ASB Best Practice Recommendation 174, First Edition
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Best Practice Recommendation for Age Estimation in Forensic Anthropology

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Foreword

This document provides recommendations to improve accuracy, quality, objectivity, and consistency of estimating age at death. This document is not a standard operating procedure nor an instruction manual for the estimation of age at death; rather, this document recommends preferred approaches , techniques, and considerations to support the implementation of ANSI/ASB Standard 133 under optimal circumstances. Informative references are provided. Implementation of this BPR requires a working knowledge of the published references. It is incumbent upon practitioners to utilize the most appropriate, validated research for the estimation of age.

Anthropological conclusions derived from the morphologic, metric, and medical imaging analyses of human remains are often supported by statistical frequencies, error probabilities, and confidence intervals from available reference data in the peer-reviewed published literature. It is acknowledged that the reference samples used in various methods do not reflect the totality of global human variation; therefore, conclusions cannot always be supported by these statistical measures. As such, this document encourages continued research and scholarly debate to improve the scientific validity of estimating age.

Age at death estimation is one component of the anthropological biological profile. The purpose of the biological profile is to provide demographic estimations to inform investigative leads regarding the identification of an unidentified decedent. As noted above, the complexities of human variation directly affect anthropological methods; therefore, the components of a biological profile are reported as intervals, estimations, or both and are meant to serve as investigative parameters. It is acknowledged that the known demographics of a missing person may fall outside of the interval or estimation reported by a forensic anthropologist. Anthropological estimates of biological characteristics are typically only used with consideration of multiple lines of evidence to contribute to the inclusion or exclusion of a missing person as a match to an unidentified decedent.

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.

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.

All hyperlinks and web addresses shown in this document are current as of the publication date of this standard.

ASB procedures are publicly available, free of cost, at www.aafs.org/academy-standards-board.

Keywords: *TBD*

Table of Contents *(to be finalized prior to publication)*

Best Practice Recommendation for Age Estimation in Forensic Anthropology

1 Scope

This best practice recommendation provides preferred approaches for the estimation of age at death in forensic anthropology. It does not provide minimum standards for estimating age at death as these are covered in ANSI/ASB Std 133.

2 Normative References

The following reference is a document that is indispensable for the application of the standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ANSI/ASB Standard 133, *Standard for Age Estimation in Forensic Anthropology*, 1st ed 2024[a]

3 Terms and Definitions

For purposes of this document, the following definitions apply.

3.1
age estimation
The estimation of chronological age from osseous, dental, or cartilaginous material, or a combination of these, reported as an interval.

3.2
chronological age
The age of an individual in years, months, or days, calculated as the difference between the individual's date of birth and a specific later date.

3.3
dental development
The growth and maturation of the dentition, including enamel mineralization, crown, and root formation.

3.4
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.

[a] Available from: https://www.aafs.org/academy-standards-board

3.5
documentation
The record of observations and scientific data used to make interpretations and conclusions, including written descriptions (i.e., bench or analytical notes) and visual representations (e.g., photographs, diagrams/sketches, radiographs, casts, 3D scans).

3.6
independent analyst
A subject matter expert not involved in the original analysis.

3.7
report
The practical synthesis of findings, interpretations, and conclusions, supported by information contained in the documentation.

3.8
secular change
A change in phenotype (e.g., stature) in a population over time.

3.9
skeleton/skeletal
Osseous, cartilaginous, and/or dental tissues.

4 General Recommendations

4.1 Age-at-death estimates can be generated from skeletal remains or representations thereof, including photographs, medical imaging, and casts. The level of description and documentation of the process, as well as the long-term storage of this information, varies among practitioners and laboratories. An age estimate is an opinion based on what is available for analysis, what is observed, and how the analyst synthesizes and interprets available data.

4.2 The procedures used to estimate age vary from case to case, but a logical and consistent process should be used to evaluate remains and develop an analytical plan.

4.2.1 This process should address the broad age category of the individual (i.e., fetal, infant/child, adolescent/young adult, older adult), the presence and condition of age indicators, life history characteristics, appropriateness of available methods, procedures for combining multiple methods, and circumstantial information potentially influencing the results.

4.3 Considerations that potentially influence the age estimate(s) should be documented in such a manner that an independent analyst could understand the choices made and evaluate their potential effects on the results.

4.4 When prior information is known, it should be treated as a working hypothesis to be rejected.

NOTE Ideally, analysts would have no prior knowledge of the suspected or known age of the decedent prior to observing potential age indicators. In practice, however, this is often not possible for sole practitioners or in labs where analysts collaborate on cases.

4.5 No biological age indicator is perfectly correlated with chronological age; age estimates should only be used as investigative leads, or as one of many lines of evidence contributing to an identification or the exclusion of an individual from further consideration.

5 Considerations for Method Selection

5.1 Analysts should inventory and document the condition of all available skeletal material prior to developing an age-estimation strategy.

5.1.1 The type, location, and potential etiologies of each observation should be considered.

5.1.2 When remains are altered or incomplete due to trauma, pathology, or taphonomic processes, analysts should avoid over-interpretation of limited information.

5.2 Analysts should assess what age group an individual likely belongs in to guide their selection of methods.

NOTE Age groups, such as fetal, infant/child, adolescent/young adult, adult, represent broad developmental periods in which similar approaches can be used (e.g., bone metrics, epiphyseal fusion, degeneration). Multiple published methods typically exist for each approach.

5.2.1 *Fetal Age Estimation:* Fetal age is reported in gestational weeks based on long bone lengths, individual bone development, developing dentition, or a combination of these. There is overlap among methods for fetal, infant, and child age estimation.

5.2.2 *Infant and Child Age Estimation:* Infant and child age estimation is based on dental and skeletal indicators including dental development and eruption, diaphyseal dimensions of long bones, and appearance and maturation of ossification centers.

5.2.3 *Adolescent/Young Adult Age Estimation:* Adolescent and young adult age estimation is based on dental development, dental eruption, epiphyseal formation, epiphyseal union, or a combination of these.

5.2.4 *Adult Age Estimation:* Adult age estimation is based on skeletal maturation, degeneration, microscopic features, or a combination of these.

5.3 Any method utilized should have source data consistent with the materials under examination (i.e., dry bones should be compared to methods based on dry bones), unless the method has been validated for use with other data types.

5.4 For each method used, the sample size, time period, and genetic, cultural, and environmental similarity to the case being examined should be considered.

5.4.1 If a sample representative of the unknown skeleton is not used or if the appropriate reference is not known, analysts should preferentially consider methods that include large and diverse samples.

5.5 Methods should be chosen from peer-reviewed sources when possible.

5.5.1 Preference should be given to methods with at least one peer-reviewed validation study using samples other than those used to derive the method and observers other than the original method developers.

5.5.2 The number of published validation studies should not be used to justify choosing one method over another.

5.5.3 If methods with independent, peer-reviewed validation are not available, methods with validations published in non-peer reviewed sources (e.g., book chapter, conference poster, master's thesis) or those validated by studies within a lab or by individual researchers may be considered.

5.5.4 In cases where no suitable peer-reviewed methods are available, this limitation should be documented.

5.6 If multiple methods for an age indicator are available (e.g., pubic symphysis), a single method should be applied.

5.7 Analysts should consider the skeleton as a whole and not be unduly influenced by one indicator or feature.

5.8 The use of multiple age-estimation methods based on different regions of the body, or a method combining data from multiple regions is strongly recommended.

6 Age-Estimation Approaches

6.1 General

The sections 6.2 through 6.5provide recommendations for age-estimation approaches. Some features provide age-informative data in multiple age groups. Specific methods are not recommended, but a list of commonly used methods is provided in Annex A, Bibliography.

6.2 Bone Metrics

6.2.1 The gestational age of fetal remains or age of infants can be estimated from metric measurements taken either from physical remains or medical imaging.

6.2.2 When evaluating methods and reporting results, practitioners should be cognizant that gestational age is different from fetal and developmental age, which are estimated from the time of conception; these terms are not interchangeable.

6.3 Ossification Centers and Epiphyseal/Apophyseal Fusion

6.3.1 The appearance and development of primary and secondary ossification centers can be used to age individuals in the fetal, infant, and child age groups. These features can be used along with epiphyseal/apophyseal fusion to age adolescents and young adults.

6.3.2 Radiographically, the appearance of ossification centers can be used for age estimation beginning in the fetal period; however, in dry bone, the appearance of primary and secondary ossification centers in fetal remains are often of limited value due to the difficulty in identifying individual epiphyses, as well as the high likelihood of postmortem loss or damage. Epiphyseal development and fusion can be particularly useful in older children, adolescents, and young adults.

6.3.3 When possible, age should be independently estimated from dental and osseous indicators; discrepancies between the two may indicate the presence of antemortem conditions (e.g., disease, malnutrition).

6.3.4 Reference books provide developmental summaries for each bone and its epiphyses from fetal development to young adulthood. Summaries are based on multiple studies available at the time of printing. These summaries provide an excellent starting point for developing a general age estimate; however, practitioners should consult the original publications to assess features of the samples, methods, and statistical analysis that may impact the suitability of any particular method in a given case.

6.3.5 Age can be estimated from a synthesis of individual age indicators throughout the body or via an atlas method that considers the developmental status of multiple structures within a single region (e.g., hand and wrist; knee). For atlas methods, practitioners should report statistics associated with the selected developmental stage.

6.3.6 Evaluation of the developmental status of the acetabulum, spheno-occipital synchondrosis, superior and inferior annular rings of vertebrae, iliac crest, and medial clavicle provide benchmarks for estimating a broad age range that can be further refined using additional epiphyses and dental development. The final age estimate is a synthesis of the intervals provided by multiple developmental indicators.

6.3.7 Young adults can display a combination of developmental and adult morphology. The use of adult indicators for actively developing individuals is inappropriate and will often provide anomalous results. When developmental features are present, they should be used rather than adult indicators (e.g., sternal rib ends, pubic symphysis) due to their higher correlation with chronological age and the poor representation of young adult individuals in the reference samples of adult indicator methods.

6.4 Dental Development and Eruption

6.4.1 Dental development can be useful from the late fetal period through young adulthood.

6.4.2 When teeth are retained in the alveolar bone, dental radiographs should be taken to capture developmental information.

6.4.3 Age estimates should be based on multiple teeth, if available.

6.5 Maturation and Degeneration (Adult)

6.5.1 Upon cessation of growth and development (i.e., fusion of all epiphyses and completion of the roots of all permanent detention), the human skeleton continues to change through processes of maturation and degeneration. Age-informative structures that undergo maturational and degenerative change include joints and areas of ligamentous ossification. These processes are less regular and predictable compared to growth and development which necessitates wider (less precise) age estimate intervals.

6.5.2 Age can be estimated from a single structure, a synthesis of individual age indicators throughout the body, or via a multivariate method that considers the maturation and degeneration of structures in multiple regions.

6.5.3 Age-related skeletal changes are influenced by intrinsic and extrinsic factors, including sex, genetics, socioeconomic status, secular change, pathological conditions, trauma, and biomechanical demands. These factors can affect the appearance of skeletal features and/or the performance of age-estimation methods. While some research exists addressing the impacts of these factors at an aggregate level, no correction or adjustment should be applied for known or assumed information about an individual decedent, beyond selection of existing method parameters.

7 Documentation and Reporting

7.1 Not all information in the documentation needs to be included in the report.

7.2 The following should be included in the documentation for each method applied, regardless of whether the method ultimately contributed to the final reported interval:

a) the reference used, including name(s) of the author(s) and date of publication;

b) the skeletal observations (e.g., element used, phase score, component scores, feature descriptions);

c) the age interval associated with those scores using the cited method; and

d) methodological and skeletal factors impacting the performance or interpretation of the method, if applicable (e.g., poor preservation, antemortem trauma).

7.3 If a method produces a point estimate, it may be reported in addition to the interval, but should not be used in isolation without inclusion of the interval.

7.3.1 If an atlas method is used, publications providing associated statistics for bone/tooth formation should be consulted to report appropriate error associated with the estimate for a particular individual.

7.4 No consensus procedure exists for combining age intervals generated from two or more methods; if multiple methods are used, an explanation of how the methods informed the final age estimate should be documented.

7.4.1 The information should be sufficient for an independent analyst to understand the:

a) process undertaken;

b) factors potentially influencing the results; and

c) how the lower and upper bounds of the interval were selected.

7.4.2 Means or other point estimates should not be averaged.

NOTE Averaging multiple point estimates is never statistically appropriate.

7.5 The complete interval from the published method should be documented (e.g., 37.8 to 63.4 years), but the age estimate should be reported as whole years rounded down and up, respectively, for the floor and ceiling of the range (e.g., 37 to 64 years; not 38 to 63 years).

Annex A
(informative

Bibliography

Please note that the following sources represent an informative bibliography—intended to assist the reader in researching, choosing, and applying appropriate age-estimation methods—not a normative bibliography providing references necessary for the application of the standard. It does not represent an all-inclusive list of age-estimation methods, and it does not supersede lists provided by practitioners' agencies/facilities. With some exceptions, the informative bibliography largely comprises more recent sources. A non-normative list of historical age-estimation methods is also included.

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