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Standard for Age Estimation in Forensic Anthropology

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Foreword

This document is intended to assist forensic anthropologists when estimating age from complete or partial human skeletal material. Age is one of several biological parameters that can be estimated from skeletal material or medical imaging. Age estimation is based on a relationship between biological changes to the skeleton and time, either through the subadult period encompassing growth and development of the skeletal system, or the adult period encompassing the end of development and skeletal degeneration. The interplay between age estimation and the rest of the biological profile is complex. In some cases age estimation can serve as a foundation for developing other essential estimates of a biological profile. In others, age estimation ~~accuracy in certain parts of the lifespan~~ may be improved through the use of ~~ancestry population~~ or sex-specific methods.

~~In the forensic setting, the estimated age interval of an unidentified individual is often compared to the age listed in a missing persons report and may be used as a basis to either include or exclude the individual from further consideration. Unless substantial differences in age exist, age should not be the sole basis for exclusion.~~

For age estimation from dental material from a forensic odontological perspective, please see ADA technical report 1077 ADA TR 1077: *Human Age Assessment by Dental Analysis*¹.

The American Academy of Forensic Sciences established the Academy Standards Board (ASB) in 2015 with a vision of safeguarding Justice, Integrity and Fairness through Consensus Based American National Standards. To that end, the ASB develops consensus based forensic standards within a framework accredited by the American National Standards Institute (ANSI), and provides training to support those standards. ASB values integrity, scientific rigor, openness, due process, collaboration, excellence, diversity and inclusion. ASB is dedicated to developing and making freely accessible the highest quality documentary forensic science consensus Standards, Guidelines, Best Practices, and Technical Reports in a wide range of forensic science disciplines as a service to forensic practitioners and the legal system.

This document was revised, prepared, and finalized as a standard by the Anthropology Consensus Body of the AAFS Standards Board. The draft of this standard was developed by the Anthropology Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science.

Questions, comments, and suggestions for the improvement of this document can be sent to AAFS-ASB Secretariat, asb@aafs.org or 401 N 21st Street, Colorado Springs, CO 80904.

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Keywords: *Forensic anthropology, age estimation, biological profile, personal identification.*

¹ <https://www.ada.org/en/publications/ada-news/2020-archive/march/ada-technical-report-on-age-assessment-by-dental-analysis-available-for-review>

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Standard for Age Estimation in Forensic Anthropology

1 Scope

Age is one of several biological parameters that can be estimated from skeletal material or medical imaging. This standard provides general procedures for the estimation of age from skeletal material or medical imaging [by forensic anthropologists](#).

Specific methods and techniques are not included in the standard.

2 Normative References

There are no normative reference documents.

3 Terms and Definitions

3.1

accuracy

~~Refers to a combination of trueness and precision.~~

3.23.1

age estimation

The estimation of chronological age from osseous, dental, and/or cartilaginous material, reported as an interval.

3.33.2

age mimicry

A phenomenon that occurs when means and confidence intervals for particular features/phases are calculated directly from the ages of individuals with those features in the reference sample, resulting in a method that produces results more influenced by the composition of the reference sample than the true age distribution of the features in the population.

3.43.3

biological profile

The description of an individual's estimated sex, ancestry, age, and living stature derived from an anthropological (skeletal) analysis.

3.53.4

chronological age

The age of an individual in years, months, and/or days, calculated as the difference between the individual's date of birth and a specific later date.

3.63.5

dental development

Growth and maturation of the dentition, including enamel mineralization, crown, and root formation.

3-73.6**dental eruption**

The process of tooth migration from its initial position in its bony crypt through the alveolar bone, the gingival tissue, and toward the occlusal plane.

NOTE For the purpose of forensic anthropology, most methods consider only eruption through the alveolar bone.

3-83.7**secular change**

Change in phenotype (e.g., stature) in a population over time.

3-93.8**skeleton/skeletal**

Osseous, cartilaginous, and/or dental tissues.

4 Requirements**4.1 General**

Skeletal elements and imaging thereof shall be analyzed in a reliable and systematic manner to estimate age. Methods applied to estimate age shall be appropriate for the skeletal elements available and their general developmental stage. All methods used shall be documented to allow verification and replication of the work performed.

Age estimation shall be made independently of suspected or presumptive identification to minimize cognitive bias.

Extensive knowledge of skeletal anatomy, including the range of normal human variation and experience with various age-estimation methods, is required to correctly apply methods and interpret results.

Age estimation from skeletal remains should be conducted even if DNA or other analyses will be performed.

Age estimation shall follow methods published in peer-reviewed sources.

If ~~one or more bones~~ skeletal material required to apply a specific method ~~are~~ is absent, the method shall not be used. If a method utilizes multiple skeletal elements/features and enough are present to sufficiently apply a method, it may be used at the discretion of the practitioner. The quality of available skeletal material shall be considered when selecting a method.

All test results and observations shall be documented and described, including those that are inconsistent with the final age estimate.

Forensic anthropologists shall comply with all legal responsibilities needed to complete their analyses, which may include state and local laws regarding consent, obtaining medical records, and storing personal data.

4.2 Procedure

4.2.1 General

Choice of age-estimation methods shall be dictated by the skeletal elements available, their condition/degree of preservation, and the age group to which the individual belongs (i.e., subadult vs. adult remains).

Relevant, published methods shall be followed, and validated methods should be given preference. When multiple methods are available, the method(s) with the greatest accuracy and most appropriate reference sample(s) (in terms of sample size, time period, genetic, cultural, and/or environmental similarity) shall be given greater consideration when synthesizing an age estimate. If a sample representative of the unknown skeleton is not used or if the appropriate reference is not known, the examiner shall address the resulting uncertainty in developing an estimated age using methods developed for this purpose.

Unless substantial differences in age exist between a set of remains and a missing person, age should not be the sole basis for exclusion for a possible identification.

Means or other measures of central tendency from multiple methods shall not be averaged.

4.2.2 Fetal Age Estimation

Fetal age is reported in gestational weeks. Age estimation shall be based on long bone lengths, individual bone development, and/or developing dentition.

4.2.3 Infant and Child Age Estimation

Infant and child age estimation shall be based on dental and skeletal indicators including dental development, dental eruption, diaphyseal dimensions, and appearance and maturation of ossification centers.

4.2.4 Adolescent/Young Adult Age Estimation

Adolescent and young adult age estimation shall be based on dental development, dental eruption, epiphyseal formation, and/or epiphyseal union.

4.2.5 Adult Age Estimation

Adult age estimation shall be based on skeletal maturation, degeneration, and/or microscopic features.

4.2.6 Considerations and Adjustments

Both sex-based and population-based variation exists in dental and osteological development. When prioritizing method selection, consider potentially confounding factors, such as socio-economic status, secular change, pathological conditions, trauma, taphonomy, and biomechanical demands on the skeleton. Age predilection of some pathological conditions may offer insights into age estimations. The age estimate shall consider intrinsic or extrinsic variables for which there is evidence that may impact age estimation during the anthropological analysis.

Choice of statistical model, age mimicry, conditional independence/dependence of features with age, and the heteroscedasticity of age-related data, are complicating factors when comparing the results of validation studies and interpreting the results of age-estimation methods. Individual practitioners cannot directly resolve these issues, but should be aware of their potential impacts.

Methods used to age younger individuals typically result in more narrow intervals than those for older individuals. With increasing chronological age, the variation produced by environmental factors and life history tends to increase.

In theory, age-estimation protocols can also be used to analyze skeletal development in living individuals, typically to address a question of whether an individual has reached the age of majority. In practice however, due to biological variation as well as method error, forensic anthropologists anthropological age estimates should not estimate age in living individuals be used to answer any question that involves a point estimate of age—either in the living or in the deceased.

4.2.7 Documentation and Reporting

All raw data, techniques, and interpretation shall be documented. Documentation should take the form of text and/or images and shall be recorded and maintained in accordance with agency or institutional policy. If multiple methods are used, explanation as to how a final minimum age and maximum age were produced, shall be documented. Documentation should allow for an independent examiner to assess how the final estimate was produced.

Specific method(s) used to generate an age estimate shall be reported. An age estimate shall be reported as an interval, per method specification (e.g., 95% confidence/prediction interval, two-standard deviation range, posterior probabilities). If a method produces a point estimate, that may be reported in addition to the interval.



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