Biological Profile Estimation

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1 Introduction

This document describes procedures for estimating the biological profile (including sex, age, ancestry, stature, or other biological features) of human skeletal material. This profile can be used to narrow the potential match pool in the identification process.

2 Scope

This document applies to Anthropology Examiners in the Trace Evidence Unit (TEU).

3 Equipment

- General laboratory supplies
- Personal protective equipment (e.g., lab coat, gloves, eye protection)

4 Procedure

4.1 Sex Estimation

A. Sex estimation is performed by morphological and/or metric procedures that examine sexually dimorphic characteristics of the skeleton.
B. If available, bones that are known to exhibit the greatest sexual dimorphism (e.g., pelvis, long bones, skull) will be examined, though other bones may also be used.
C. Selection and application of sex estimation methods depend on the skeletal elements available for examination, their condition, and the general age of the individual (i.e., adult versus subadult).
D. Generally, the estimation model with the highest correlation and the lowest standard error will be selected. When applicable, population- and temporal-specific models will be used.

4.1.1 Morphological Methods

A. Skeletal differences in morphological traits vary between the sexes by shape, features, and relative size.
B. When multiple methods are available, the most dimorphic trait(s) shall be given greater consideration.
C. Whichever methods are applied, bone-specific reference literature and/or casts, will be used when available and documentednstructions for technical step(s).

4.1.2 Metric Methods

A. Measurements used in sex estimation generally involve limb bone size and articular surface size.
B. Metric techniques require bone-specific literature and/or software such as FORDISC.
C. Multiple measurements and multivariate techniques will be used when possible.
D. For metric procedures, measurements will be taken following methods described in appropriate reference literature, depending on the metric technique used.

E. Reference material will be used according to the method described within and cited in the case notes.

4.1.3 *Subadult Sex Estimation*

A. Sex estimation methods for fetal, infant, or child remains under ~12 years of age are considerably different from those applied to adults because many sexual differences are not yet expressed skeletally.
B. If sex estimation is performed for subadult remains, the published method will be followed and documented.

4.2 Age Estimation

A. Age estimation is based on evaluation of developmental or degenerative skeletal changes.
B. The method(s) used will be determined by the type, condition, and amount of remains present.
C. Depending on the skeletal material available for analysis, the estimation model with the highest correlation and the lowest standard error will be selected.
D. In most cases, age estimation will be performed by visual examination and documentation of developmental or degenerative status. These techniques may require bone-specific reference literature and/or casts.
E. To assess the status of material that cannot be seen visually (e.g., unerupted teeth), radiologic examination may be performed.
F. Reference material will be used according to the method described within and cited in the case notes.

4.2.1 *Age Estimation for Subadults*

A. If teeth are present, they will be assessed for their stage of mineralization and/or eruption. This will typically require the use of radiology, but when possible may also involve direct visual examination. Dental development is more highly correlated with chronological age than bone development.
B. Osseous development including appearance of ossification centers, long bone diaphyseal lengths, and epiphyseal union may also be used when available.

4.2.2 *Age Estimation for Adults*

A. Age estimation in adults generally involves assessment of degenerative and other skeletal changes.
B. Certain methods are more applicable to particular periods of adult life.
C. Valid methods include assessment of pubic symphyseal morphology, sternal rib ends, histological bone remodeling, as well as more general indicators of senility (e.g., osteoporosis, osteoarthritis, other age-related skeletal disease).

4.3 Ancestry Estimation

A. Ancestry estimation is performed by analyzing geographically-varying cranial non-metric and/or cranial and post-cranial metric characteristics commonly associated with individuals from particular geographic regions.
B. Depending on the skeletal element(s) available for analysis, the estimation model with the highest correlation and the lowest standard error will be selected.

4.3.1 Morphoscopic (Non-Metric) Methods

A. Morphoscopic methods involve assessment of traits and trait complexes that are associated with geographic ancestry.
B. Morphoscopic methods require bone-specific reference literature.

4.3.2 Metric Methods

A. Metric methods involve assessment of skeletal measurement that are associated with geographic ancestry.
B. Metric methods require bone-specific reference data and software tools such as FORDISC.

4.4 Stature Estimation

A. Stature estimation provides the most probable stature of an unknown individual by performing calculations based on bone dimensions.
B. Stature may be estimated by anatomical or linear regression methods as appropriate.
C. Stature estimates will be reported to include a 95% prediction interval.
D. Depending on the skeletal element(s) available for analysis, the estimation model with the lowest standard error will be used.
E. Estimation models employed will be derived from an appropriate reference population, where available.
F. Reference material will be used according to the method described within and cited in the case notes.
G. Measurements taken will follow method-specific definitions and/or measurement guidelines.
H. Consideration will be given to any conditions that may affect stature estimation including age (e.g., advanced age or subadult) and pathological conditions.

4.4.1 Anatomical Method

A. The anatomical method involves estimating stature based on the sum of the vertical measurements of all bones that contribute to stature, along with a correction factor for soft tissue.
B. Measurements and calculations applied will follow the relevant published method.

4.4.2 *Linear Regression Method*

A. The linear regression method involves estimating stature based on the mathematical relationship between stature and bone dimensions.
B. Most linear regression methods are based on measurements of complete limb bones.
C. Formulae also exist for fleshed body parts and non-limb bones, these methods may be used when validated.

4.5 Other Biological Features

A. Other biological features of the skeleton may further narrow the potential match pool.
B. Such features may include skeletal anomalies and pathologies. Anomalies include skeletal variants from normal anatomy that are typically nondisruptive to function. Pathological conditions are changes in normal anatomy due to a disease process.
C. The analysis of skeletal anomalies and pathologies may require visual, radiological, microscopic, or histological examination.
D. Anomalies and pathologies can be identified by differential diagnosis through comparison to descriptions or exemplars from medical or anthropological sources.
E. Documentation may include a written description and supporting images (e.g., photographic, radiological, sketches, and/or diagrams) of the location, distribution, pattern, and characteristics of the anomaly or pathological condition.

5 LIMITATIONS

The conclusions that can be reached from anthropological examinations for estimating the biological profile of skeletal remains are dependent on the condition and completeness of the remains. Results based on fragmentary or poorly preserved material may be inconclusive.

From studies of known individuals, suites of traits as well as metric relationships are understood to characterize certain groups; however, due to variation within the human species due to both genetic and external factors (such as diet and lifestyle), no particular feature or measurement is considered diagnostic of membership in any one particular group.

Due to differences in ancestral reporting standards, possible matches with individuals of ancestries other than those reported should not be excluded without further investigation.

6 SAFETY

- While working with physical evidence, laboratory personnel will wear at least the minimum appropriate protective attire (e.g., laboratory coat, safety glasses, protective gloves).
- Universal precautions will be followed.

- Exposure to biological and radiological hazards may be associated with the examination techniques performed. Safety procedures related to specific instruments or equipment will be followed. Refer to the FBI Laboratory Safety Manual for guidance.

7 References

ANSI/ASB Standard 045. Standard for Stature Estimation in Forensic Anthropology (current version)

ANSI/ASB Standard 090. Standard for Sex Estimation in Forensic Anthropology (current version)

ANSI/ASB Standard 134. Standard for Analyzing Pathological Conditions and Anomalies in Forensic Anthropology (current version)

FBI Laboratory Safety Manual (current version)

ANTHRO-300: Forensic Anthropological Examinations (current version)

8 Revision History

Revision	Issued	Changes
03	08/22/2021	Replaced SWGANTH documents with OSAC standards in References. Language (including Reporting examples) revised to reflect language in OSAC documents.
04	01/28/2022	Language revised to reflect language in ANSI-ASB Standards. Added procedure for subadult sex estimation. Formatting and language changes to conform to new template.