

Age estimation for forensic purposes in Italy: ethical issues

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Abstract Age assessment in children and young adults is a relevant medicolegal issue due to the gradual increase of persons devoid of proper identification documents in European countries. Because of the illegal immigration and growing crime rates among children and adolescents, age estimation for forensic purposes is often required. The scientific research and the extensive experience of forensic experts in the last decades focused on the use of radiographic methods addressed to evaluate the degree of skeletal or dental development as the most accurate parameters to estimate the chronological age of children and adolescents. This paper analyzes the ethical issues related to age estimation procedures based on radiographic methods, showing how the ethical principles of beneficence, nonmalevolence, justice, and autonomy may be guaranteed during the execution of the age assessment in forensic practice. The procedure might be conducted in accordance with international guidelines and protocols, though they need a higher homogenization and standardization. A strong collaboration between various scientific societies of professionals (forensic odontologists, forensic pathologists, forensic anthropologist, radiologists, pediatricians, and psychologists), who have been involved in age estimation for years, is needed to reach this goal.

Keywords Age estimation · Ethical issues · Unaccompanied minors · X-rays

Introduction

Age assessment in children and young adults is a relevant medical-legal issue due to the gradual increase of persons

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devoid of proper identification documents in European countries. This phenomenon, which requires accurate age estimation (AE), is related to illegal immigration and growing crime rates among children and adolescents.

According to the data from the Italian Ministry of Justice [1], until 31 May 2013, the number of crimes committed by foreign minors that resulted in criminal proceedings was 9,529. Furthermore, in Italy, immigration has increased significantly in recent years; a report of the Ministry of Labour and Social Policies [2] indicates that in February 2013, 7,066 unaccompanied children (93.9 % males) were registered, of which 1,464 (20.4 %) were missing (could not be reached).

The outcome of the assessment may have important judicial and political/administrative implications. According to the Italian law, unaccompanied minors may not be sent back to the country of origin, and the asylum must be granted if they are asylum seekers. As in many countries, Italian criminal and civil law implies different legal requirements [3] based on the age of the offender. In the case of a crime committed by a child/adolescent, the AE is ordered by the criminal court who appoints one or more experts (e.g., pediatricians, radiologist, forensic pathologist, odontologist, and anthropologist). The criminal liability varies in Italy: <14 years, the subject is assumed to have no legal responsibility; from 14 to 18 years, the subject may be liable, depending on the degree of maturity reached, but the jurisdiction is the Minor Court; >18 years, the subject is presumed liable, and the jurisdiction is of the Ordinary Court. In civil cases, the AE is often requested by the subject or the relatives (e.g., parents of adopted children).

In the literature, several methods of AE for children and young adults have been studied and reported.

Many authors [4–8] recommend that the subject whose age has to be assessed should be interviewed and subjected to physical inspection of secondary sexual characteristics. The scientific research and the extensive experience of forensic experts in the last decades focused on the use of radiographic methods addressed to evaluate the degree of skeletal or dental

development as the most accurate parameters to estimate the chronological age of children and adolescents. A huge number of studies [9–15] reported that the methods based on radiological investigation of bones or teeth have a higher correlation with the actual age of the subject compared with other methods (such as the assessment of sexual and mental maturity), thus becoming the most accurate methods for the AE process [16]. Nevertheless, some authors [17–19] claimed that the methods based on the X-rays of the wrist and the orthopantomography (OPG) offer just a suggestive AE and are not able to accurately determine chronological age, thus exposing the subject to a “useless” risk [19]. There are different positions, at the moment, on the reliability of the AE methods, ranging from convictions that sustain their “uselessness” to opposite opinions of authors who claim that “the only thing that provides more reliable information (than dental age estimation) is an authentic birth certificate” [16].

A computed tomography (CT) scan of the clavicle is reported as a useful examination when 21 years is the age threshold of interest [7], while the utility and reliability of a standard X-ray of the clavicle is a cause of high concern [20].

Apart from the methods applied for AE, the United Nations Children’s Fund (UNICEF) [21] and the United Nations High Commissioner for Refugees (UNHCR) [22] have recommended that the identification process of unaccompanied minors for administrative and legal purposes have, as a fundamental principle, the charge to protect the “best interests” of children. According to the UNHCR recommendations, the process of AE should never be imposed and must be in accordance with the individual’s cultural background: “... such identification measures include age assessment and should not only take into account the physical appearance of the individual, but also his or her psychological maturity. Moreover, the assessment must be conducted in a scientific, safe and gender-sensitive manner, avoiding any risk of violation of the child’s physical integrity” [22]. Also the UNHCR Guidelines of 2009 [23] and the declaration of the Parliamentary Assembly of the Council of Europe no. 1967/2011 [24] have established that the procedure should be carried out through medical tests (though not exclusively through them), not overpowering the sphere of the individual and respecting “Medical Ethical Standards.”

Materials and methods

The aim of this paper is to analyze the ethical issues related to AE procedures based on radiographic methods used to estimate age through the evaluation of dental mineralization and bone maturation.

Through the analysis of the literature, European and Italian legislations, the Ethics Recommendation and the Scientific Guidelines and Recommendation, the authors analyzed and

discussed the ethical implications related to age assessment according to four different ethical principles: beneficence, nonmalevolence, justice, and autonomy [17–19, 25, 26] suggesting the possible alternatives and solutions.

Discussion on ethical issues

Before analyzing in more detail each ethical principle, it is necessary to clarify that the more relevant and more debated [27–29] ethical issue is related to the “nonclinical” use of ionizing radiations on subjects in the growth phase. The “clinical” use of X-rays includes the purpose of preventing, diagnosing, or treating or rehabilitating a disease or an injury or its symptoms. The European Union of Medical Specialists [30] adopted a definition of “medical act”: “The medical act encompasses all the professional action, e.g. scientific, teaching, training and educational, clinical and technical steps, performed to promote health, prevent diseases, provide diagnostic or therapeutic care to patients. The medical act must always be performed by a licensed medical doctor/physician or under his/her direct supervision and/or prescription”. According to this point of view, the use of X-rays for legal or administrative purposes cannot be considered as a “treatment” or a diagnosis, because the objective of the exam is to establish an age that can permit to access to some benefits, e.g., asylum. About this aspect, it is essential to remember the World Health Organization (WHO) definition of “health” [31]: “Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” The AE could be considered in this perspective, considering, for instance, the execution of AE for adoption purposes; for an appropriate school placement or for asylum requests (after which, the minor could not be expelled and could be introduced in a social context appropriate to its age).

The question is still not resolved, and already in 1996, the Royal College of Radiologists in London [32] stated that it was “unjustified to undertake a radiograph examination for age estimation purposes. It is not acceptable to expose children to ionizing radiation for an examination which has no therapeutic benefit and is purely for administrative purposes.” Likewise, many clinicians, radiologists, and pediatricians highlighted the ethical issue connected to exposing growing individuals to the risk (exposure to ionizing radiation) solely for administrative/legal purposes. The Royal College of Radiologists in 2007 reiterated that there was little evidence on the reliability of AE through wrist and hand X-ray and OPG, asserting that “from a patient safety viewpoint, we could never recommend irradiating for nonmedical purposes. No level of radiation is safe” [33]. At the moment, the position of the UK Border Agency about AE is: “The use of X-rays to assess the age of children is not admissible. Doctors must not be asked to use radiological date when giving age assessments” [34]. Furthermore, a pilot project started in March 2012 in the

UK, which included the execution of dental radiographs of all asylum seekers in order to assess their age, was immediately stopped because of the lack of the ethics committee approval [35].

The Royal Australian and New Zealand College of Radiologists (RANZCR) declared that “any possibility of taking an X-ray of a person’s body part as a prescribed procedure for age determination” was unlawful, affirming that the radiation risk in dental AE was greater than the benefit [36]. The Senate Committees of the Parliament of Australia has pointed out a different orientation, admitting the possibility of ordering X-ray exams for AE: “Australian courts... should have access to all relevant evidence in determining the age of a defendant, including X-ray age assessments where necessary” [36].

Moreover, some authors have pointed out [16] that the issues connected to the use of X-rays for legal purposes in children come out mainly from the extensive use of X-rays to assess the damage; for insurance purposes, children generally undergo radiological investigations without any expression of dissent from clinicians prescribing/performing the exams. Each position, therefore, should be shareable as long as it moves from principles that (1) the child must always be protected during the AE process and (2) only essential, not detrimental, and scientifically and ethically based procedures should be applied. The Italian Legislative Decree of 26 May 2000 no. 187 [37] states that the X-rays use must always be justified, and that exposure for forensic purposes is allowed only if it is justified and kept “as low as [is] reasonably achievable.”

Autonomy

The autonomy principle is founded on the right to noninterference of others on the sphere of each individual (i.e., privacy and confidentiality) and the recognition of self-determination as a right to be informed and to consent to medical care. The intense debate, concerning the right of autonomy for minors [38–41] is specifically meaningful for the age assessment process, as children who undergo age estimation seldom receive previous information about the procedure or are given information in language unfamiliar to them. Investigated children are often in an altered psychological state of fear, uncertainty about the future, loss, and loneliness, a state that investigators may not perceive or may choose to neglect. As stated by Pruvost et al. [26], “in most cases the forensic physician ignores the adolescent’s word.”

The resolution of the Council of Europe [42] explicitly states the necessity of obtaining complete information about the whole procedure, overcoming any language barriers by ensuring the presence of an interpreter, if necessary. The information should concern the purpose of the investigation, the reasons, the implications of the results (including of the case of the attribution of the legal age), the use of ionizing

radiation, and the risks associated with X-ray exposure [43]. Such detailed information is needed in order to make the minor aware of the procedure, even if investigations are imposed by authorities/judge. The subject has to be informed that AE procedures provide probabilistic evaluations and that the criminal law requires them to be assigned the lower age when doubts persist about the attainment of major age [44–47]. Following the information process, the possibility of dissent might theoretically imply that no one agrees to undergo the procedures, but in the absence of reasonable grounds for refusing the assessment, the subject could not be automatically considered a minor. In such situations, public interest might conflict with the ethical issues, since the users of a right should not be punished for it. Rather, the absence of a valid reason for refusing age assessment could endorse the suspicion of an actual age different than that declared by the person. In the absence of a concrete risk of damage, the authority pursuing the justice measures and administrative law application has the right/duty to request the AE. Regarding this issue, a recent judgment by the Italian Supreme Court has stated that [48]: “a radiographic examination may be considered likely to an external inspection, because the radiograph provides only an extension of the examination, that, through the use of radiological technique (or even other technique), is not limited only to the external appearance of the suspect but is also extended to an ‘inspection’ inside the human body. Neither...the act can be considered prohibited in terms of art. 32 of the Constitution which guarantees the right to health and forbids all forms of compulsory medical treatment except those imposed by a specific law.” This also affirms that [49] “...in cases where the X-ray examination is carried out in order to assess the age of the subject, it is useful for the public interest; and it has to be taken into account balancing of the various interest protected by the constitutional requirements.”

In cases of unaccompanied minors seeking asylum, the European legislation requests the appointment of a “guardian” since Guardianship is a right of the child [50]. This figure ensures that all decisions taken are in the child’s best interests and that a child has suitable legal representation to deal with his/her immigration status or asylum claim. Because of their young age, minors might not be able to completely understand the provided information or able to give valid consent to the age assessment; thus, a guardian can support them in making the best choice for obtaining legal protection and rights. If the European principles are respected, the right of autonomy of the minor is guaranteed.

Nonmalevolence

Regarding the potentially detrimental effect of X-rays, several studies have focused on the dose of radiation of X-rays taken for clinical purposes. These studies revealed that ionizing

radiations imply a general risk of carcinogenesis, particularly if exposure occurs in childhood [51, 52], but this risk depends on many variables such as the type of radiography, the dose, the anatomic location of the irradiated site, the number of examinations, and the time elapse between expositions [53]. Data are reported also for those radiographies routinely used for AE procedures such as the radiography of wrist-hand bones and the OPG, along with the lower X-ray exposure ensured by digital rather than analogical techniques (Table 1) [54]. OPG and X-ray of the wrist are characterized by a radiation dose less than an X-ray examination performed on other parts of the body (e.g., the chest) [55–58].

Ramsthaler et al. [58] reported on an estimated long-term cancer risk for 5-year-old children of $1.2\text{--}1.5 \times 10^{-8}$ connected to left hand X-ray, of $3.1\text{--}3.9 \times 10^{-6}$ related to OPG, and of $1.2\text{--}9.9 \times 10^{-4}$ associated to CT of the thorax. Moreover, comparing the risk of an OPG to the “hazard of everyday living,” they reported that a single OPG was associated with an average risk of developing a neoplasm equal to $1.0\text{--}1.9 \times 10^{-6}$, a value much lower than, for example, the estimated risk of death from murder, equal to 3.5×10^{-4} . Similarly, the risk of 7 h of intercontinental air travel is comparable in terms of exposure to ionizing radiation, to undergoing two OPGs [59].

Someone could also claim that there is a risk of genetic damage. However, in this respect, back in 1970s, when the dose of ionizing radiation delivered by the diagnostic radiological devices was much higher than the current ones, the genetically significant annual average dose (GSD) calculated for natural ionizing radiation is 0.9 versus 0.2 mSv of radiation with X-rays used for diagnostic purposes [60].

A different matter concerns CT scans of the clavicle, proposed by Schmeling et al. [61] to be useful in AE to ascertain if a subject has attained the age threshold of 21 years. CT scans involve a higher dose of radiation than OPG and hand X-ray, resulting in a greater risk of carcinogenesis, since the clavicle CT produces an exposition that is close to the range of radiation reported in epidemiological studies for cancer [62]. A

recent study found that in individuals aged 0–19 years, who underwent CT examination between 1985 and 2005, there is a higher incidence of cancer compared with unexposed controls. Hence, it is recommended that CT scans be limited to cases of precise and defined clinical indications, in balancing the risks and benefits of the exam, and the radiological exam be optimized to provide useful diagnostic images at the lowest possible dose [63]. On the contrary, OPG and the radiographic examination of wrist bones reported low dose X-rays and are considered relatively harmless [58], but this is not sufficient to guarantee the health of the unknown individual; it is else necessary that the forensic experts responsibly use the ionizing radiation and prescribe radiation doses that are “as low as reasonably achievable” [64], in accordance with the principle of “as low as reasonably achievable” (ALARA).

Although the radiation dose delivered by OPG and hand and wrist X-rays is low [29], it is not radiation-free, but at the moment, there are no scientifically valid and reliable methods that can be used instead of these investigations. One of these, in fact, is the physical visit and especially the inspection of sexual development of the subject. Actually, this is highly questioned both for its poor utility and for the ethical issues raised by a practice that may result in intrusiveness or violating the right of children/adolescents who often are not assisted by parents and whose possibilities to refuse the procedure are very limited. The UNICEF [21] and individual authors [17] criticized the examination of secondary sexual characteristics, considering this practice “highly intrusive and ethically questionable when conducted without medical or therapeutic benefit,” (as well as the use of X-rays). Furthermore, the standards for puberty examinations are largely based on the work of Tanner, who in 1962 identified clear stages of puberty, which develops over a 2–3-year period [50]. Because there is a large variation in the timing of pubarche (ranging from 8 to 15 years) [65, 66], the evaluation of sexual maturation may give general information of the life phase (i.e., pre-pubarche) and can be useful in clinical context, never providing age estimations endowed with the accuracy demanded to accomplish the legal requirements [67].

The Royal College of Paediatrics and Child Health [21] stated that no reliable information about the age of an individual can be obtained by anthropometric assessments, and therefore, such examinations should not even be conducted. The inspection, therefore, may take place after full disclosure of the subject, respecting a refusal or even the expression of any doubts.

In spite of poor usefulness in forensic purposes, the physical visit could be useful to discover disease or anomalies that could need care or could influence the bone growth or dental maturation. The visit, on the other hand, is perceived highly intrusive for these individuals who arrived in a foreign country alone, frightened, and without knowledge of the language. So, visit should be performed only after a suitable and completed

Table 1 Types of radiographic examinations and dose in mSv

Radiography type	Authors	Dose (mSv)
Left hand X-ray	Ramsthaler et al. [58]	0.0001
Limb X-ray	Baysson et al. [52]	<0.01
Extremities	Regulla et al. [57]	0.01–0.1
OPG	Regulla et al. [57]	0.026
	Linet et al. [55]	0.012
OPG (digital)	Baysson et al. [52]	0.02
	Grünheid [56]	0.0215
Dental examinations	Regulla et al. [57]	<0.01
CT chest	Linet et al. [55]	10
CT thorax	Ramsthaler et al. [58]	1.1–6.6
	Regulla et al. [57]	6–10

information about the kind and the purpose of the exam and after obtaining a real informed consent.

It is hoped that future research focuses on the development of reliable methods based on other imaging techniques, such as MRI or ultrasound that can be implemented in AE procedures. Currently, these diagnostic investigations seem promising, but they are used with no scientific evidence of their accuracy and reliability [68–72] compared to OPG or wrist X-rays. Moreover, the routine prescription of MRI for age investigations would cause remarkable economic problems due to the high costs of these exams and feasibility issues, as not all health-care facilities could provide MRIs in deadlines responsive to administrative/legal needs. In Italy, the Home Office [73] has recently started a project, co-funded by the European Union, to establish a new AE approach, designed to assess psychological maturity and to study the maturation of the hand and wrist anatomical structures using MRI. Although this project might be promising from a scientific point of view, its possible implementation in the daily practice of age ascertainment seems rather far. Because of it is low cost, easy to carry, and radiation-free, the ultrasound for studying wrist bone development is of great interest to the scientific community, but at the moment, there are questions not only on its reliability but also on its reproducibility, so its use is not suggested for AE of children and young people in the forensic context [17].

Beneficence

As already mentioned, the UNICEF [21] and UNHCR [22] recommend that AE should always be performed in a manner which respects the individual's liberty and dignity, pursuing especially the best interest of the children and adolescents. Nevertheless, the best interest of children/adolescents is not an a priori known condition, and it is not always to be classified under the legal threshold of age. Some forms of criminal abuse or exploitation of children such as forced prostitution, theft, and drug distribution may be facilitated by reiterated minor age estimation, so that the children avoid the criminal indictment, but, at the same time, the protection of authorities. On the contrary, in some circumstances, a child (e.g., victim of sex trafficking) is forced by their persecutors to claim to be of legal age. In 2011, Save the Children [74] reported a significant number of trafficking victims, and 959 unaccompanied minors were included in a social protection program in Italy in the period from 2000 to 2007; the more common forms of exploitation include forced prostitution for females, and drug dealing and exploitation in agricultural work or holdings occurred more frequently among males.

Moreover, for civil cases, children or adolescents' best interest might result in being correctly classified over the legal threshold, thus they attain some civil rights (e.g., driver's license, getting married, legal capacity). Hence, forensic

experts should carefully avoid any cognitive bias, i.e., the context influence [75] possibly resulting from social inputs, such as the desire to assign the major age to children accused of important crimes or to expel undesired asylum seekers. The simple awareness of the legal consequences that the subject ought to face if he/she was classified over the age threshold may result in a non-negligible source of bias; thus, proceeding in a blind manner ignoring the type of crime could be the safer and the most recommendable approach [76]. Given the relevant legal consequences of AE, only physicians and dentists qualified in the forensic field at large and in AE methods and procedures should be called to give their expert opinions. In 2012, Pinchi et al. [77] reported many cases in which children were misclassified over the age threshold by the police after incomplete and rushed radiological examinations of wrist-hand bones were provided mostly by physician's employees in first aid facilities.

Justice

The ethical principle of justice is the most complex to face and refers to both social equity and solidarity among human beings in burden sharing. It also refers to the fact that similar cases should be treated similarly, that there is fairness in distributing benefits and risks and equal opportunities for access to benefits. Concerning the age assessment procedures based on radiological methods, all legislation ought to adhere to the positions of international organizations involved primarily in the protection of minors such as the UNICEF, UNHCR, and Separated Children in Europe Programme (SCEP) [78], who recommend that.

- Individuals should only be requested to undergo an AE when this is considered to be in the best interests of the child;
- Age assessments should only be initiated if serious doubts about the child's age exist and as a measure of last resort;
- Age assessments should be applied without discrimination based on race, religion, sex, nationality, immigration status, or statelessness;
- Assessments must follow the least intrusive method that upholds the dignity and physical integrity of the child at all times and be gender and culturally appropriate;
- Where there is a margin of error, this should be applied in favor of the child; and
- Age assessments should only be undertaken by independent and appropriately skilled staff.

Regarding these standards, the national legislation (for example, in Italy) is often silent. It would perhaps be desirable to draft a memorandum of law on the point, containing operational guidance that indicates, in accordance with the ethical

principles, the methodology to be followed, depending on the age groups to be investigated.

The fairness of the AE investigation lies, in principle, according to the persistence of the doubt about the age of the subject that allows for the guarantee of the best interest of the subject with all the administrative and legal grants that this entails. The AE cannot give certainty about the actual chronological age of the subject, but for legal purposes, what generally suffices is to assess if the child/adolescent has attained the age threshold of interest. The estimated age is an evaluation on which the court can form its free conviction, always having in mind the best interest of the child and the law provisions. Furthermore, as already stated by other authors [79] who analyzed the risk/benefit of AE, it is in favor of benefits for the assisted child. In the face of a risk, in fact, an almost insignificant one with regard to radiation, the subject, if recognized as a minor, will be included in a judicial and rehabilitative course appropriate and adapted to their age. Once AE is performed, the asylum seekers who are below the legal age are legally recognized as unaccompanied minors and are not deprived of their right of asylum, but the justice principle regards also the economic resources of the host countries, which are not unlimited and must be reserved and distributed to the entitled subjects (i.e., unaccompanied minors).

Conclusions

AE, as well as being a valid and established method on a scientific level, raises ethical and deontological issues and multidisciplinary debates. In accordance with European laws, the age estimation of children must protect the best interest of the presumed minor and ensures the compliance with the ethical principles of autonomy, beneficence, nonmalevolence, and justice.

The first step for an age assessment that results conformity to the ethical principles is the interview with the minor. The interview is an invaluable occasion for the expert/operator to inform subjects about the AE procedure and its aims and phases since it is seldom that children/adolescents have been previously and correctly informed of the process; this is especially true when they are accused of crimes. Moreover, it is mainly addressed to disclose dental or bone pathologies possibly affecting the child's development or to know whether the subject has already undergone previous radiographic investigations (e.g., OPG) to avoid further and unnecessary X-ray exposure.

Despite the ethical debate about the use of ionizing radiations, a recent review showed that the majority of European countries include X-rays to reach the diagnosis of age [50] because, as mentioned above, there are no suitable alternatives to their use. To ensure that the age assessment is ethically

permissible, the procedure might be conducted in accordance with international protocols and guidelines [4–7, 80], performed by operators experienced in skeletal and dental age estimation and applying scientifically based methods for AE. Since the age assessment is ordered by authorities (courts, foreign office, police, immigration service, etc.) that may not have any experience in medical science, it is an ethical duty of forensic experts to inform those authorities about what investigations are useful while explaining their potential radiological risks. Finally, the operators/experts should stress the use of modern devices, always proposing digital investigations rather than analogical techniques and the high dose connected to CT scan, suggesting alternative methods. The possibility that a subject might have undergone other AEs in the same or in other countries must be always kept in mind by operators, who could sometime accomplish the legal demand through retrieving old radiographies of the child and avoiding new X-rays. A higher international collaboration, and at least a European database of minor asylum seekers, may contribute to this aim.

As recently argued [81], homogenization and standardization of international protocols are needed, resulting from a collaboration between various scientific societies of professionals (forensic odontologists, forensic pathologists, radiologists, pediatricians, anthropologists, and psychologists) who have been involved in age estimation for years, which pursue a balance and reconciliation of individuals' interests and the needs of the community called to protect them.

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