Determination of Biological Sex
Anthropological Protocol

- Is the bone human? Context?
- How many individuals?
- Biological profile:
  - **Biological sex determination**
    - Morphology/anthroposcopical (visual)
    - Metric/anthropometric (measurement)
  - Age-at-death
  - Ancestry
  - Stature
- Unique pathology or condition?
- Trauma?
Biological Sex vs. Gender

- **Biological Sex**
  - The physical/anatomical difference between males and females
  - Often based on the type of gametes produced by the gonads (ova = female, spermatozoa = male)

- **Gender**
  - Social construct
  - Specifies the socially and culturally prescribed roles men and women are to follow
    - Can be influenced by an individual’s biological sex
Biological Sex Determination

• Sexual dimorphism
  – Size
    • Males larger, more muscled than females
  – Architecture
    • Female pelvis designed to bear children

Image courtesy of Ashley L. Humphries
Population Differences

European Female

Asian Male
Sex Determination of Immature Skeletons

- Difficult, not very accurate
- Sex differences do not become pronounced until puberty
Accuracy of Indicators
Anthroposcopnic (Visual)

- Skull and pelvis together
  - 90-100% accuracy
- Pelvis alone
  - 90-95% accuracy
- Skull alone
  - 80-90% accuracy
- Long bones alone
  - ~80% accuracy

Image from www.edupics.com
**Sex Differences of the Pelvic Girdle**

<table>
<thead>
<tr>
<th>ANTERIOR VIEW</th>
<th>SUPERIOR</th>
<th>INFERIOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEMALE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;90 degrees</td>
<td>Sacrum Tilted Back</td>
<td>Flared Ilia</td>
</tr>
<tr>
<td><strong>MALE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;90 degrees</td>
<td>Sacrum Tilted Forward</td>
<td>Narrow Ilia</td>
</tr>
</tbody>
</table>
Greater Sciatic Notch

Males: Narrower  Females: Wider

Preauricular Sulcus

Males: Absent, Rare

Females: Usually Present

Image from Byers (2008)
Ischiopubic Ramus

Male: Wide, blunt  Female: Narrow, sharp
Pubic Body

Males: Triangular  Females: Rectangular, Square
Male or Female?

A. 

B. 

Advances in Forensic Anthropology TTW

Biological Sex Determination
Male or Female?
Male or Female?
Sex Differences of the Skull (Anthroposcopically)

Nuchal Area

Males: rugged, sometimes w/ hook
Females: smooth, hook uncommon
Mastoid Process

Males: Larger, more projecting
Females: Smaller, non-projecting
Supra-Orbital Margin

Males: Rounded

Females: Sharp
Browridges
Males: Large or pronounced

Females: Small or none
Frontal Bone

Males: Slanted

Females: High, rounded
Shape of the Mandible

Males: Broad, square
Female: Narrow, pointed, rounded
Male or Female?
Male or Female?
Determining Sex
Metric Approaches

- AKA: Anthropometry
- Quantified approaches
- Early comparisons based on single measurements or indices
- Recent analyses have taken advantage of multivariate statistics
- Accurate measurements require knowledge of the skeleton and its various features and landmarks

Images from Bass (2005)

Image from http://www.anthro4n6.net/forensics/
Metric Analysis - Postcrania

- Femoral Head Diameter
  - European American
    - Female <42.5
    - Female? 42.5-43.5
    - Indeterminate 43.5-46.5
    - Male? 46.5-47.5
    - Male >47.5
  - From: Stewart (1979)
**Metric Analysis - Postcrania**

- **Humeral Head Vertical Diameter**
  - Females: <43mm
  - Indeterminate: 44-46mm
  - Males: >47mm

- **From: Stewart (1979)**

![Image from www.edupics.com](www.edupics.com)
Ischio-Pubic Index

- \( \frac{\text{pubic length}}{\text{ischium length}} \times 100 \)
  - Male <84  - Female >94

- If ancestry is known:
  - African American
    - Male <84  - Female >91
  - European American
    - Male <91  - Female >94

- From: Bass (2005)
Cranial Measurements
Allow researchers to summarize the dimensional elements of Sexual Dimorphism

- Size and shape analysis based on linear distances between landmarks
- Linear measurements plugged into discriminant function equations to produce sectioning points
- Female <sectioning point> Male
- Ancestry dependent standards
- Beware of standards based on inappropriate data

Images from Bass (2005)
Example Discriminant Functions:
Sex Estimation using Cranial Metrics
African American: \( \text{measurement} \times \text{coefficient} = \text{value} \)

- Max breadth (XCB): \( 142 \times 9.22 = 1309.24 \)
- Max length (GOL): \( 190 \times 7.00 = 1330 \)
- Basion-Bregma (BaBr): \( 132 \times 1.00 = 132 \)
- Basion-Prosthion (BaPr): \( 105 \times 5.89 = 618.45 \)
- Bizygomatic breadth (BB): \( 134 \times 31.11 = 4168.74 \)
- Palatal breadth (PB): \( 57 \times -30.56 = -1741.92 \)
- Nasion-alveolare (NaAlv): \( 75 \times 20.22 = 1516.5 \)
- Mastoid length (LM): \( 37 \times 47.11 = 1743.07 \)
- **Sum of all values: 9076.08**

Greater than 8171.53? = yes
Male or female? = **Male**
3D-ID


• Linear measurements taken between endpoints (landmarks) provide incomplete information about their relative positions

• Geometric Morphometrics
  - Size and shape analyses that uses Cartesian coordinates of anatomical landmarks from which traditional linear measurements are taken

• 3D-ID
  - X, Y, Z coordinates from an unknown are compared to a known reference population

Image from Slice and Ross http://www.3d-id.org (2011)
Cited Scientific References


Questions?

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Note: All images are courtesy of Dr. Ann H. Ross, unless otherwise indicated.