

## **A probability model for estimating age in living relative to the 15, 18 or 21-year old thresholds**

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**Introduction:** Age estimations is relevant for pre-trial detention and sentencing in criminal cases as well as part of the evaluation in asylum processes to protect the rights and privileges of minors. No method currently used for medical age estimations can determine an exact chronological age due to the individual variations in biological development. This study seeks to develop a validated statistical model for estimating an age relative to key legal thresholds (15, 18, and 21 years) based on skeleton (CT-clavicle, X-ray-hand/wrist, MR-knee) and teeth (X-ray-third molar) developmental stages.

**Methods:** The model has been developed based on results from scientific studies. By applying stringent inclusion and exclusion criteria, incorporation the minimum possible bias in the development of the model is ensured. Each dataset from the separate studies is subsequently individualized and reconstructed using statistical models tailored to their unique characteristics. The core framework of the model is built upon transition analysis. This approach is further developed with a combination of a type of parametric bootstrapping and Bayesian theory. Validation of the model include sensitivity analyses of varying upper age limits, comparing the fitted model to the underlying data as well as testing the model on independent datasets of individuals with known ages.

**Results:** This version of the probability model is based on 31 scientific studies, divided into examinations of the hand/wrist (15 studies), clavicle (5 studies), knee (4 studies), and third molar (10 studies). In total, data from approximately 27,000 individuals has been incorporated. The validation approach confirms that assessments of the independent populations corresponds well with the model's predictions.

**Conclusion:** The probability model based on the combination of a skeleton indicator and radiography of mandibular third molars is a valid method to assess age relative to the 15, 18, 21-year old threshold in both men and women. The uncertainty with the model is based on biological variation and assumptions in the model.