Are we using the appropriate reference samples to develop juvenile age estimation methods for a forensic context in developed nations?

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INTRODUCTION

The congruence of the populations on which forensic juvenile skeletal age estimation methods are developed and applied has not been critically considered.

Previous research suggests that child victims of homicide tend to be from socioeconomically disadvantaged contexts, and that these contexts impair growth. Thus, juvenile skeletal remains examined by forensic anthropologists may be shorter for age, and age estimation methods developed on healthy, middle class populations may be yielding inaccurate estimates.

This study compares juvenile accident victims and homicide victims in order to assess whether homicide victims, taken to represent population examined by forensic anthropologists, show signs of growth delay compared to accident victims, taken to represent the general population.

MATERIALS AND METHODS

A total of 1256 cadaver lengths were obtained from records of autopsies of children (≤18 yo) having died from homicides (n=499) or accidents (n=757) in Australia (n=272), New Zealand (n=141), New Mexico (n=110), New York City (n=393), and Cuyahoga County, Ohio (n=393). The age distribution of the sample is presented in Figure 1.

The sample was divided into life history stages: infant (birth to 3 years), child (3 to 7 years), juvenile (7 to 10 years in females and 7 to 12 years in males), and adolescents (10-18 years in females and 12-18 years in males).

Height for age Z-scores were calculated using the CDC-2000 reference. Z-scores were compared between the manner of death groups in each coronial sample and age category using independent sample t-tests to assess whether homicide victims show growth delay compared to accident victims.

To assess whether the accidental death group accurately represents the general population, their cadaver lengths were converted to stature according to Krishan and Sharma. Z-scores were recalculated and compared against zero using one sample t-tests.

RESULTS

Australia and New Zealand did not show consistent or significant differences between the manner of death groups.

In samples from the United States, homicide victims were consistently shorter for age than the accident victims. Three groups showed significant differences in growth between the manner of death groups at the 0.15 level: New Mexico children, New York City infants, and Cuyahoga County infants and children.

Australiap and New Zealand accident victims never deviated from the reference sample, indicating that they were an appropriate comparison to the general population (Table 2).

This was not the case in the United States. In one case (Cuyahoga County infants), the accidents were significantly smaller than the reference, indicating that they did not accurately represent the average population (Table 2). In two further cases (New Mexico and Cuyahoga County children), the deviation neared significance at the 0.10 level.

DISCUSSION

When differences between the manner of death groups occurred, the homicide group was shorter for age than the accident group.

In Australia and New Zealand, there were no consistent difference between the manner of death groups. In coronial samples from the United States, the homicide group was always shorter than the accidental death group, sometimes significantly so (Figure 3).

The difference in growth seen between the forensic and general population in the United States but not in Australia or New Zealand may be driven by higher socioeconomic inequality in the United States.

The largest growth deficits of the forensic population equate to 2.3 months of growth in infants (0-3 years) and 6-10 months in children (3-7 years). Stull et al report a 95% prediction interval of ±1 month (at birth) to ±2.5 years (at 12 years) for femur length, and Cardoso et al report a 95% prediction interval of ±5.5 months (under 2 years old) to ±2.32 (2-12 years old) for that same bone.

While the difference in growth is not always significant, the homicide victims are consistently shorter for age than the general population, which could lead to errors in age estimation when using methods developed on healthy children.

The samples used to develop juvenile skeletal age estimation methods should be critically selected to consider the likely impaired growth status of the forensic anthropology population.

ACKNOWLEDGEMENTS

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REFERENCES

2. Krishan M, Sharma JC. 2002. Access to data for this study was kindly provided by the National Coronial Information System (Australia and New Zealand), the Office of the Chief Medical Examiner (New York City), and the Cuyahoga County Medical Examiner (Cuyahoga County).

Figure 1. Age and sex composition of the sample by manner of death

Figure 2. Height for age Z-score spread over the age range in Australia and New York City. In Australia (left), differences between the manner of death groups are not consistent throughout the age range. In New York City (right), accident victims are consistently shorter for age than the accident victims.

Table 2

<table>
<thead>
<tr>
<th>Sample</th>
<th>Infant</th>
<th>Child</th>
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<th>Adolescent</th>
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<tr>
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<td>-1.07</td>
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<tr>
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<td>0.33</td>
</tr>
<tr>
<td>Cuyahoga County</td>
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<td>2.01</td>
<td>0.02</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Table 2. Test and p-values for one sample t-tests of height for age Z-score against zero for the accidents in each age group from each coronial sample. Stature estimated for the children, juveniles, and adolescents using Krishan and Sharma (2002). Negative values indicate that the accident group is smaller for age than the reference sample.