H33 Reducing Intraand Inter-Observer Error Through Histomorphometric Variable Selection

Christian M. Crowder, MA, and Zoe H. Morris, BSc, University of Toronto, Department of Anthropology, 100 St. George Street, Toronto, ON M5S3G3, Canada*

After attending this presentation, attendees will understand how the selection of variables can affect the precision and, in turn, the accuracy of histological age estimation.

This presentation will impact the forensic community and/or humanity by demonstrating the importance of exploring the precision of histological variables before they are entered into prediction equations where the output may mask precision issues. This will ultimately lead to better selection and definitions of variables for future methods. This research also provides an indication of the experience needed to perform certain histological analyses, concern for which may be the cause of nonintegration of quantitative bone histology in forensic examinations.

Associated with histological methods of age estimation are the numerous ways to count and define histological structures. For most methods, intact and fragmentary osteons are the core variables that carry the most statistical weight with known age at death. These variables are often entered separately into regression equations. The inability to correctly identify osteon types directly affects age estimations. Using osteon population density (OPD), which combines the intact and fragmentary osteon counts and divides them by the amount of cortical area evaluated within a cross-section of bone, is a technique designed to reduce the counting error if an intact osteon is misidentified as a fragment or vice versa. The goal of this project is to determine the precision of osteon population densities versus separated intact and fragmentary densities ($_{I}$OPDs and $_{F}$OPDs) within and between observers. Intra-observer analysis, performed by a researcher with histological experience, and inter-observer analysis, incorporating observations by a researcher with no histological experience, will determine how well the OPD variable corrects for inconsistency and inexperience in identifying osteonal structures.

Rib cross-sections from 234 individuals of known age and sex from the cemetery site of Spitalfields, London, were evaluated. An independent researcher randomly selected 30 individuals for the analysis of intraobserver error (14 male, 16 females; aged 27-79 yrs.) and another sample of 30 individuals were selected for the analysis of inter-observer error (18 females, 12 males; aged 23-80 yrs). The independent researcher was instructed to select non-diagenetically modified samples for the interobserver sample. Data was collected using osteon definitions from Cho and colleagues [(1)] and the grid counting method from Stout [(2)]. Plotting the difference between observations against the mean of the first and the second observation was utilized for OPDs, $_{I}$OPDs and $_{F}$OPDs. Absolute mean percent differences were calculated to quantify the magnitude in variability between measurements with the 10% error level as the cutoff for acceptance.

The results for the intra-observer analysis show that absolute mean percent difference in OPD values is 8.5%. The mean difference is not significantly different from zero, further indicating that repeatability was achieved. Considering the OPD variables separately increases the absolute mean percent difference to 11% ($_{I}$OPD) and 22% ($_{F}$OPD). The mean difference for $_{I}$OPD is significantly different from zero indicating a lack of variable agreement. The $_{F}$OPD mean difference is not significantly different from zero, but less than 95% of the differences are within the limits of agreement, indicating a lack of agreement.

The results for the interobserver analysis show that absolute mean percent difference in OPD values is 11.4%. A plot of the mean differences indicated a magnitude bias in measurements requiring the data to be logged transformed to provide a clearer picture of agreement. The overall mean difference of the transformed data is significantly different from zero and less than 95% of the values are within the limits of agreement, thus indicating lack of inter-observer agreement. Considering the OPD variables separately produces larger error levels ($_{I}$OPD=20%, $_{F}$OPD=27%). The $_{I}$OPD mean difference is significantly different from zero and the $_{F}$OPDs mean difference is not significantly different from zero; however, less than 95% of the $_{F}$OPDs values are within the limits of agreement. Both $_{I}$OPD and $_{F}$OPD demonstrate a lack of inter-observer agreement.

Analysis of the OPD variable indicates that the combination of intact and fragmentary osteon densities reduces overall intraand inter-observer error compensating for some identification inconsistencies. Individually the measurements exceed the 10% error level, indicating difficulty in differentiating or identifying osteons. The larger differences in $_{F}$OPD compared to $_{I}$OPD indicates a bias in identification and/or counting possibly due to the subjectivity in determining if more than 10% of the Haversian canal is remodeled or differentiating a fragment without any remnant of a Haversian canal from crowded interstitial

 ** Presenting Author*

lamellar bone. Observer 2 demonstrated more difficulty in differentiating intact osteons from fragments. Despite the higher individual variable error levels, observer 2's combined OPD error level was just above the 10% cutoff. While this indicates that some histological training/experience is needed, it also demonstrates the ability of the consolidated OPD variable to compensate for identification inconsistencies. Fragments consistently produce higher intraand inter-error levels, indicating that better definitions may be needed. For example, it may improve accuracy to define intact osteons as having a complete Haversian canal removing the subjectivity in deciding what percentage is unremodeled. This research has shown that more error is associated with individual intact and fragmentary osteon counts. Histological methods of age estimation that do not consolidate counts are subject to significantly higher levels of precision error.

References:

1. Cho H, Stout SD, Madsen RW, and Streeter MA. Population-specific histological age-estimating method: a model for known African-American and European-American skeletal remains. *J Forensic Sci*, 2002; 47(1):12–18.
2. Stout SD. The use of bone histomorphology in skeletal identification: The case of Francisco Pizarro. *J Forensic Sci*, 1986; 31(1):296–300.

Observer Error, Histomorphometry, Osteon Population Density (OPD)