Pediatricians are involved in the process in several countries, although not regularly. Social workers are very seldom involved, although in some countries social workers (e.g. UK) belonging to government institutions determine the child's age based on a practical assessment.

The presence of a cultural-linguistic mediator is very important. However, this mediator is rarely included in these procedures. Professionals undertaking the examinations virtually receive no training on how to conduct testing and the reasons for age assessment. In addition, they generally are not familiar with the child's cultural and environmental background.

Not all countries use margins of precision for each method and different approaches for combining results when several methods are used (7-10).

Interview and documentation

The first task consists of finding age related evidence, such as: available identification documents, the age declaration by the applicant, the information accessed during interviews with the applicant and information obtained from the country where the applicant originates. It is, however, important that these children know the consequences of the results. This in many cases imply that they will be treated as adults. The examiners may be either non-medical workers such as case worker or a specialized staff. The report must be written in non-scientific language which can easily be understood by the decision maker(s).The "benefit of the doubt" should be always taken in consideration and reported in details.

The following phrasing should be used in the report: "there is a very high probability that the given date of birth is not correct but that an earlier date can be assumed; there is a very high probability of an age of above 14 years; there is but very low probability that the 18th year of age has been reached". This will allow the Magistrate to interpret the age assessment results on the 'balance of probabilities' and give the detainee the right to the rule of the "benefit of the doubt" (11).

Medical and radiological approaches to assessment of age

1. Physical examinations

Examination methods for age estimation may be performed as "holistic approach"(4) or purely based on medical findings . Medical examination consists of assessing height and weight, body mass index, as well as any visible signs of sexual maturity. There are clearly defined methods for rating puberty as described by Marshall and Tanner (12,13). These give the ages of various stages of attainment of pubertal appearances, starting on average at 11 years in both males and females and going through to the final stages acquired two or three years later. Axillary hair growth, facial hair growth and laryngeal prominence development should also be registered. In addition a general physical examination should be performed to describe any signs of a pathological condition which may interfere with the maturation rate.

Anthropometric measurements do not take into consideration variations between ethnicity, race, nutritional intake and socioeconomic background. The evaluation of sexual maturity has the greatest margin of error and should be used if needed for age determination only in conjunction with skeletal maturity and tooth development.

The basic ethical values of bio medics need to be respected during age estimation examinations in living individuals. As a consequence, a medical examiner needs permission from the patients themselves, to perform a medical investigation or apply treatment. It is also important to remember that physical evaluation has to be done in respect to cultural and religious believes. An example is the examination of a female adolescent that must be performed by a lady doctor, and always with particular attention and respect.

2. Social and psychological evaluation

The aim of this process is to assess the mental maturation of the subject. Classifying unaccompanied minors as mentally mature, needs specific examinations performed by specialised investigators in a standardized way. A professional interpreter should be involved

during the interviews. There is very little information available about how psychological or social assessments of age are carried out. Furthermore, even among children from similar ethnic backgrounds who grow up in the same social and economic environment there are significant physical and emotional differences.

A psychological evaluation can demonstrate, in subjects more than 18 yrs old, an important immaturity or cognitive and psychological disabilities . In these situations the authorities of the country of reception must decide what to do in these weak "adult" subjects who need of protection.

3. Dental age (DA)

Age can be estimated in children and in adolescents by means of development and eruption of deciduous and permanent teeth up to 14 years. After this age the third molar is the only remaining tooth that is still developing and consequently dental age estimation methods have to rely on the development of this tooth until the age of 23 years (14).

Like puberty, teeth develop in clear patterns in certain age ranges. The clinical interpretation of this method indicates if the child is dentally advanced, average or delayed compared to the reference. DA is generally considered to be the an useful and reliable indicators of maturation because it is less affected than other body tissues by endocrinopathies, environmental insults, and other factors such as malnutrition or systemic illness (14).

A positive direct correlation exists between the individual's chronological age, dental age and skeletal age and correlation also exists in the twin pairs of the same zygosity and among each pair but no correlation exists between different zygotic twins (15). On average, estimated DA over-estimated chronological age (CA) by 0.29 years (14). The maximum likely difference between the estimated DA and CA was 1.65 years. These data suggests that radiographic determination of DA could be a useful tool, providing an additional source of information.

However, the lack of data on the influence of the ethnic factor in mineralization represents a restriction in the reliability of age assessment. Furthermore, the effective radiation dose should be taken into account, in particular the relative sensitivity of the different exposed tissues.

4. Assessment of third molar (wisdom teeth)

The third molar represents an important parameter in calculating dental age in a range of 14-20 years (16-19). The staging of third molar crown and root mineralization can be accomplished easily and non-invasively through evaluation of dental radiographs. Demirjian's classification distinguished 8 stages from (A-H), four stages of crown (A-D) and four stages for root development (E-H) (17). Stage A is the beginning of mineralization of separate cusps, stage B begins, after fusion of cusps, stage C beginning of dentinal deposits, stage D crown formation is completed, stage E the root length is less than the crown height, stage F the root length is equal to or greater than the crown height, stage G the walls of the root canal are parallel and its apical end is still opened and stage H the apical formation is completed (19). In some individuals, matured (stage H) the third molars can be seen as early as 15 years of age, while, in others, the third molars may have not appeared at all even at 25 years.

Cameriere et al. developed a method for assessing adult age based on the relationship between age and the third molar maturity index (I3M), which is related to the measurement of the open apices of the third molar. The I3M is obtained through an evaluation of the radiographic aspect of the wisdom tooth and, in particular, by measuring the open apices and the length of the tooth itself. The method was developed in order to identify a cut-off value (I3M=0.08) which could represent a threshold for discriminating between individuals aged 18 or over and those under 18 years. The results showed that the sensitivity of the test was 86.6%, with a 95% confidence interval of (80.8%-91.1%), and its specificity was 95.7%, with a 95% confidence interval of (92.1%-98%). The proportion of correctly classified individuals was 91.4%. Estimated post-test probability, p was 95.6%, with a 95% confidence interval of (92%-98%). Hence, the probability that a subject positive on the test (i.e., I3M<0.08) was 18 years of age or older was 95.6% (20,21).

In brief, the only teeth that can be used, as an indicator of whether or not someone is an adult, are the

3rd molars. Due to genetic and environmental factors, these may appear anywhere from 16-25 years of age. The alternative is to study tooth mineralization that is unaffected by ethnicity or nutrition. Nevertheless, even without these influences, it has a ± 2 year margin of error and therefore none of these measurements by themselves gives any reliable assessment of age (22).

In summary, although the reliability of third molars in age estimation has been evaluated by several research groups (23-26), consensus on the usefulness of these teeth has not been reached because there are several factors that can influence dental age assessment in the daily practice (regarding non-invasive methods). Given the scarcity of other available age indicators, the method reported by Cameriere et al. appears to be a valuable supplementary parameter. Unfortunately, it has not been validated. Therefore, this technique, in cases of identification for legal purposes, should be applied with caution and in combination with other previously introduced complementary methods (27).

6. Radiograph of the hand and wrist for bone age assessment

Because of the importance of skeletal maturity, several methods have been developed for estimating skeletal age. Currently, there are two main approaches that use X-ray images: the Greulich and Pyle (GP) method and the Tanner and Whitehouse (TW2 or TW3) methods.

GP tends to overestimate age, especially for females aged up to 17 years and to underestimate for males aged up to 15 years. On the other hand, TW3 emerges as the most reliable method especially for females, despite the slight tendency to underestimate girls 'ages after 12 years and boys after 13 years (28). Furthermore, the TW3 BA terminates at 16.5 for boys and 15 years for girls, while the GP BA terminates respectively at 19 and 18 years. In other words, the TW3 method stops 2.5-3 years earlier. Therefore, the TW3 method, as reported above, is unsuitable for ascertaining if a female has reached the age threshold of 16 or 18 years or a boy has attained the 18-years threshold (28,29).

Practically, although GP is quite simple and less time consuming, its general trend to overestimate and the relevant rates of false positives should be kept in mind when applied for age estimation in criminal proceedings. The margin of error is ± 2 years but in particular cases may be 3-4 or more (delayed or anticipated puberty, previous malnutrition, rickets, early sexual activity, contraceptives, pregnancies, abortions, ethnic and genetic factors and so on) (4,28-30).

Pinchi et al. (31) stated that when performing forensic age estimation in subjects around 14 years of age, it could be advisable to use and associate the TW3 and GP methods along with other biological features (e.g. dental mineralization). Automated software solutions can help reduce the intra/inter observer variability and make measurements more objective and repeatable (28,29).

7. Collar bone X-ray

The radiological examination of the medial clavicular epiphysis is of particular interest to age estimation due to the fact that the sterno-clavicular joint displays a relatively late maturation process compared to other regions of interest for age diagnostics (32,33). Imaging of medial end of clavicle is used for calculation of bone age of individuals of ages 18-22 years. Clavicle is the first long bone to start ossifying in fetal life. During adolescence, a secondary epiphyseal ossification centre appears at the medial end of the clavicle that results in growth and remodelling of the bone till complete fusion occurs at approximately 22 years.

The ossifications stages of the medial clavicular epiphyseal cartilage are categorized on the basis of classification criterion used by Schmeling et al. (33).

Stage 1:	Ossification centre has not yet ossified.
Stage 2:	Ossification centre has been ossified, but epiphyseal cartilage not ossified.
Stage 3:	Epiphyseal cartilage partially ossified.
Stage 4:	Epiphyseal cartilage completely ossified, but epiphyseal scar is still visible.
Stage 5:	Epiphyseal scar is no longer visible

At present it is not clear what radiological method should be used to assess the ossification status of the medial clavicular epiphysis. Conventional radiography of the clavicle is often plagued by overlapping shadows

produced by structures of mediastinum, the vertebrae and the ribs. This results in inaccurate visualization of the medial epiphysis and thus cannot be used for staging the extent of maturation (33).

A computed tomography (CT) scan of the clavicle is reported as a useful examination when 21 years is the age threshold of interest and provides more accurate structural features of the surrounding soft tissue structures. The recommended slice thickness for CT based study should not exceed more than 2 mm (34,35). Spiral CT requires shorter time to perform resulting in better patient compliance and less artefacts, but has a higher radiation dose when compared with standard CT.

X-rays, medico-ethical and legal considerations

Although the exposure to radiation during a carpal X-ray in relation to an age assessment is minimal there are ethical concerns around exposing children to any level of radiation. Radiology inflicts a dose of radiations which, in case of X-ray exams are applied to assess chronological age, bring no health benefit to the individual concerned (28,29). This method was designed for medical use in diagnosis and monitoring of disorders of growth (28,29). Therefore, applying them for migration control purposes without therapeutic benefit raises major ethical issues and may be illegitimate according to existing legal frameworks. The effective dose from an standard X-ray examination of the hands is 0,1 microSievert (μSv), 26 μSv in case of orthopantomograms, 220 μSv in X-ray examination of the proximal epiphyses of the clavicle and 600 to 800 μSv in case of TC of the sternoclavicular joints (36).

The effective dose from naturally-occurring radiation exposure in north European countries has been calculated from 1,2 mSv to 2,0 mSv per year. The radiation exposure from intercontinental flight at an altitude of 12000 meters is 0,008 mSv per hour (37). On the basis of these data the health risk as a result of usual X-ray examinations for age assessment is negligible but is more consistent for the other discussed procedures (e.g. computed tomography).

In conclusion, those using radiations or invasive procedures should be used only in specific cases and by experienced person with a motivated reason for their utility. Moreover, legal informed consents of both the alleged child (minor) and the tutor are required. The possible detrimental effects due to radiation exposure must be considered (38).

The pros and cons for the medical age assessments in unaccompanied minors are summarized in table 3.

Non-radiological methods of imaging bone development

In light of the ethical limitations in using X-rays for age assessment, the use of non-ionizing radiation methods, such as magnetic resonance imaging (MRI) and ultrasound (US), is attracting increasing interest among medical experts and institutions. However, MR scanning may be expensive but the intra-rater reproducibilities are high (39). Furthermore, to date there is no good information on the application of these techniques to age assessment of asylum seekers. Nevertheless, these findings indicate that MRI could be a potential powerful, non-invasive, and non-irradiative method for assessment of skeletal bone age in children (37,38).

The ultrasound for studying wrist bone development is of great interest to the scientific community because of it is low cost, easy to carry and radiation-free but, at the moment, there are questions not only on its reliability but also on its reproducibility (28,29, 39-43).

In summary, further research are needed to validate the MRI and US approaches to assessing age in normal populations before considering its use as a routine method for children and young people subject to immigration control.

Conclusions

Unaccompanied minors need particular attention in order to avoid possible exploitation by adult illegal immigrant or criminal organization. They have special rights: they must have a tutorship and the guarantee to education. They cannot be repatriated against their will even if the parents, from the country of origin, ask for this procedure.

Table 3. Summary of pros and cons for the medical age assessments in unaccompanied minors

Approaches to the assessment of age	Rationale	Pros	Cons
Physical examination	The aim of this process is to assess the individual auxological parameters and pubertal status. Physical evaluation has to be done with respect of cultural and religious believes, for example for female adolescent the examination should be performed by a lady doctor, and always with particular attention and respect.	It is recognised by the World Health Organisation as the method universally applicable, inexpensive and non-invasive available to assess the proportions, size and composition of the human body.	It does not take into consideration variations according to ethnicity, race, nutrition intake and socio-economic background. The interpretation of results is an imprecise factor for the prediction of chronological age . Moreover, the assessment of sexual development is highly intrusive and ethically questionable when conducted without medical or therapeutic benefit.
Social and psychological evaluation	The aim of this process is to assess the mental maturation of the subject.	It is inexpensive and non-invasive.	There is very little information available about how psychological or social assessments of age are carried out in migrant children in Europe.
Dental age	It is an indicator of the biological maturity of the growing children.	The method is fast, cheap and not very influenced by intra- and inter-observer error.	Dental development can be altered by long term conditions, congenital syndromes, nutrition deficiencies or hormonal disorders. There are also ethical concerns for exposing children to any level of radiation.
Third molar for age assessment	The only teeth that can be used as an indicator of whether or not someone is an adult are 3rd molars.	The assessment of development of the third molars is possible for individuals from 14 years up to 23 years of age, when their mineralization is completed in most healthy individuals.	Wide range of variability in the timing of dental development, conveying the need to take ethnic differences into account. There are also ethical concerns for exposing children to any level of radiation.
X-ray hand bone age	Growth takes place at the ends of each long bone where there is an ossification (bone development) centre with a growth plate or epiphysis of soft bone (cartilage).	On average the skeletal development of hand bones is complete at the age of 17 years in girls and at the age of 18 years in boys.	Intra- and inter-observer errors have been documented. Racial factors and nutrition may significant influence bone age assessment. There are also ethical concerns for exposing children to any level of radiation.
Collar bone X-ray	The aim is to estimate the age of a person who is assumed to be older than 18 years.	A conventional radiography is needed to examine the medial clavicular epiphysis in living individuals. If the fusion of epiphyses is complete and an epiphyseal scar is visible, it can be assumed, in the case of women, that the person is at least 20 years old, and in the case of men, that the person is at least 21 years old	More research is needed to define more precisely the best standardized approach to different methods. There are also ethical concerns for exposing children to any level of radiation.

Age assessment is not necessary if the minor has a valid documentation and if his age is certainly under 18 years. It is fundamental that age determination procedure is initiated only in subjects declaring an unlikely minor age or when age determination is important for legal problems due to illegal or unlawful conduct. In that case it could be also important to establish if the child is under or over the age of civil responsibility, usually 14 years.

In all circumstances the presence of a cultural mediator expecially during psychological evaluation for detecting immature subjects, presence of mental retardation or other cognitive and psychological disabilities is very important.

Some medical practitioners, administrative and legal institutions in the country of arrival of the unaccompagned minors are unaware of the methodological problems and limits associated with the bone and dental assessment for estimating chronological age. They believe that their use is 'helpful' to children and young people who are subject to immigration control (4). This belief leads to frequent, useless, excessive and inaccurate use of these invasive methods. This use is often performed in peripheral facility, with unskilled medical structures and relying on the report (sentence) of untrained radiologists with the possibility of big errors (4,44-46).

Therefore, medical methods for age assessment must be used in a multidisciplinary team if they are strictly necessary. Comprehensive age assessment of living individuals may necessarily involve the use of ionising radiation (X-rays). Whilst this exposure is not at a level sufficient to cause immediate harm, it does raise the total lifetime dose of radiation experienced by the individual. More research is needed to define more precisely the best standard approach for age estimation based on a combination of different methods.

In conclusion, it is very important, both for the asylum seekers and for the authorities, that the age estimates are as correct as possible, appropriate and possibly useful for a diagnostic and therapeutic use and decision, but not for legal reasons, especially when they pose risk on the subject. Certainly the professional figures (social workers, psychologist or neuropsychiatric pediatricians, pediatric endocrinologists, intercultural mediators) entrusted to perform the age determinations of unaccompagned minor must be well trained and periodically updated.

It has been also advised that the expert report should give the degree of age probability to allow Magistrate to interpret the age assessment results on the 'balance of probabilities' and give the detainee the right to the rule of the 'benefit of the doubt'. It also addresses concerns rested in the convention of the Rights of the Child.

References

1. European migration network. Policies on reception, return and integration arrangements for, and numbers of unaccompanied minors - an EU comparative study. May 2010. [Internet]. [cited 2012 Aug30th]; Available from: http://emn.intrasoftintl.com/ Downloads/prepareShowFiles.do?directory ID=115.
2. Available from: http://appsso.eurostat.ec.europa.eu /nui/ show. do?dataset =migr_ asyunaa&lang=en.
3. Australian Human Rights Commission; Inquiry into the treatment of individuals suspected of people smuggling offences who say they are children; Discussion paper: December 2011.
4. Aynsley-Green A, Cole TJ, Crawley H, Lessof N, Boag LR, Wallace RM. Medical, statistical, ethical and human rights considerations in the assessment of age in children and young people subject to immigration control. Br Med Bull 2012; 102: 17-42.
5. Hunter A. Between the domestic and the international: The role of the European Union in providing protection for unaccompanied refugee children in the United Kingdom. European Journal of Migration and Law 2001; 3: 383–410.
6. Bhabha J,Young W. Not adults in miniature: Unaccompanied child asylumseekers and the newUS guidelines. Int J Refugee Law 1999; 11: 84–125.
7. Geddes G. Foreign lands: Part 3: And your date of birth is? Age assessments. Fam Law 2013; 4: 443-447.
8. Available from: www.unicef.org/crc/index_30168.html. Access: May 19, 2014.
9. European migration network. Comparative EU study on unaccompanied minors, 2010.
10. Separated Children in Europe Programme (SCEP). Review of Current Laws, Policies and Practices Relating to Age Assessment in Sixteen European Countries. www.separated children- Europe programme.org/separated_children/publications/reports/index.html (15 January 2012, date last accessed).
11. Branson C, Hill JA. Inquiry into the treatment of individual suspected of people smuggling offences who say they are children.Australian Human Rights Commision.Australian Human Rights Commission, Discussion paper, December 2012, pp 1-23.

12. Marshall WA, Tanner JM .Variations in pattern of pubertal changes in girls. Arch Dis Child 1969; 44: 291-303.
13. Marshall WA, Tanner JM.Variations in the Pattern of Pubertal Changes in Boys. Arch Dis Child 1970; 45: 13-23.
14. Roberts GJ, Parekh S, Petrie A, Lucas VS. Dental age assessment (DAA): a simple method for children and emerging adults. Br Dent J. E7; discussion 192-3.
15. Gupta M, Divyashree R, Abhilash PR, Bijle MNA , Murali KV. Correlation between chronological age, dental age and skeletal age among monozygoyic and sizygotic twins. J Int Oral Health 2013; 3: 16-22.
16. Ajmal M, Mody B, Kumar G. Age estimation using three established methods: A study on Indian population. Forensic Sci Int 2001; 122: 150-154.
17. Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. Ann Hum Biol 1976; 3: 411-421.
18. Thevissen PW, Pittayapat P, Fieuws S, Willems G. Estimating age of majority on third molars developmental stages in young adults from Thailand using a modified scoring technique. J Forensic Sci 2009; 54: 428-432.
19. Koch G, Modee T, Poulsen S, Rasmussen P. Dental age estimation. In: Pedodontics A Clinical Approach. Ch. 4., Munsksgard, Copenhagen, 1994; pp.60-61.
20. Cameriere R, Cingolani M, Giuliodori A, De Luca S, Ferrante L. Radiographic analysis of epiphyseal fusion at knee joint to assess likelihood of having attained 18 years of age. Int J Legal Med 2012; 126: 889-899.
21. Cameriere R, Pacifici A, Viva S, Carbone D, Pacifici L, Polimeni A. Adult or not? Accuracy of Cameriere's cut-off value for third molar in assessing 18 years of age for legal purposes. Minerva Stomatol 2014; 63: 283-294.
22. UNICEF Child Rights Advocacy & Education Section – PFP Geneva, Identification of Unaccompanied and Separated Children: Exploring Age Assessment Challenges. Background and Discussion Paper for the Expert Seminar on Unaccompanied Minors, Children Crossing the External Borders of EU in Search of Protection organized by the Belgian Presidency of the European Union, 2010, p. 3.
23. Solari AC, Abramovitch K. The accuracy and precision of third molar development as an indicator of chronological age in Hispanics. J Forensic Sci 2002; 47: 531-535.
24. Kasper KA, Austin D, Kvanli AH, Rios TR, Senn DR. Reliability of third molar development for age estimation in A Texas Hispanic population: A comparison study. J Forensic Sci 2009; 54: 651-657.
25. Arany S, Iino M, Yoshioka N. Radiographic survey of third molar development in relation to chronological age among Japanese juveniles. J Forensic Sci 2004: 49534-49538.
26. Mincer JJ, Harris EF, Berryman HE. The A.B.F.O. study of third molar development and its use as an estimator of chronological age. J Forensic Sci 1993; 38: 379-390.
27. Acharya AB. Clinical and radiological perspective of forensic dentistry. In: Ongole R, Praveen BN, editors. Textbook of Oral Medicine, Oral Diagnosis and Oral Radiology. India: Reed Elsevier India Private Limited; 2010. p. 741.
28. De Sanctis V, Di Maio S, Soliman AT, Raiola G, Elalaily R, Millimaggi G. Hand X-ray in pediatric endocrinology: Skeletal age assessment and beyond. Indian J Endocrinol Metab 2014; 18 (Suppl 1): S63-71.
29. De Sanctis V, Soliman AT, Di Maio S, Bedair S. Are the new automated methods for bone age estimation advantageous over the manual approaches? Pediatr Endocrinol Rev 2014; 12: 200-2005.
30. Bull RK, Edwards PD, Kemp PM, Fry S, Hughes IA. Bone age assessment: A large scale comparison of the Greulich and Pyle,and Tanner and Whitehouse (TW2) methods. Arch Dis Child 1999; 81: 172-173.
31. Pinchi V, De Luca F, Ricciardi F, Focardi M, Piredda V, Mazzeo E, Norelli GA. Skeletal age estimation for forensic purposes: A comparison of GP, TW2 and TW3 methods on an Italian sample Forensic Sci Int 2014; 238: 83-90.
32. Kellinghaus M, Schulz R, Vieth V, Schmidt S, Pfeiffer H, Schmeling A.Enhanced possibilities to make statements on the ossification status of the medial clavicular epiphysis using an amplified staging scheme in evaluating thin-slice CT scans. Int J Legal Med 2010; 124: 321-325.
33. Schmeling A, Schulz R, Reisinger W, Mühler M, Wernecke KD, Geserick G.Studies on the time frame for ossification of the medial clavicular epiphyseal cartilage in conventional radiography. Int J Legal Med 2004; 118: 5-8.
34. Kaur G, Khandelwal N, Jasuja OP. Computed tomographic studies on ossification status of medial epiphysis of clavicle: Effect of slice thickness and dose distribution. 2010 [cited 2013 Jul 13]; Available from: http://imsear.hellis.org/handle/123456789/134629.
35. Cameriere R, De Luca S, De Angelis D, Merelli V, Giuliodori A, Cingolani M, Cattaneo C, Ferrante L.Reliability of Schmeling's stages of ossification of medial clavicular epiphyses and its validity to assess 18 years of age in living subjects. Int J Legal Med 2012; 126: 923-932.
36. Ramsthaler F, Proschek P, Betz W. How reliable are the risks estimates for X-ray examinations in forensic age estimations? A safety update. Int J Leg Med 2009; 123: 199-204.
37. Schmeling A, Reisinger W, Geserick G, Olze A . Forensic Age estimation of live adolescents and young adults. In: Forensic Pathology reviews. Vol 5. Editor: Michael Tsokos. Forensic Pathology Reviews, vol 5. Humana Press, 2008.
38. Ramsthaler F, Proschek P, Betz W, Verhoff MA.How reliable are the risk estimates for X-ray examinations in forensic age estimations? A safety update. Int J Legal Med 2009; 123: 199-204.
39. Terada Y, Kono S, Tamada D, Uchiumi T, Kose K, Miyagi R, Yamabe E, Yoshioka H. Skeletal age assessment in children using an open compact MRI system. Magn Reson Med 2013; 69: 1697-702.
40. Rachmiel M, Naugolani L, Mazor-Aronovitch K, Levin A, Koren-Morag N, Bistritzer T. Bone age assessment by a novel quantitative ultrasound based device (SonicBone), is comparable to the conventional Greulich and Pyle method. Horm Res Pediatr 2013; 80 (Suppl 1): 35.

41. Shimura N KS, Arisaka O, Imataka M, Sato K, Matsuura M. Assessment of measurement of children's bone age ultrasonically with Sunlight BonAge. Clin Pediatr Endocrinol 2005; 14(Suppl 24): 17-20.
42. Mentzel HJ, Vilser C, Eulenstein M, Schwartz T, Vogt S, Böttcher J, Yaniv I, Tsoref L, Kauf E, Kaiser WA. Assessment of skeletal age at the wrist in children with a new ultrasound device. Pediatr Radiol 2005; 35: 429-433.
43. Khan KM, Miller BS, Hoggard E, Somani A, Sarafoglou K. Application of ultrasound for bone age estimation in clinical practice. J Pediatr 2009; 154: 243-247.
44. Separated Children in Europe Programme (SCEP). Review of Current Laws, Policies and Practices Relating to Age Assessment in Sixteen European Countries. www.separatedchildren- Europeprogramme. org/ separated_c hildren / publications /reports/index.html (15 January 2012, date last accessed).
45. Smith T, Brownless L. Discussion paper: age assessment practices a literature review and annotated bibliography-United Nations International Children's Emergency Fund (UNICEF). http://www.unicef.org/protection/Age_Assessment_Practices_2010. pdf. Accessed 16 Jul 2013.
46. Crawley H. When is a child not a child? Asylum, age disputes, and the process of age assessment. Immigration Law Practitioners Association (ILPA), London, 2007.

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