Age estimation using radiographic Staging of Medial Clavicular Epiphysis

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Forensic Age Estimation

Why age estimation?

1. Juvenile status for criminal responsibility
2. Sports categorization
3. Voting rights, driving license
4. Immigration and Asylum proceedings

Hillewig et al., 2011
Kreitner et al., 1998
Techniques of age estimation

1. Bone/skeletal age assessments
2. Physical examination
3. Teeth assessment
4. Psychological evaluation

Schmeling et al., 2007
Dewitte et al., 2002
The use of clavicle

- More interest = young subjects below 30 years

- Fusion of epiphysis = Onset @ puberty
  = Complete 13 years later

- Other bones ossify = ≤20 years

Kellinghaus et al., 2010
Schmeling et al., 2007
Problem statement

• The current reference data = Northern Hemisphere
  = High socio-economic status
• Presented as a series of ‘atlases’

Paucity of information - African population

Meijerman et al., 2007
Schmidt et al., 2008
Problem statement

- Can the results of previous studies act as reference to subjects of different
  i. Racial origin
  ii. sexes
  iii. socio-economic status
  iv. Current generation
Aims

Influence

- Sex
- Race
- Laterality
Materials and methods

- N = 210
- PA chest X-rays
- Black, white and Indian SA populations (14-30 years)
- Schmelings's scoring system
- The difference in Chronological age (CA) and Estimated age (EA) = Bland-Altman plot CI= 95%
- BREC 267/14
Materials and methods . . . Scoring/Staging system

1. OC not ossified
2. OC ossified. Epiphyseal cartilage not ossified
3. Epiphyseal cartilage partially ossified
4. Epiphyseal cartilage completely ossified. Epiphyseal scar visible
5. Epiphyseal cartilage completely ossified, no visible scar

Schmeling et al., 2011
Results

- Laterality-Asymmetry 12.9% of all cases. \( p = 0.0731 \).
- Gender dimorphism

<table>
<thead>
<tr>
<th>Race</th>
<th>Sex</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average mean</td>
<td>Males</td>
<td>16.2±1.2</td>
<td>19.5±1.5</td>
<td>22.9±1.3</td>
<td>24.5±1.2</td>
<td>27.3±2.0</td>
<td>0.0373</td>
</tr>
<tr>
<td></td>
<td>Females</td>
<td>14.4±1.5</td>
<td>18.7±2.1</td>
<td>21.6±1.9</td>
<td>24.6±1.3</td>
<td>27.5±1.9</td>
<td></td>
</tr>
</tbody>
</table>
### Racial variations at stage 1; onset of fusion

<table>
<thead>
<tr>
<th>Stage</th>
<th>Group</th>
<th>Mean± Std. Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Whites</td>
<td>14.81±0.91</td>
<td>14-16</td>
</tr>
<tr>
<td>Onset of fusion</td>
<td>Indians</td>
<td>15.74±1.45</td>
<td>14-18</td>
</tr>
<tr>
<td></td>
<td>Blacks</td>
<td>15.92±1.81</td>
<td>14-19</td>
</tr>
</tbody>
</table>

Stage 1. ossification center not yet ossified
**Racial variation at stage 3; partial fusion**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Group</th>
<th>Mean± Std. Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 3</td>
<td>Whites</td>
<td>21.30±1.02</td>
<td>19-22</td>
</tr>
<tr>
<td>Partial fusion</td>
<td>Indians</td>
<td>23.01±1.00</td>
<td>22-25</td>
</tr>
<tr>
<td></td>
<td>Blacks</td>
<td>23.11±2.31</td>
<td>19-25</td>
</tr>
</tbody>
</table>

Stage 3 Epiphyseal cartilage has partially ossified
### Racial variation at stage 4; Complete fusion

<table>
<thead>
<tr>
<th>Stage</th>
<th>Group</th>
<th>Mean± Std. Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 4</td>
<td>Whites</td>
<td>23.32±1.03</td>
<td>22-25</td>
</tr>
<tr>
<td>Complete fusion</td>
<td>Indians</td>
<td>25.06±0.70</td>
<td>24-26</td>
</tr>
<tr>
<td></td>
<td>Blacks</td>
<td>25.13±1.80</td>
<td>21-27</td>
</tr>
</tbody>
</table>

Stage 4. Epiphyseal cartilage ossified, scar visible
The Bland-Altman plot for CA and EA in the Black population. The limits of agreement were -2.3 to 2.5 years.
Discussion

- Gender dimorphism

Females achieved maturity earlier

- 1.8 years - Bassed et al. (2011) Australia
- 2.5 years - Wittschieber et al. (2013) Germany
- 1 years - Brown et al. (2013) Ghana
- 2 years - Marera & Satyapal (2014) RSA

"She said that girls mature faster than boys, so I pulled her hair."
Discussion

- Racial difference

White population mature 1-1.5 years earlier

i. 2.5 years - Wittschieber et al. 2013

ii. 0.6 years - Mansourvar et al. 2013

iii. 1.5 years - Schmeling et al. 2004
Conclusion

I. References from one group should **not** be applied across different racial origin

II. Gender variations

III. Laterality


The end

Thank you