



Physical Anthropology Section – 2004

H96 An Evaluation of the Greulich and Pyle Skeletal Aging Standards for the Hand and Wrist in a Contemporary Multiethnic Population

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The objectives of this pilot study are two-fold: 1) to evaluate the accuracy of the Greulich and Pyle (1959) hand and wrist development standards when used to estimate the age of subadult individuals of diverse ethnic backgrounds and, 2) to measure the direction and magnitude of error in different age and ethnic subgroups. Attendees will gain an awareness of the limitations of the Greulich and Pyle standards when applied as an age-determination technique and how to best utilize the existing standards when estimating the age of individuals from different ethnic backgrounds.

The contribution of this research to the forensic community is the awareness of the magnitude and direction of error in applying the Greulich and Pyle standards for hand and wrist development when determining age-at-death for contemporary subadults of various ethnic and socioeconomic backgrounds and the need for further research to develop new standards for skeletal age assessment of the hand and wrist.

Forensic Anthropologists apply age-determination techniques in a wide variety of contexts. They are frequently asked to provide age estimates for unidentified individuals, applicants seeking asylum in the United States, and to reconcile various records that report conflicting ages. The reliability of the techniques applied is, of course, of utmost importance and unreliable techniques can have significant consequences, including delaying identification of an unknown individual, denial of asylum, and an erroneous conclusion as to an individual's probable age. The research presented here reports the results of a pilot study conducted to assess the accuracy of the Greulich and Pyle (1959) standards for the development of the hand and wrist when applied to a contemporary multiethnic sample of children from an urban medical examiner's office.

The impetus for the current research was a case involving legal documents that reported two different birth years for an individual accused of homicide. The county attorney's office responsible for prosecuting the case requested an age-assessment in order to determine if the accused should be tried as an adult or juvenile. The individual was born outside of the United States and is of Southeast Asian descent. Given that the individual was still living, the age determination techniques applied were limited to an evaluation of dental development and eruption and epiphyseal union. Skeletal radiographs were taken of numerous sites of the skeleton. The skeletal development exhibited by the individual necessitated heavy reliance on the stage of development of the hand/wrist.

A literature search conducted during the case indicated that the Greulich and Pyle (1959) standards of development were the most recently published standards for the hand and wrist. These standards were devised from a sample of radiographs from the Brush Foundation collection housed at Western Reserve University School of Medicine. This collection consists of a longitudinal sample of x-rays taken between 1931 and 1942 of children from families described as "above average in economic and educational status." The sample utilized by Greulich and Pyle is comprised of from two to 21 hand/wrist films of 1000 healthy, American-born "White" children, most of Northern European ancestry, from the Cleveland area of Ohio. The literature search also identified recently published articles that concluded the Greulich and Pyle standards of development might not be accurate for healthy individuals of non-White ethnic backgrounds.

In order to assess the accuracy of the Greulich and Pyle hand/wrist standards of development in a contemporary multiethnic sample of individuals from varied socioeconomic backgrounds, the medical examiner case files of all children between the ages of birth and 19 years of age autopsied by the Hennepin County Medical Examiner's Office between 1974 and 2001 were reviewed. Case files containing recorded demographic data, including date of birth, date of death, sex, and ethnicity and the existence of x-rays of sufficient quality to reasonably assess hand/wrist development and the presence of Harris lines were selected for analysis. The research sample consists of 359 individuals, 231 males and 128 females. The sample is further subdivided into four age-categories (Early, Middle, Late Childhood, and Adolescence - per Loder et al. 1993) and six ethnic groups (American Indian, "Black," Asian, Hispanic, "White," and multiethnic). Country of birth and antemortem health status were not recorded in the case files. Following definition of the sample, each author evaluated the radiographs of each individual and assigned a skeletal age using the standards defined by Greulich and Pyle. Degree of agreement of the three observers was calculated and indicated only a moderate degree of agreement between the three observers reflecting, most likely, differences in level of experience. For this reason, differences between recorded chronological age and the estimated bone age of each observer were calculated. A Paired-Samples Ttest was performed to evaluate the null hypothesis that the mean difference between the chronological and skeletal ages was zero. Mean differences were compared between subgroups defined by sex, age, and ethnicity. Statistically significant differences between chronological and skeletal age exist for both males and females variously by age category and ethnicity. The results of our study support the need for the development of new standards for hand/wrist development to accurately assess the age of subadult individuals from a variety of ethnic backgrounds.



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Loder RT, Estle DT, Morrison K, Eggleston D, Fish DN, Greenfield ML, Guire KE. Applicability of the Greulich and Pyle skeletal age standards to black and white children of today. *Amer J Diseases Children* 1993;147:1329-1333.

Age Determination, Hand/Wrist Development, Accuracy Assessment