

# The Value of Radiographic Standardization in the Medico-Legal Setting



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# The Biological Profile

## Adults:

- Sex
- Ancestry
- Stature
- Age

## Subadults (<20 years)

- Age



# Inadequacies of Available Methods

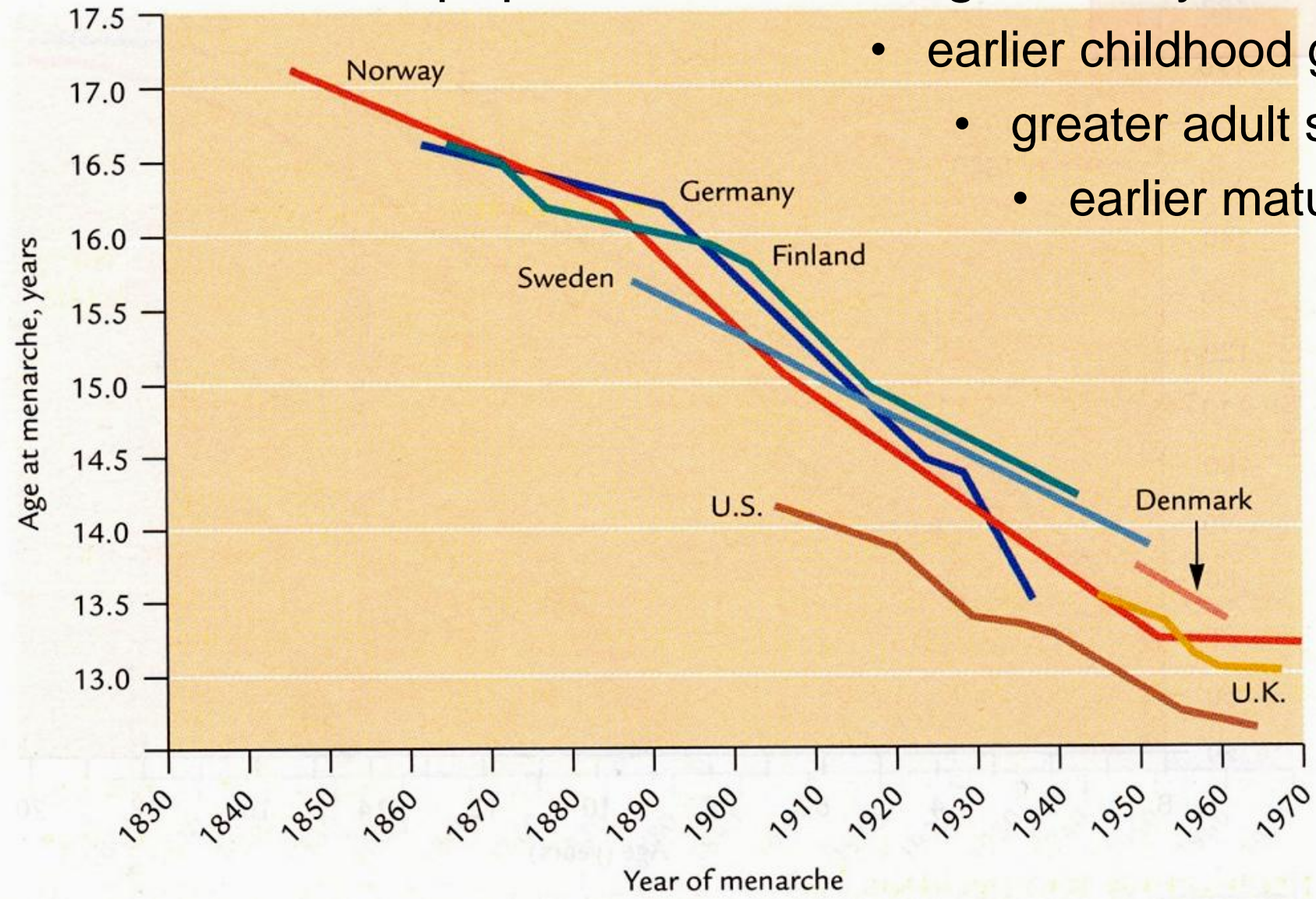
Based on considerably antiquated samples

- Scheuer and Black (2000) published reference data for long bone age at death estimates
  - Reference Maresch (1970)
- Original data source: Maresch (1939)

# Inadequacies

Modern populations show significantly:

- earlier childhood growth
- greater adult stature
- earlier maturation



# Inadequacies

Previous data limited to European-Americans

Differences in age of epiphyseal union

- Mexican-Americans 15
- African-Americans 16
- European-Americans 17

(Crowder and Austin 2005)



# Inadequacies

## Statistical Issues

- Historically
  - normal growth for known age
  - failure to meet *Daubert* standards
- Currently
  - predict age from bone length
  - apply appropriate statistics

# Lack of Modern Samples

- Few known modern skeletal collections
- Collections almost exclusively adults
- Donations by parents of deceased children - exceedingly rare

# Radiographs

- Problems with clinical radiographs
- Extensive radiographs routinely collected by medical examiners and coroners
- Most comprehensive source of modern subadult osteological information
- Demographic information available



# NIJ Grant

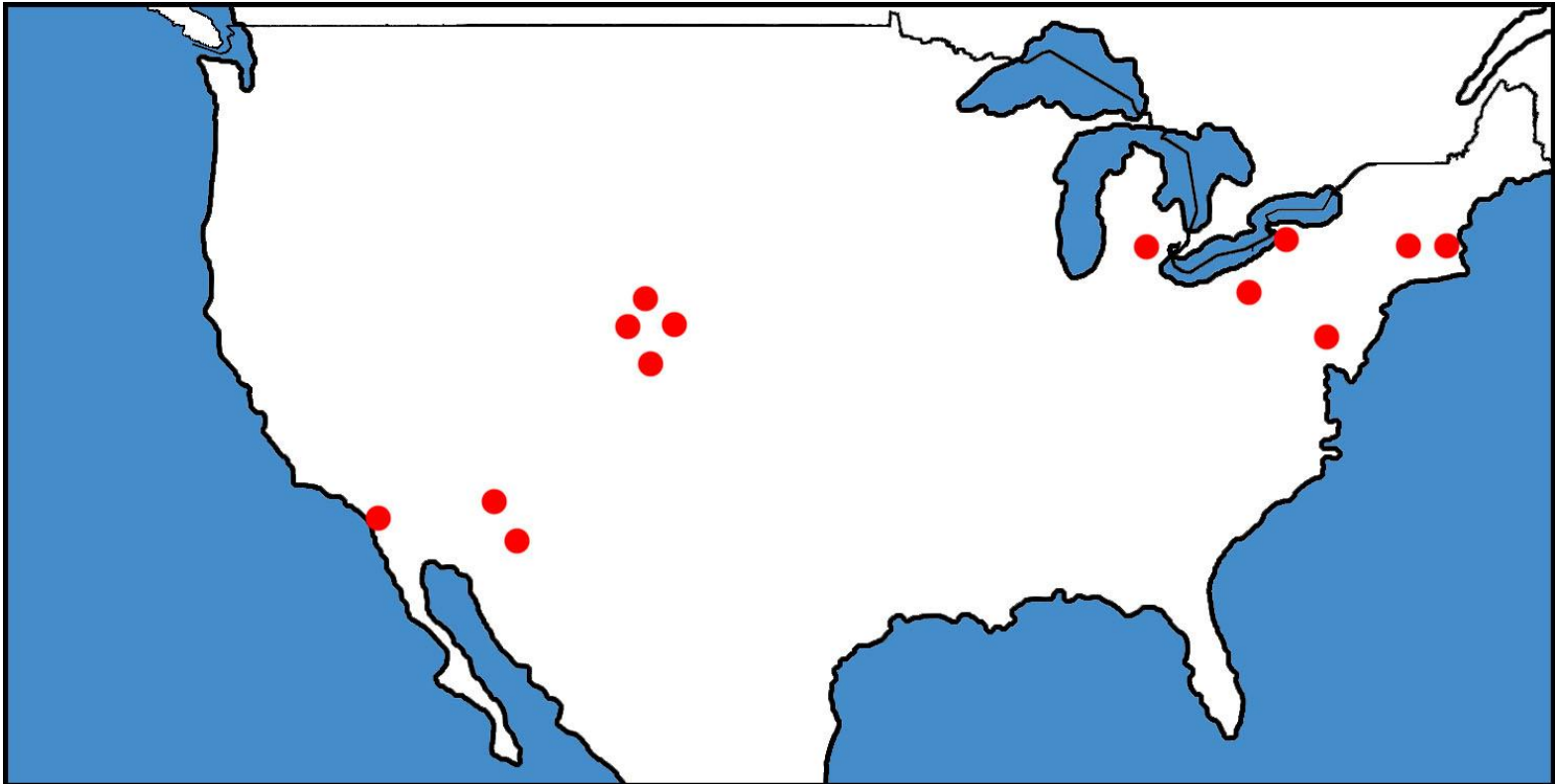
- Creation of digital database
- Sample selection
  - Individuals under the age of 20
  - Year of death after 2000
  - Geographically diverse
- Goals:
  - Scan radiographs
  - Link to demographic information
  - Make available for research

# Data Collected

- Demographic
  - Sex
  - Ancestry/Race/Nationality
  - Height
  - Weight
  - DOB/DOD
  - COD/MOD
- Metric
  - Crown-Heel
  - Crown-Rump
  - Head Circumference
  - Chest Circumference
  - Abdominal Circumference
  - Foot Length
  - Anterior/Posterior Fontanelle - Closed/Open
- Medical History

# Research Progress

- 13 offices
- 11,612 radiographs
- 2,466 individuals



# Value of Radiographic Data

- General impression
  - Not used to form “diagnoses”
  - Used to locate artifacts and image trauma
- Another perspective
  - Significant research potential
  - Need high quality forensic evidence
  - Can impact determination of COD/MOD
  - Possibility of subpoena

# X-Ray Equipment

- Financial obstacles to modernization

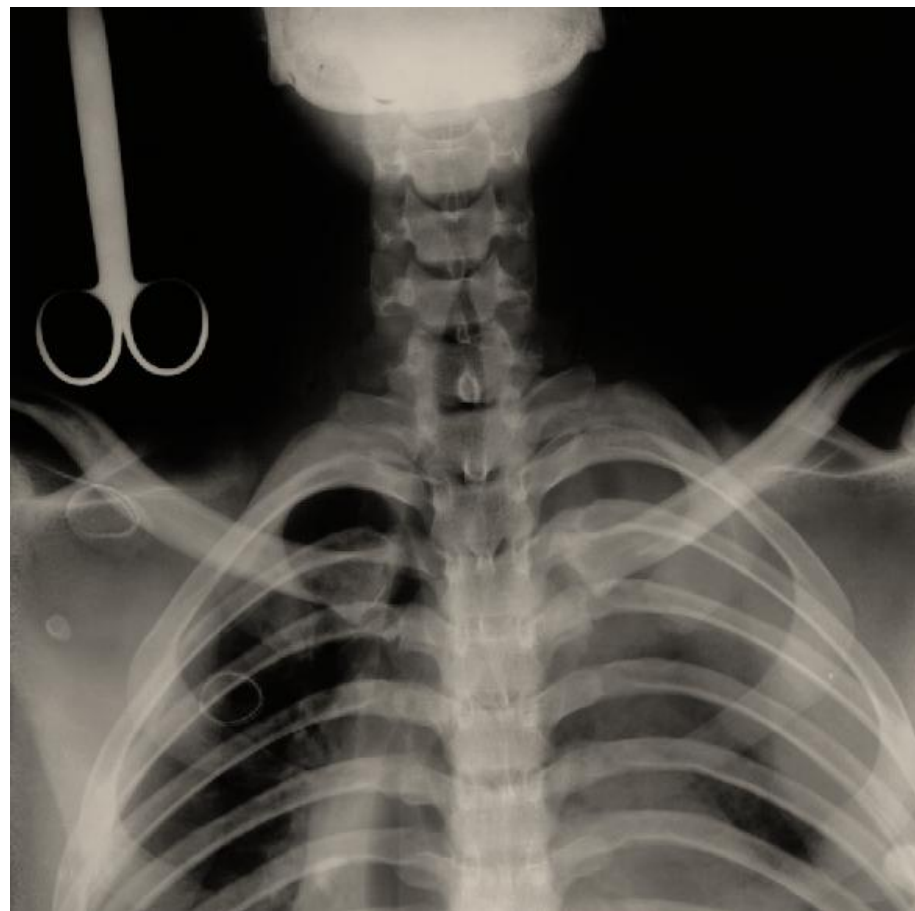
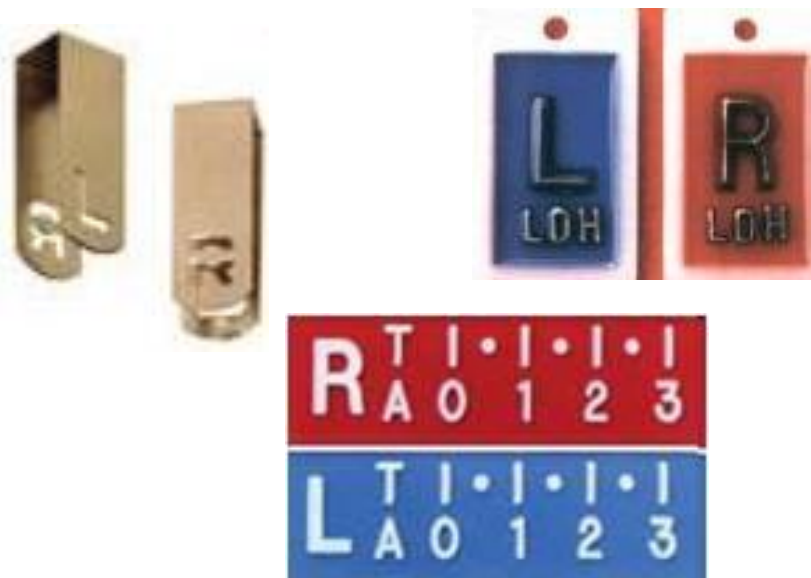
- Less expensive options
  - Use digital processor with original source
  - Refurbished equipment
  - Regular service and maintenance



# Recommendations

## Standardize Radiographic Content

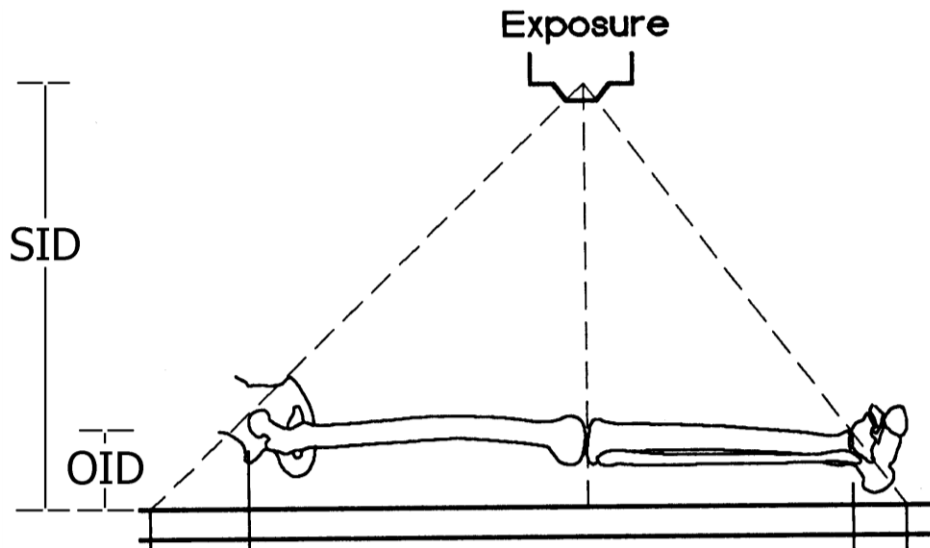
- Permanently embedded information
  - Office name
  - Case number
  - Scale
  - Side Identifier



# Recommendations

## Standardize Technique

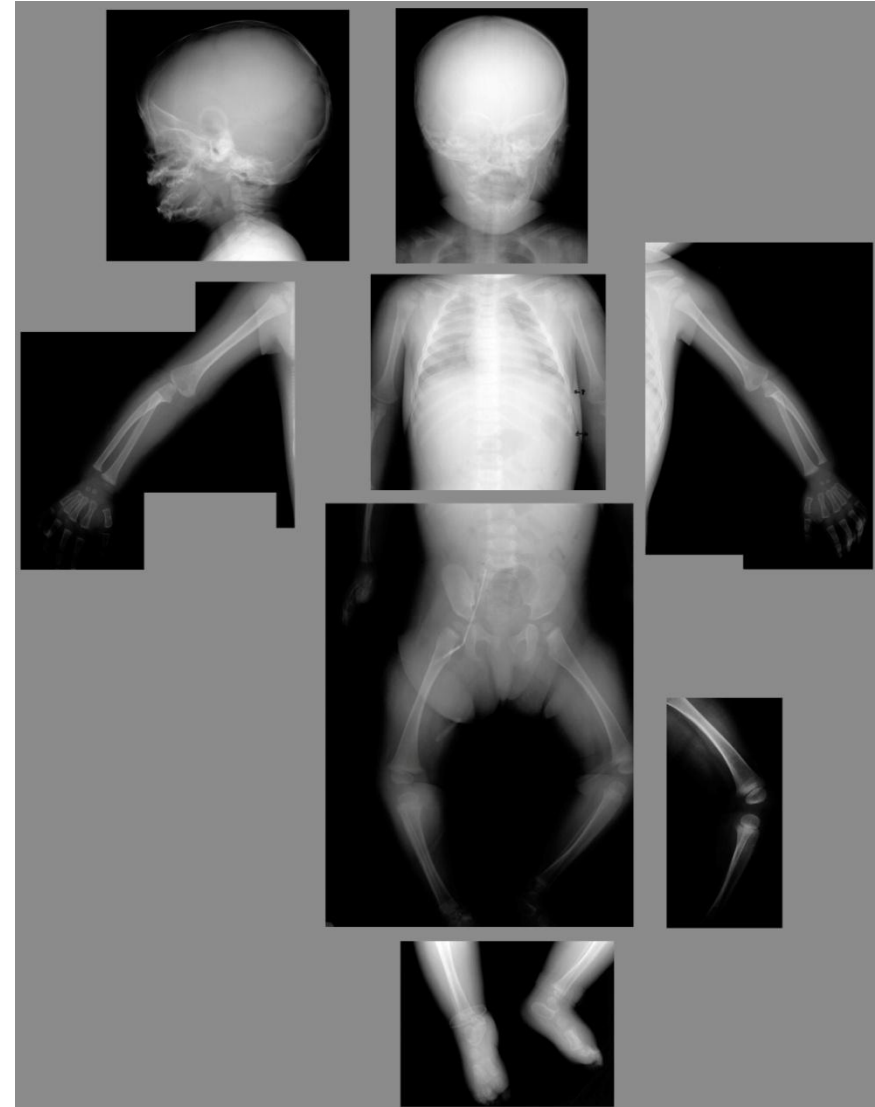
- Maintain 40" source to image distance (SID)



# Recommendations

## Standardize Positioning

- Straighten or flatten limbs
- Avoid crossing appendages
- Record maximum amount of data





# Recommendations

## Standardize Training

- Autopsy tech radiology training to include:
  - Concepts and principles applied
  - Radiation exposure and safety
  - Basic functions of the machinery
- Appropriate training programs seldom available
- Development of national standards as framework for in-house training and certification

# Recommendations

## Archival Standards (film)

- Protected and organized storage
- Cool and dry environment
- In boxes (consider weight)
- Acid-free folders

## Archival Standards (digital)

- Consider saved file resolution

# Current and Future Applications

## Age Estimation

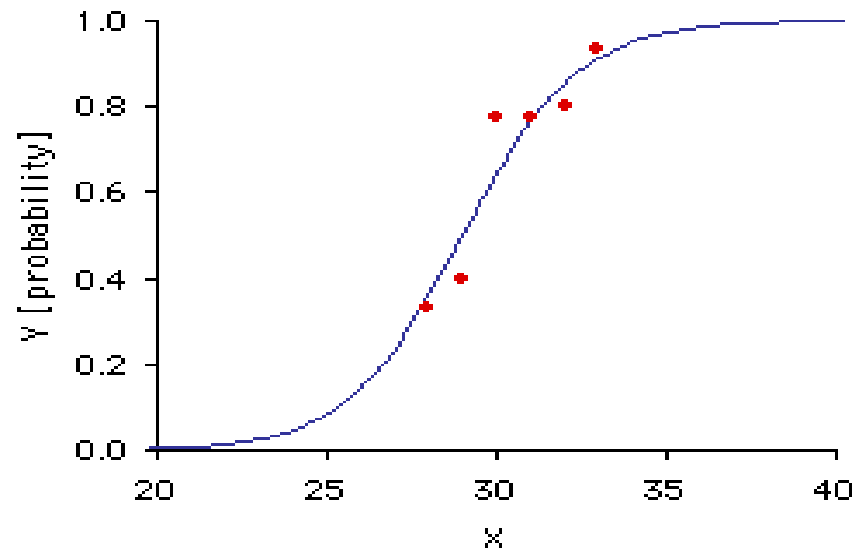
- epiphyseal appearance, fusion
- bone appearance (wrist/ankle)
- bone measurements (corrected)

## Further Research

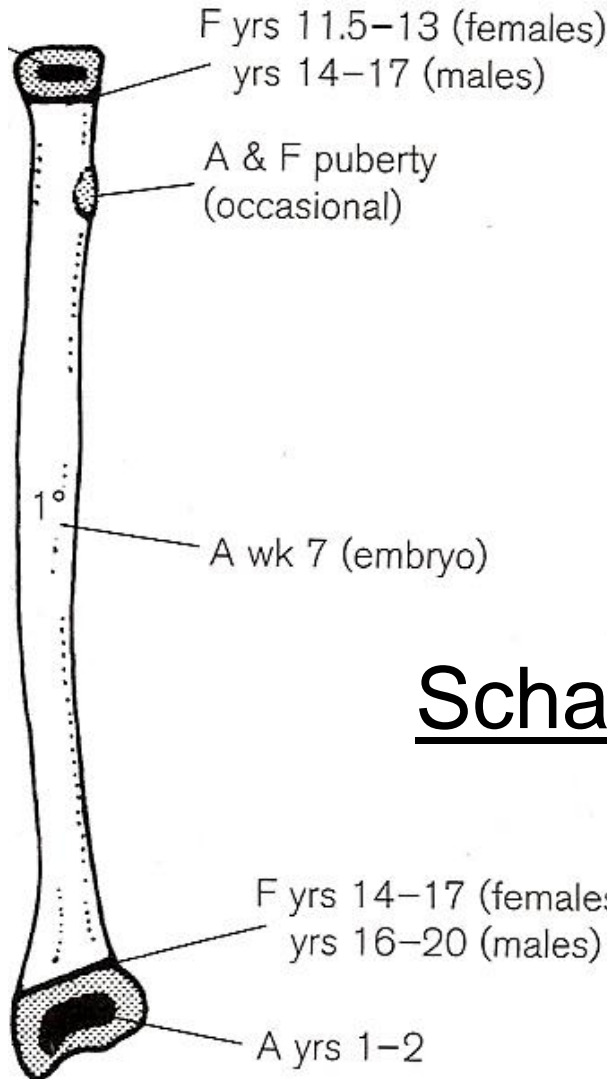
- Similar to Anthropological Research Facility and Forensic Data Bank (UT-Knoxville)

# Valid Age Estimates

- Modern data
- From diverse ethnic groups
- Better statistical methods for discrete data
  - Logistic regression
    - provides explicit confidence intervals for age prediction



# Distal Epiphysis of the Radius



## Scheuer and Black (2000)

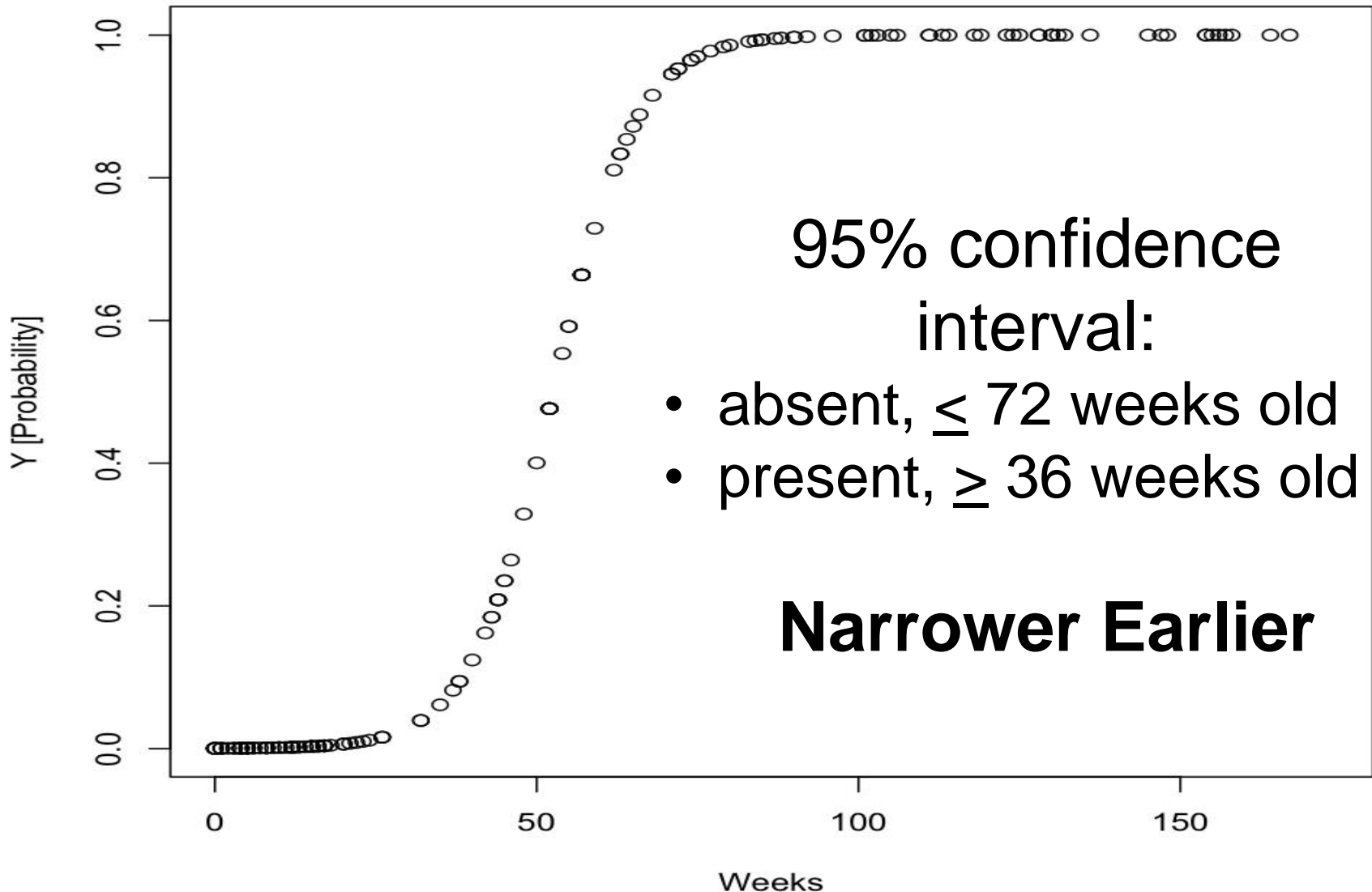
- Cite older radiographic and skeletal studies
- **Appears at 1 to 2 years**

## Schaefer, Black, and Scheuer (2009)

- **Appears at 1 to 2 years**
  - Absent:  $\leq 2.5$  yo
  - Present:  $\geq 4$  mo

# Distal Epiphysis of the Radius

Logistic Regression Curve

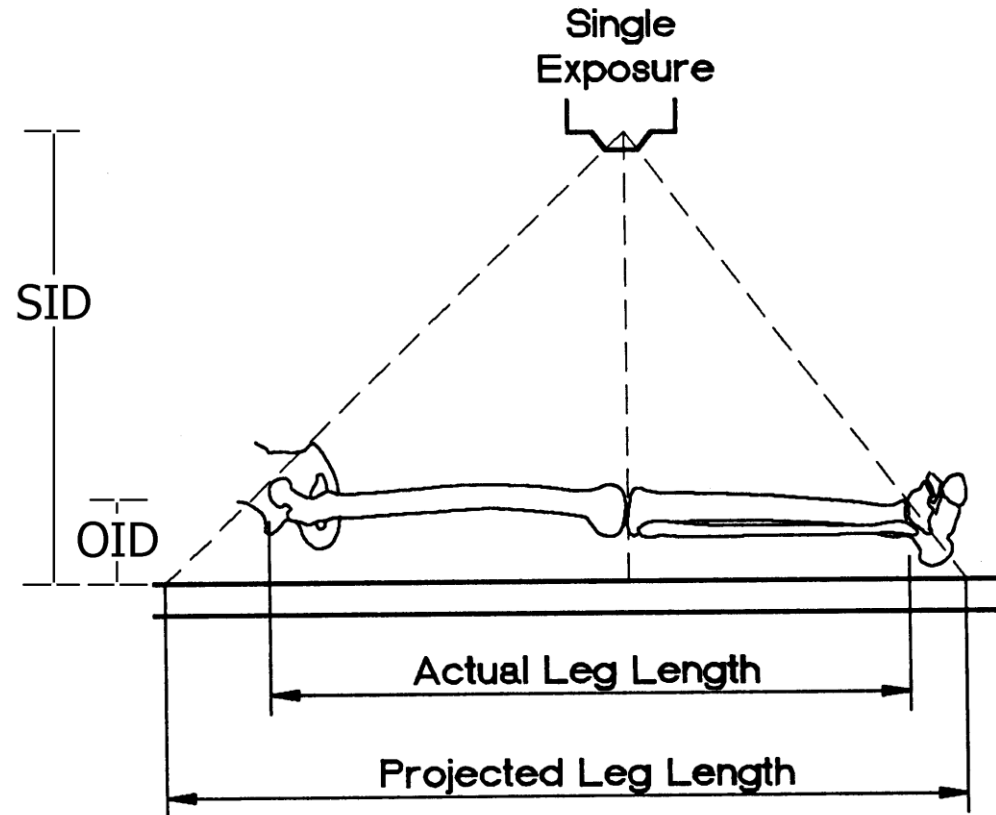


# Better Methods for Measuring from Radiographs

Adjust for size and shape distortion

## Statistical methods

- Nonlinear regression
- Logistic regression
- Robust regression
- Resampling



# Software

- Estimate age from specific bones ossified, measurements
- Ancestry- and sex-specific standards
- For known-age children, calculate percentiles of weights, measurements



# Further Growth in Growth Data

Permanent home at Mercyhurst College

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- If you are interested in participating in this research, please contact the authors. Also, if there is a change to digital and destruction of archived xrays will be taking place, we may be able to provide on-site scanning of those films into our database.