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## THE LONDON ATLAS OF TOOTH DEVELOPMENT: A STEP FORWARD

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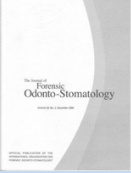
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The authors declare that they have no conflict of interest.

**Aim:** To develop a comprehensive, validated, evidence based, practical, user-friendly atlas of dental age estimation and compare its performance with two widely used atlases.

**Methods:** Diagrams representing ages between 28 weeks in-utero and 23 years were developed (The London Atlas) based on the radiographic appearance of tooth development in 528 individuals aged 2-23 years and 176 neonates using the median stage of tooth development for each tooth in each age category/chronological year. Accuracy was determined by ageing skeletal remains/radiographs of 1514 individuals (aged 32 weeks in-utero to 23 years) using The London Atlas (LA), the Schour and Massler (SM) and Ubelaker (Ub) atlases. Estimated age was compared to real age. Bias, absolute mean difference and proportion of individuals correctly assigned by age were calculated. Intra-observer variation (Kappa) was measured by re-assessment of 130 radiographs. To test the application of the London Atlas, a questionnaire was used to validate its use. Ninety 3rd year dental students were divided randomly into three subgroups, and blinded from the researcher. Each group used one of the 3 atlases to estimate the radiographic age of 6 individuals and complete the questionnaire. To take the London Atlas a step further, a decision to develop an interactive software computer program was taken using the data sheets of median stages of tooth development and all hand illustrations of tooth formation (appendix 10). The software program was designed to have three sections: (1) Playback mode to feature dental development for males, females and mixed sex covering all age ranges present in The London Atlas (31 age categories). (2) Data entry mode to feature a dental age calculator that enables the user to enter data for tooth formation and eruption according to Moorrees et al. (1963b; a) and modified Bungsten's stages (Bengston, 1935; Liversidge and Molleson, 2004). (3) Comparison mode to allow the user to compare tooth/teeth development between two different ages from the same sex or between different sexes at the same age.

**Results:** Excellent reproducibility was observed for all three atlases (Kappa: LA 0.879, SM 0.838 and Ub 0.857). LA showed no bias ( $P=0.720$ ) and correctly estimated 53% of cases. SM and Ub showed significant bias by consistently underestimating age ( $P=0.026$  and  $P=0.002$ ) with 35% and 36% correctly estimated for SM and Ub respectively. The mean absolute difference for LA (0.72 years) was smaller than SM (1.15 years) and Ub (1.17 years). LA was preferred over the other two atlases in all quality measures tested (clarity, design, simplicity and self-explanation).



***Conclusion:*** *The London Atlas represents a substantial improvement on existing atlases facilitating accurate age estimation from developing teeth. Development of interactive online and mobile app versions is complete.*

**KEYWORDS:** Forensic Odontology, Age estimation, London Atlas.

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