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A Comparison of Four Methods of Dental Age Estimation and Age Estimation from the Risser Sign of the Iliac Crest

Rebekah A. Goltz

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A COMPARISON OF FOUR METHODS OF DENTAL AGE ESTIMATION AND AGE ESTIMATION FROM THE RISSER SIGN OF THE ILIAC CREST

By

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Abstract

Age estimation techniques are of medicolegal importance for estimating the age of living asylum seekers, as well as for unidentified human remains from forensic cases. As there are many techniques for age estimation, this study compares four different methods using dental radiographs of modern subadults (under 18 years) to determine which is more accurate for the modern sample. Additionally, this study explores age estimation from apophyseal fusion in the pelvis using the Risser method of the iliac crest compared to estimates of dental age. This study additionally compares the accuracy of four dental age estimation methods, including: Schour and Massler (1941), Schour and Massler (1944), Ubelaker (1989), and the London Atlas Method by AlQahtani et al. (2010). To determine the accuracy of the methods, this project correlates the actual age of modern individuals and the age estimated by each of the aforementioned methods. Overall it was found that Schour and Massler (1941), Schour and Massler (1944), and the London Atlas Method overestimated the age while the Ubelaker method slightly underestimated the age. All dental age estimation methods far exceed the accuracy of apophyseal fusion of the iliac crest using the Risser method.

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Introduction

Age estimation techniques are important for a number of reasons. Lewis and Senn (2010) thought that there were five important reasons to have accurate age estimation techniques: 1) to narrow the search possibilities when examining unknown victims; 2) to determine the age at death when unknown; 3) to differentiate victims of a mass grave; 4) to determine whether someone is eligible for social security benefits; and 5) to aid immigration services for undocumented immigrants (Thevissen et al. 2012). Age estimation techniques can be done using various elements of the human skeleton including the pubic symphysis (pelvis), the auricular surface of the ilium (pelvis), teeth, first and fourth ribs (Martrille et al. 2007), although the accuracy of each method can vary. This paper will compare dental age estimation techniques and iliac crest age estimation techniques on a medieval population and four dental age estimations for a modern population, along with the Risser method based on fusion of the iliac crest of the pelvis. The four dental age estimation methods that I will be examining will be those put forward by Schour and Massler (1941 and 1944), Ubelaker (1987), and the London Atlas Method (2010). This research is important because there are multiple age estimation techniques and methods that are available and having one that is accurate is crucial.

Background

Long bones and dentition develop differently; therefore, the age estimation techniques applied must differ, as well. Long bones grow because osteoblasts that deposit bone material. When using long bones to estimate age, the standard manual for practitioners, *Human Osteology*, recommends that you use a method that is based on a

skeletal collection of similar ancestry to what you are studying, as populations can vary in rates of growth and development. Teeth, being more tightly constrained by genetics, develop in a more predictable pattern, which can be used for more accurate age estimation. Teeth also tend to be used to estimate age because they are more durable than bone and are most commonly found when a set of remains has been exhumed. Dental age estimates are more accurate when looking at children because the teeth are still developing, compared to age estimation based on wear in adults, which is extremely dependent on environmental factors. Once the third molar emerges, estimating the age of an individual using teeth can be difficult (White et al 2012).

Bioarchaeology

Bioarchaeology, a subfield of anthropology, combines skeletal biology with archaeology. Clark Spencer Larsen describes bioarchaeology as the exploration of the human culture in regards to the skeleton. Various things including illness, nutrition, and what we do in our day-to-day lives can affect the skeleton. To look at individuals from the distant past, a bioarchaeologist must look also at the cultural context to understand how their lifestyles may have affected their skeletal remains (Larsen 2000).

Using bioarchaeology to look at the health of past populations can be questionable in regards to accuracy. For most bioarchaeology research, the bioarchaeologist is looking at remains found in cemeteries. One issue is that when looking at a population that is fluctuating in size, the age of individuals in the cemetery reflects more upon fertility than on mortality. Another issue is that when you study skeletons in a cemetery, they all died for some reason. If the skeletal remains all show signs of gout that does not necessarily mean that everyone in that population had gout. It just means that some people had gout

and those individuals died. It is also difficult to figure out the health of past populations because not all illnesses are present on the skeleton. If someone died quickly from a pathogen that was spreading, then there may not have been time for the pathogen to leave its mark on the skeleton. This is called the "osteological paradox" (Wright and Yoder 2003). Although there are some issues with interpretation in bioarchaeology, progress is being made every day to better improve the methods that bioarchaeologists are using to gather their information. This study helps to validate the accuracy of one important component of the biological profile when analyzing unknown individuals or human skeletal remains: age estimation.

Dental Age Estimation: Schour and Massler Method (1941)

In 1941 Isaac Schour and M. Massler published: "The Development of the Human Dentition." Their article focused mainly on the different developmental stages of teeth. They published a chart (see Figure 1 below) for estimating age based on dental development. Not much information was given on the subjects they were studying or how exactly they conducted their research.

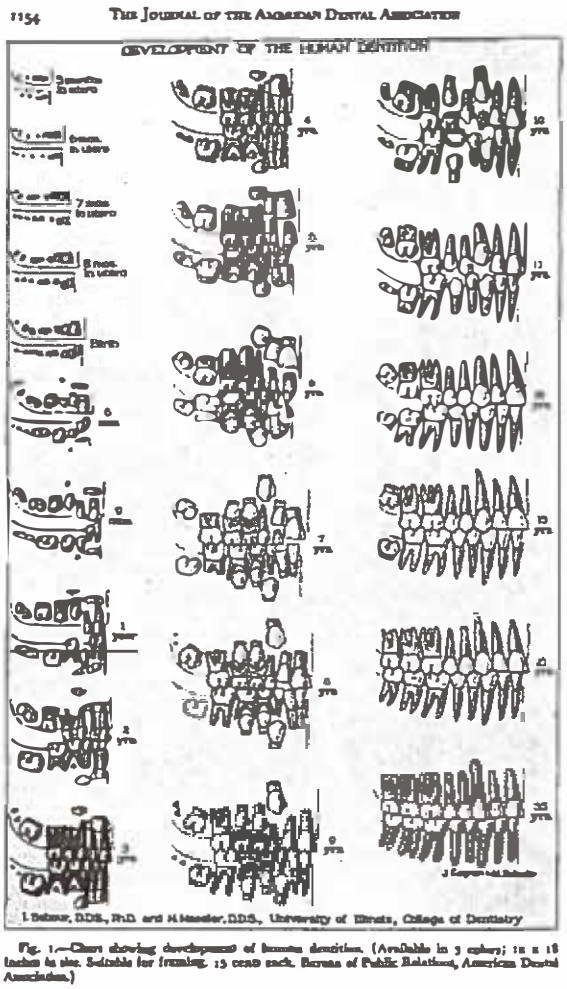

Figure 1. Schour I., & M. Massler (1941)

Dental Age Estimation: Schour and Massler Method (1944)

In 1944 Schour and Massler published another article entitled: "Study in Tooth Development: Theories of Eruption." In this article the authors focus on what factors can affect the eruption of teeth. They defined eruption as, "the process whereby the forming tooth migrates from its intra-osseous location in the jaw to its functional position within the oral cavity." Schour and Massler had three different goals for their research: 1) to test the accuracy of each eruption theory, 2) to see which factors about eruption would stand

up to this type of research, and 3) to get a better understanding of how eruption works. One criticism of this paper is that they again did not list their materials clearly, so there was no information about the subjects on whom they were testing their hypothesis. They published a revised chart to estimate age shown in Figure 2 below. Schour and Massler 1941 and 1944 were chosen for the current study in order to test the accuracy of some of the earliest methods of dental age estimation.

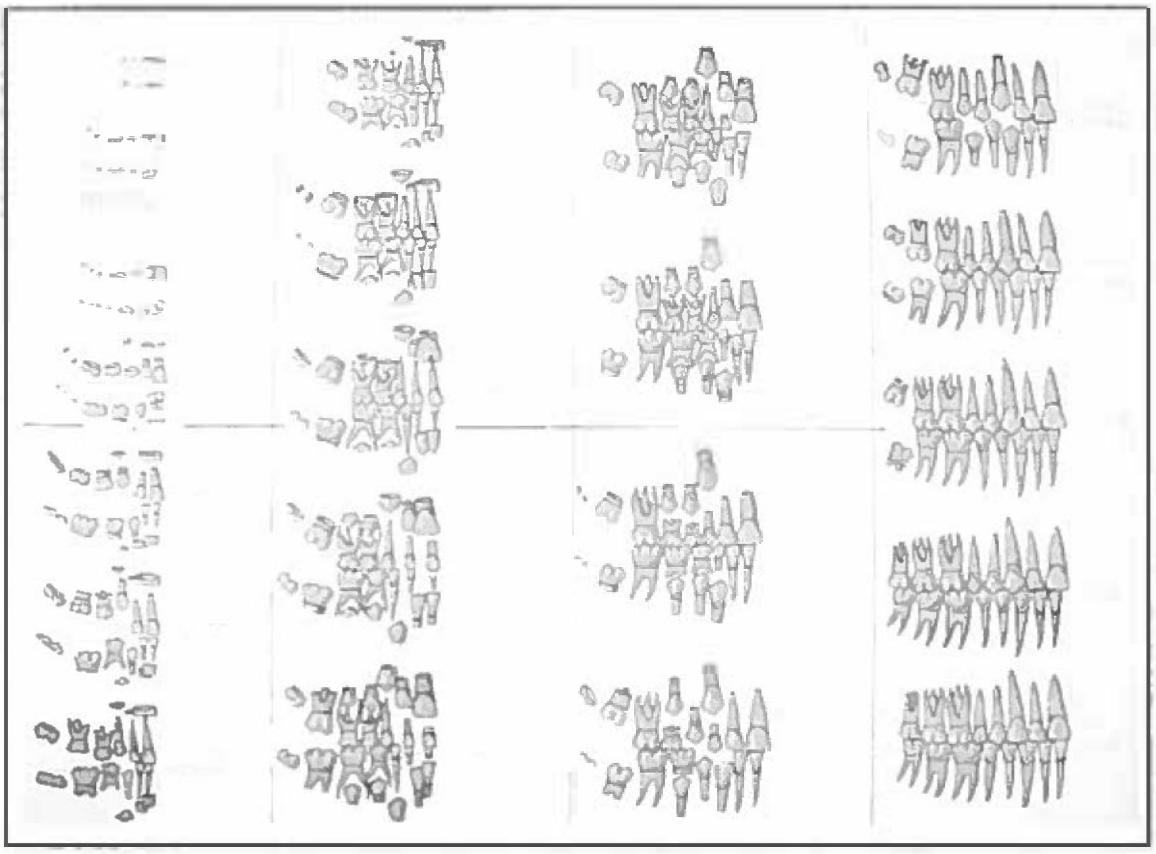

Figure 2. Schour & Massler (1944)

Dental Age Estimation: Moorrees, Fanning, and Hunt (1963)

In 1963, Moorrees, Fanning, and Hunt published their stages for estimating age based on an individual's dental development. They looked specifically at ten different teeth: the maxillary incisors and all eight mandibular teeth. There are two different charts that were used to rate the teeth depending on whether they were single or multiple rooted (see Figures 3 and 4 respectively). Moorrees, Fanning, and Hunt suggested that there are four things to keep in mind when assessing an individual's age: 1) how that data fits in with the population where the child is from, 2) the possibility of variation between individual teeth, 3) experience of the researcher rating the teeth, and 4) the obtainability of past and future records to serve as a base reference (1963).

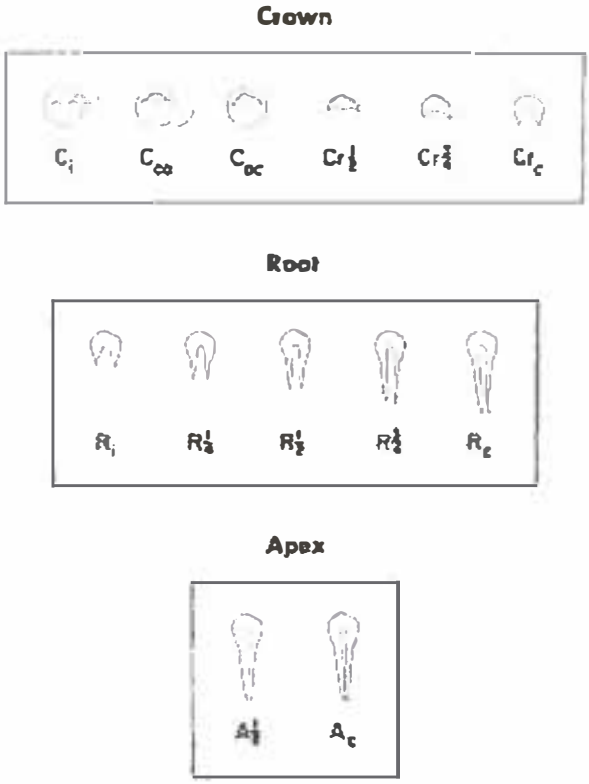

Figure 3. Moorrees, Fanning, and Hunt 1963 chart for the development of single-rooted teeth

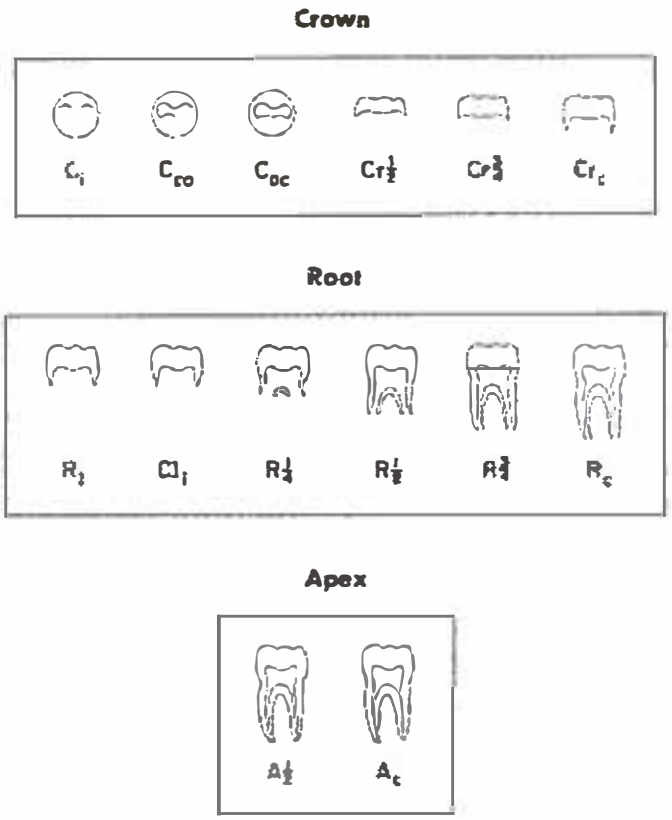

Figure 4. Moorrees, Fanning, and Hunt 1963 chart to show development of permanent mandibular molars

This method was chosen due to the recommendation from Ubelaker and Buikstra in *Standards for Data Collection from Human Skeletal Remains* (1994). This method was useful for the medieval population because one can estimate the age of an individual using the third molar, which is the focus for the medieval sample as part of the current research.

Dental Age Estimation: Ubelaker Method (1987)

In his article: "Estimating Age at Death from Immature Human Skeletons: An Overview *(1987),"* Douglas H. Ubelaker's goal with was to review the contemporary methods available for estimating the age at death. Ubelaker stated that knowing the age at death was important because this knowledge could help in identifying the individual and

in estimating when the date the death occurred. When trying to estimate the age of immature skeletons Ubelaker recommends looking at as many of the follow systems as possible: "appearance and union of epiphyses, bone size, the loss of deciduous teeth, the eruption of teeth, and dental calcification (1987)." When estimating age based on dental development Ubelaker recommends using the charts put forward by Moorrees et al. (1963). Ubelaker suggests that if you are using the then popular Schour and Massler dental age estimation charts, you need to pay close attention to which edition of the chart is being used. The reason for such a recommendation is that between the 1941 and 1944 edition, there were many changes and some could affect an age estimate by as much as two years (1987). Ubelaker was beginning to do research on the emergence and formation of teeth among American Indians and provided a new chart (see Figure 5 below) that showed some of his early research on the subject (AlQahtani et al. 2014). This method is applied in this study so as to replicate the study of AlQahtani and colleagues' "Accuracy of Dental Age Estimation Charts: Schour and Massler, Ubelaker, and the London Atlas (2014)."

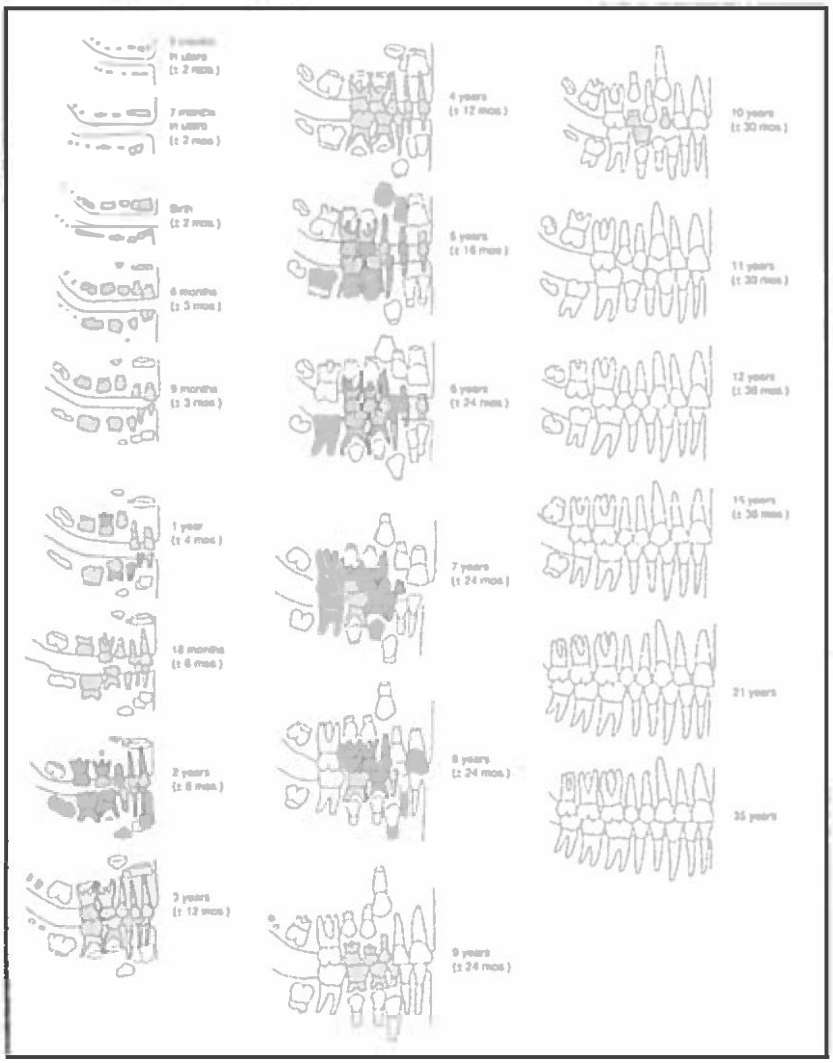

Figure 5. Age Estimation Chart for Ubelaker (1987)

In 1994 Jane Buikstra and Douglas H. Ubelaker published their *Standards for Data Collection from Human Skeletal Remains.* In creating this manual, Buikstra and Ubelaker had three main goals. Their goals were to: "(1) maximize information recovery per unit time; (2) minimize intra- and inter-observer error; and (3) use standard data collection procedures whenever possible." To set the standard, they use the charts put forward by Moorrees et al (1963) because they believe that most observers are already comfortable with those methods. Although recommended in *Standards*, I did not use this method because it takes every tooth individually and gives them a score. The radiographs

from the Bolton Brush Collection are not consistently clear enough to be able to apply this method successfully.

Dental Age Estimation: London Atlas Method (AlQahtani et al., 2010)

The last method explored in the current research is the London Atlas method put forward by Dr. Sakher J. AlQahtani and colleagues in 2008, then revised in 2010. AlQahtani and his colleagues looked at two different ethnic groups for their research, half of the subjects were of European Ancestry and half were Bangladeshi. The London Atlas chart was developed to show the growth and emergence of teeth for individuals anywhere from 28 weeks *in utero* to those 23 years of age (see Figure 6 below). To create the chart, the researchers looked at 704 radiographs of individuals of known age. The diagrams were meant to show the median tooth development and the alveolar eruption stages. This chart is divided into different sections based on development. In the last trimester of pregnancy, diagrams represent monthly development, two weeks apart when you get to 40-week mark, quarterly for the individual's first year, and yearly after that. One thing the author wanted to point out, especially for this study, was that birth was not an age but rather an event that does not affect the dental formation (AlQahtani et al. 2010). This method was chosen for the current research because it was a method that also looked at the entire dental arcade, rather than each tooth individually. A benefit to using this method is that the chart is freely available on the Internet for public use.

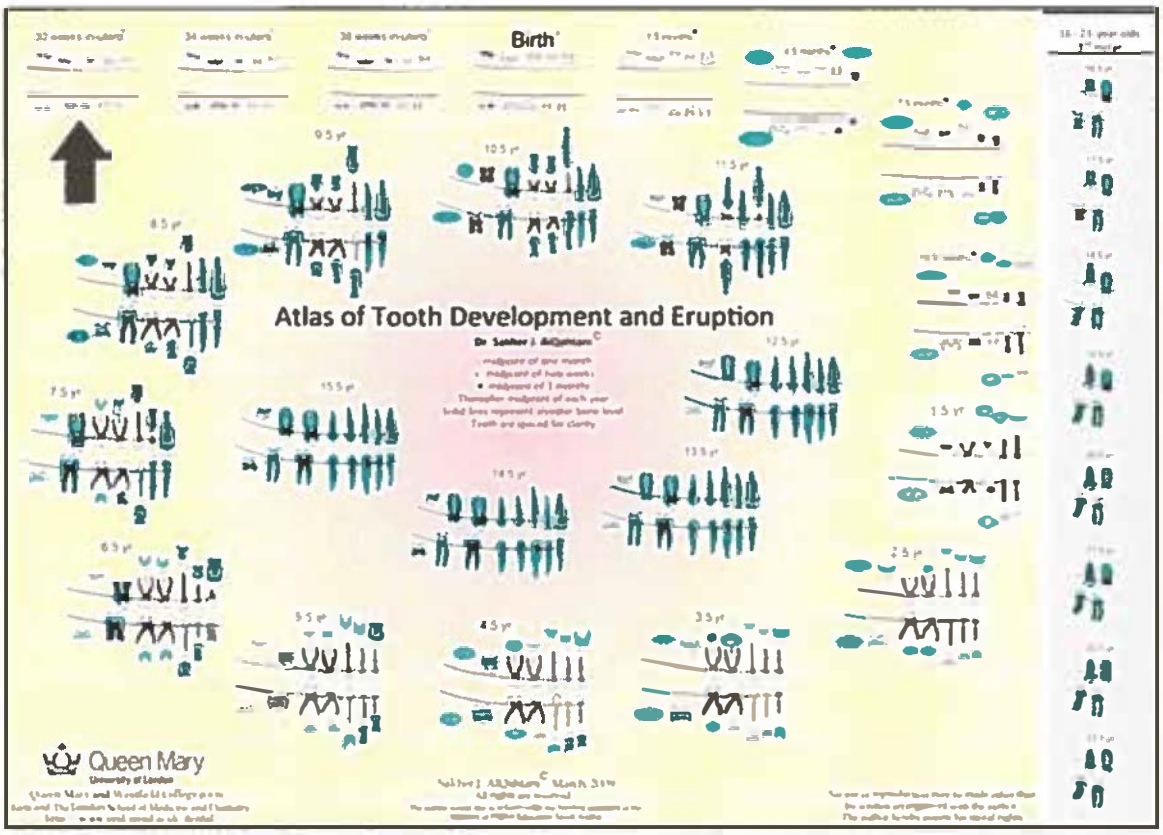

Figure 6. Age Estimation Chart from AlQahtani et al. (2010)

In an attempt to assess the accuracy of three different methods, AlQahtani, Hector, and Liversidge completed a study entitled: "Accuracy of Dental Age Estimation Charts: Schour and Massler, Ubelaker, and the London Atlas (2014)." For this study, they looked at an extremely large sample of 1506 individuals (some were skeletal remains while others were panoramic dental radiographs). The Luis Lopes collection from Portugal, the De Froe and Vrolik collection from the Netherlands, the Hamann-Todd collection from the United States, the Belleville's collection from Canada, and the Collection d'Anthropologie from France provided the skeletal remains for this study. This sample also included 183 younger individuals who ranged in age from 31 weeks in utero to 4.27 years old. The panoramic radiographs were of 1,323 individuals of

Bangladeshi and British origins. These individuals ranged in age from 2.07 years old to 23.86 years old. They noted that there are many critics of Schour and Massler for several reasons. Two of the main criticisms of Schour and Massler are that, of the 29 individuals studied, 19 of them were younger than two years of age. The other criticism was that there was a limited explanation of the material; they did not give a description of their analysis, they had undefined tooth stages and eruption levels, and the age ranges were small. For the AlQahtani et al. (2014) study, the researchers looked at skeletal remains and panoramic radiographs of individual's with known age. When analyzing the skeletal remains and the radiographs, the individual's age was blinded so that the researchers would not be biased by their prior knowledge of the age. The study found that all three methods were quite easily reproduced. It also found that all three underestimated the age of individuals, although the London Atlas method was deemed more accurate.

Apophyseal Fusion: Risser (1958)

In 1958 Dr. Joseph C. Risser Sr. published a chart (see Figure 7 below) that showed the ossification of the iliac crest at different stages in an individual's development (Manring and Calhoun 2010). The iliac crest is the top part of the ilium, the broad bone of the upper part of the pelvis. The iliac crest has many different centers of ossification; these centers of ossification are where bone growth begins. The *Human Bone Manual* defines an apophysis as an "outgrowth or small bony projection" (White et al 2005); in this case, the iliac crest forms the top ridge of the pelvic bone. As an individual ages, the iliac crest apophysis begins to fuse to the iliac crest. The Risser method measures the amount of ossification (i.e. fusion) to determine age. There are two different Risser sign grading systems: the US grading system and the French grading

system. The difference between the two systems is that the US grading system divides the iliac crest apophysis into quarters while the French grading system divides the iliac crest apophysis into thirds. Once the iliac crests have been analyzed the number is cross-referenced on a chart to determine an age estimate (Wittschieber et al 2013).

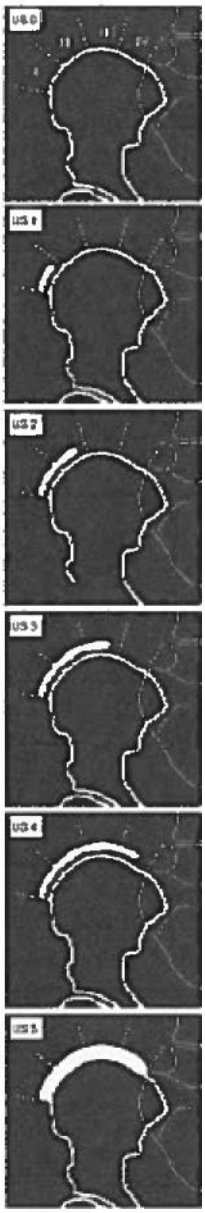

Figure 7. US Risser Grading System (Wittschieber et al.2013)

This method was chosen for this study because it could be used in both biological anthropology and bioarchaeology. When looking at living individuals, one could use radiographs to determine the ossification of the iliac crest apophysis, although there is variation between radiographs and osteological analysis in scoring apophyseal fusion.

Materials

The early medieval population studied in this project comes from a cemetery from the ancient site of Saleux near the northern French city of Amiens. The cemetery was found when the French Department of Transportation attempted to construct a highway in this area. State archaeologists under the leadership of Isabelle Catteddu hurriedly excavated the area in 1993 and 1994. There are approximately 2000 individuals in the sample. Almost half (49%) of the individuals found are subadult, meaning their skeletal show signs of growth and development. This group of individuals lived in Saleux between the 7th and 11th century (Catteddu 1997). As of today, the remains are kept in boxes in a storage facility curated by Dr. Guy Sergheraert. The iliac crests, mandibles, and maxillae of 20 individuals from this northern France population were examined, although a complete analysis was only done on five individuals. The sample size was reduced due to lack of third molars in individuals. This sample includes two males and three females ranging in estimated age from 18 to 25 years of age at death.

For the modern population, I examined radiographs of 50 individuals (25 males and 25 females) who participated in the Case Western Bolton Brush Growth Study. For this study, the American Association of Orthodontists Foundation's (AAOF) Craniofacial

Growth Legacy Collection was utilized, as this is the organization that maintains public access to a selection of this collection. This is an online collection of radiographs started in the 1930s. There are 4309 subjects in the Broadbent-Bolton Growth Study, though not all are available publically via the Internet. The children in the study are described as "being American-born children of Anglo-Saxon or Teutonic origins, children of Sicilian immigrants, or Black children." There were six requirements for the children who initially participated in the study. The first was that the researchers needed the approval of their family physician or the physician in charge of the child. The second requirement was that the child was to be radiographed at pre-determined intervals. When the individual was an adolescent, the x-rays needed to occur once a year close to the birthday. The third requirement was that a psychological exam would happen on or near the birthday. The fourth requirement was that the parents cooperated completely in providing information and records that concerned the child in regards to the research. The fifth requirement was that the child was a permanent resident of Cleveland, Ohio or in the vicinity of the city. The final requirement was that the child needed to arrive at the examination place on time (Behrents and Broadbent 1984).

Methods

For the early medieval population, the very limited sample was chosen based on the appearance of a third molar and a complete iliac crest. The iliac crest was examined for the amount of fusion visible using the method described by Wittschieber et al. (2013). The left side of the iliac crest was used, unless taphonomic damage concealed development, in which case the right side was used. The iliac crests were rated on a scale from zero to five according to the Risser sign scale from the United States method (see

Figure 7 above). If the iliac crest was completely fused, then it was given a rating of five while those with no fusion were given a score of zero (see Figure 8 below). If the pelvic bones examined had intact mandibles and maxillae, then the third molars were x-rayed to compare the fusion of the iliac crest to the mineralization of the third molar. To look at the development of the third molar we used the method described by Anderson et al. (1976). The third molars (see Figure 9 below) were scored according to Moorrees et al. (1963). Once the third molar was analyzed, the results were analyzed using SPSS.

Figure 8. Iliac fusion scored using the Risser sign

Figure 9. Radiograph of a 3rd molar

For the modern population, radiographs were chosen from the Bolton Brush Growth Study based on clarity of the radiograph and age of the individual (see Figure 10 below). There are fifty individuals in this study ranging in age from 10 years, 1 month to 17 years, 10 months, with 25 male individuals and 25 female individuals. Each radiograph was analyzed using each dental age estimation technique and the corresponding age estimations were recorded. See the Appendix for a complete table of all age estimations by individual compared to actual age. When all the data was collected, a paired t-test was performed between the actual age of an individual and the estimation.

Figure 10. Female individual 4665 at 14 years 0 months

Results

Medieval Population

For the medieval population, the results indicated that the age estimated from the mandibular 3rd molars was 4.0 (±1.99) years older on average than the age estimated from the Risser sign (n=5). The previous age estimates made by the French researchers in 1994 using the fusion of the long bone epiphyses for this population are 7.9 (±1.86) years older on average than those from the Risser sign (n=9) in this study (see Table 1 below).

Table 1. Median Age Estimate from Risser Sign, 3rd Molar, and the difference between these estimates

Grave Number	Sex	RSS Median Age	Mandible Mean Age	Difference in Mandible and Risser Age Estimates
349	M	14.28	18.2	3.92
1071	F	15.23	18.3	3.07
970	F	13.83	15.4	1.57
856	M	12.46	16.8	4.34
857	F	11.31	18.3	6.99

Despite the small sample size, T-tests demonstrated that there were significant differences ($p<0.05$) between age estimates from the 3rd molar development and from the Risser sign (see Table 2, below).

Table 2. One-Sample Test comparing Risser Sign and 3rd Molar Median Age Estimates

	Test Value=0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
RSS Median	19	4	0	13.422	11.5027	15.3413
Mandible	30	4	0	17.4	15.8026	18.997

Modern Population

The absolute value of the mean difference between methods was determined because this shows the average amount of error of the estimate in either direction from the mean. The mean difference was also calculated because this number determines whether the method is overestimating or underestimating. If the average was positive than the method was underestimating the age, likewise if the average was negative than the method was overestimating the age. A complete list of the age estimates can be found in the Appendix below. It was found that when males and females were combined, the Schour and Massler 1941, Schour and Massler 1944, and the London Atlas method all overestimated the age of an individual: Schour and Massler 1941 overestimated by 2.66, Schour and Massler 1944 overestimated by 3.86 months, and the London Atlas Method overestimated by 2.66 months. Ubelaker was found to slightly underestimate the age of an individual by 0.22 months. Ubelaker was found to best estimate the age of an individual, as there was no significant difference between the actual age and the estimated age using the Ubelaker method (p-value=0.962); however, the deviation was so high that it lacks precision (absolute average difference in estimation was 18.1 months). The London Atlas Method and Schour and Massler 1941 performed equally well (p-value 0.579 and 0.536 respectively) with similar ranges (absolute average difference was 12.9 and 12.78 respectively). See Table 3 below for a summary of these statistics.

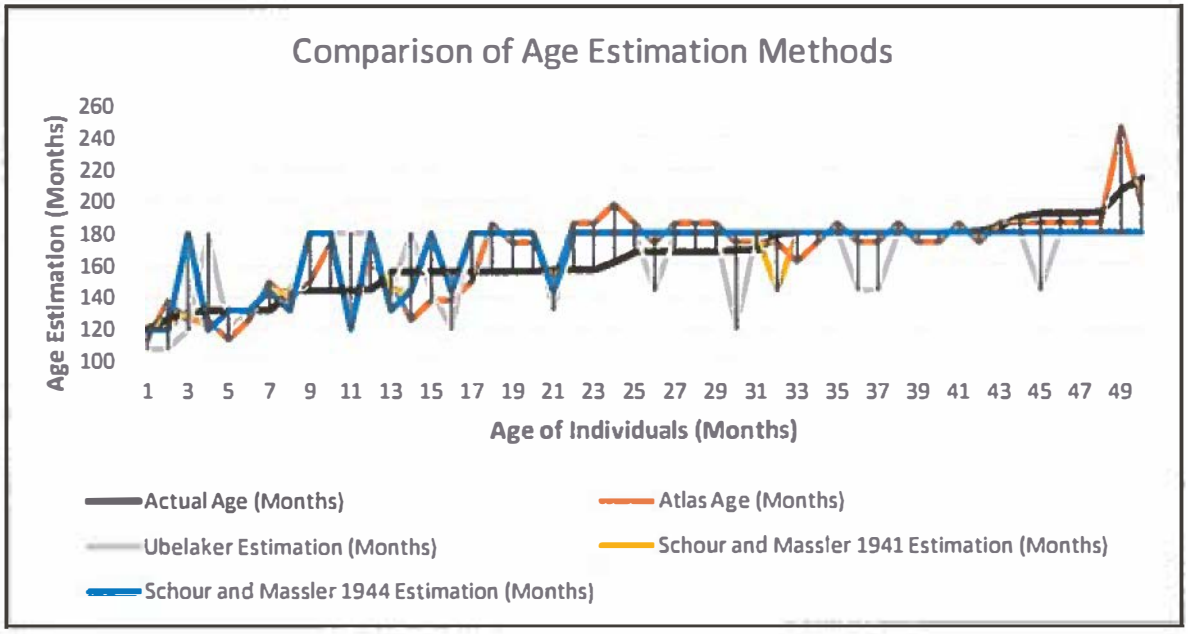

Figure 11. Comparison of four age estimation methods to actual age for sexes pooled

Table 3. Comparison of four age estimation methods to actual age for sexes pooled.

	Atlas	Ubelaker	Schour and Massler 1941	Schour and Massler 1944
std dev	9.4723	14.0120	11.2654	11.9270
abs average	12.9	18.1	12.78	13.54
average	-2.66	0.22	-2.66	-3.86
significance	0.579		0.536	0.369

When looking at male individuals the accuracy of each chart changed slightly (see Figure 12 and table 4). For males the London Atlas method and Schour and Massler 1941 performed best (p-values 0.978 and 0.994 respectively). The London Atlas method slightly underestimated the age of an individual while Schour and Massler slightly overestimated the age of an individual. Ubelaker performed worst for males (p-value 0.331).

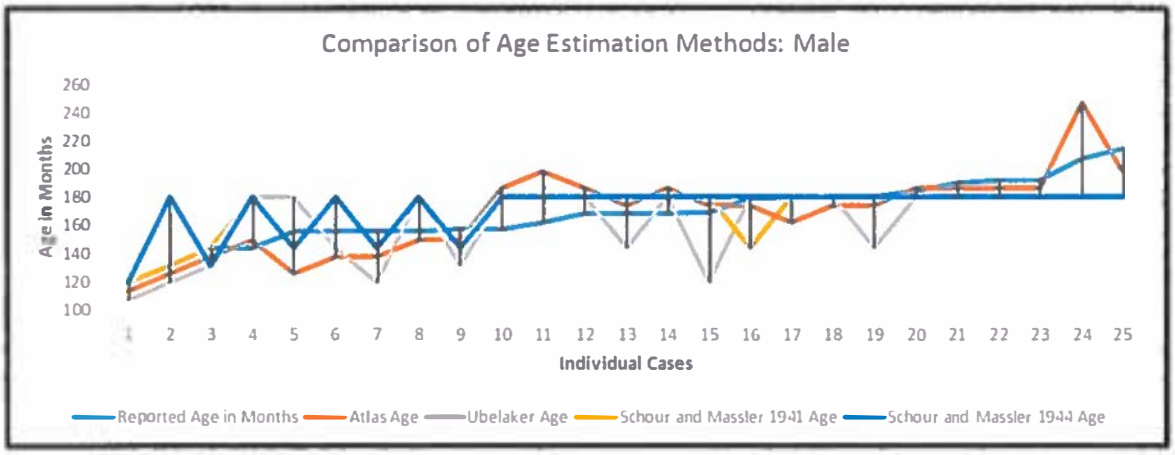

Figure 12. Comparison of four age estimation methods to actual age for males

Table 4. Comparison of Age Estimation Methods for Females

	Atlas	Ubelaker	Schour and Massler 1941	Schour and Massler 1944
std dev	10.688	12.792	11.303	12.318
abs average	12.92	18.68	13.8	12
average	0.2	6.68	-0.04	-2.92
significance	0.978	0.332	0.995	0.612

When looking at females, all methods performed approximately equally well, with Schour and Massler 1941 and Schour and Massler 1944 performing only slightly better (see figure 13 and table 5). The London Atlas Method, Ubelaker, and Schour and Massler 1941 all underestimate the age of an individual while Schour and Massler 1944 overestimates the age.

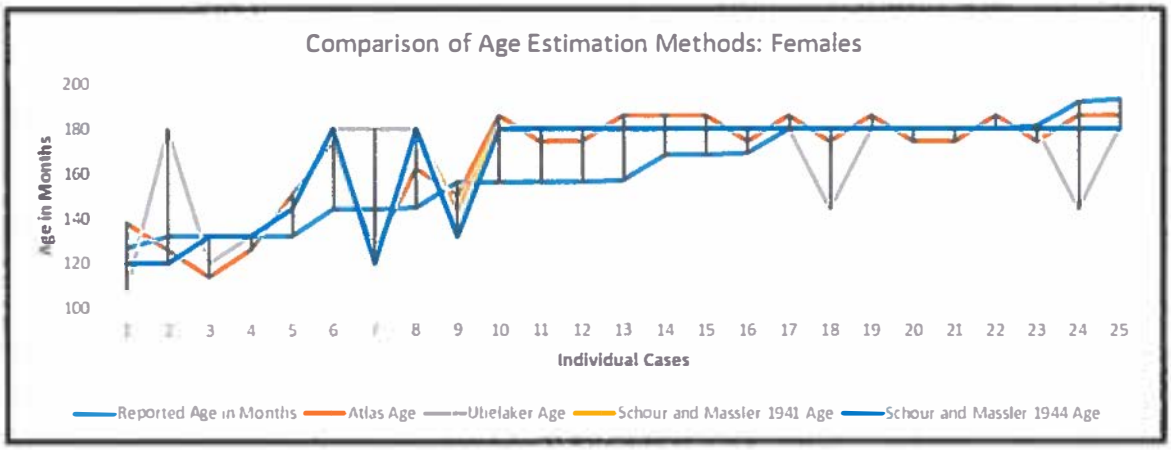

Figure 13. Comparison of four age estimation methods to actual age for females

Table 5. Comparison of age estimation techniques for females

	Atlas	Ubelaker	Schour and Massler 1941	Schour and Massler 1944
std dev	8.303	15.379	15.627	11.627
abs average	12.880	17.520	11.760	12.240
average	-5.520	-6.240	-5.280	4.800
significance	0.378	0.311	0.401	0.452

Discussion

For the medieval population it was found that the Risser sign was not a reliable indicator for chronological maturity, with the age estimates significantly lower ($p<0.05$) than age estimates from the mandibular 3rd molar. This is consistent with the current research that has attempted to use the Risser sign as an age estimation method for asylum seekers in Italy (Di Vella and Nuzzolese 2008). These authors found that the fusion of the iliac crest is typically complete between 14-16 years. The older estimates from the long bone epiphysis (as reported by the previous researchers) compared to the dental age may point towards a delay in overall skeletal maturation in comparison with a modern population.

Overall it was found that the methods performed similarly for the modern population, although more research is needed on dental age estimation methods. One reason that Ubelaker was not as accurate as other methods is due to the fact that the chart that was used was based on data collected on American Indians while Schour and Massler used those of European descent. One major limitation to the current research was the quality of the radiographs. Looking at radiographs taken in the 1930s through the 1980s meant that the quality varied greatly. Of the 4309 individuals who participated in the study, only 102 of those individuals have radiographs available for viewing on the database. Of those 102, I was not able to use all of them for my research because many of the radiographs were not very clear or were overexposed that you could not make out individual teeth, let alone their roots to analyze development (see Figure 14 below).

Figure 14 Female Individual 01119 at 12 years 1 month

In "Accuracy of Dental Age Estimation Charts: Schour and Massler, Ubelaker, and the London Atlas," it was determined that the London Atlas method was "better in all measures of performance than Schour and Massler and Ubelaker (AlQahtani et al 2014)." However, for my sample, I found that for the pooled data the London Atlas Method and Schour and Massler 1941 performed equally well. One possible reason for this difference is sample size. AlQahtani et al. (2014) had a sample of 15016 individuals while I only had access to 50. Studies with high sample sizes are more accurate because there can be sample bias in smaller samples.

One explanation for the differences in accuracy between males and females is sexual dimorphism. Sexual dimorphism can be defined as the biological differences between males and females in regards to biology. In *Homo sapiens*, most sexual dimorphism is not present until after puberty has started. Thus, there is little sexual dimorphism that can be seen on the skeletal remains of infants and children, so trying to estimate sex of individuals who have not yet reached puberty is problematic. At puberty there is a surge of hormones that cause changes in the skeletal system and development of secondary sexual characteristics, such as the widening of the pelvis in females (Frayer and Wolpoff 1985).

Conclusion

Accurate age estimation techniques are vital to anthropologists and to other medical professionals for various reasons, including determining age at death when unknown, differentiating victims in a mass grave, and determining eligibility for social security benefits. Age estimation techniques should be chosen based on the population being studied. If the population is of European ancestry, then the London Atlas method (AlQahtani et al. 2010) should be used, if studying a Native American sample, then the Ubelaker (1987) method would likely be preferred. When looking at a medieval population, there may be some discrepancies due to differences in cultural habits, but we do not have known age samples from the early medieval period, therefore modern methods have to suffice. As for the age estimation from the Risser sign, although the sample was extremely small, the results suggest that error of this method is too great to be recommended for practical application. We need accurate age estimations techniques so that we cannot only accurately estimate age of past populations in bioarchaeological contexts, but that so we accurately estimate age of those of unknown age today in forensic settings and for social security benefits or special status of immigrant children. Future research with the medieval population should increase the sample size. For the modern populations, the hope is to continue the analysis of age estimation techniques using data from the other modern growth studies that are available through the AAOF Craniofacial Growth Legacy Collection.

Appendix

Table 6. Raw Data Comparing Actual to Dental Age Estimation with Four Methods

Sex	Actual Age (Months)	Atlas Age (Months)	Difference between Actual and Atlas	Ubelaker Estimation (Months)	Difference between Actual and Ubelaker	Schour and Massler 1941 Estimation (Months)	Difference between Actual and Schour and Massler 1941	Schour and Massler 1944 Estimation (Months)	Difference between Actual and Schour and Massler 1944
m	127	114	7	108	13	120	1	120	1
f	127	138	-11	108	19	120	7	120	7
m	131	126	5	120	11	132	-1	120	-49
f	132	126	6	180	-48	120	12	120	12
f	132	114	18	120	12	132	0	132	0
f	132	126	6	132	0	132	0	132	0
f	132	150	-18	144	-12	144	-12	144	-12
m	144	138	6	132	12	144	0	132	12
m	144	150	-6	180	-36	180	-36	180	-36
f	144	174	-30	180	-36	180	-36	180	-36
f	144	126	18	180	-36	120	24	120	24
f	145	162	-17	180	-35	180	-35	180	-35
f	156	150	6	144	12	144	12	132	24
m	156	126	30	180	-24	144	12	144	12
m	156	138	18	144	12	180	-24	180	-24
m	156	138	18	120	36	144	12	144	12
m	156	150	6	180	-24	180	-24	180	-24
f	156	186	-30	180	-24	180	-24	180	-24
f	156	174	-18	180	-24	180	-24	180	-24
f	156	174	-18	180	-24	180	-24	180	-24
m	157	150	7	132	25	144	13	144	13
m	157	186	-29	180	-23	180	-23	180	-23
f	157	186	-29	180	-23	180	-23	180	-23
m	162	198	-36	180	-18	180	-18	180	-18
m	168	186	-18	180	-12	180	-12	180	-12
m	168	174	-6	144	24	180	-12	180	-12
m	168	186	-18	180	-12	180	-12	180	-12
f	168	186	-18	180	-12	180	-12	180	-12
f	168	186	-18	180	-12	180	-12	180	-12
m	169	174	-5	120	49	180	-11	180	-11
f	169	174	-5	180	-11	180	-11	180	-11
m	179	174	5	180	-1	144	35	180	-1
m	180	162	18	180	0	180	0	180	0
m	180	174	6	180	0	180	0	180	0
f	180	186	-6	180	0	180	0	180	0
m	180	174	6	144	36	180	0	180	0
f	180	174	6	144	36	180	0	180	0
f	180	186	-6	180	0	180	0	180	0
f	180	174	6	180	0	180	0	180	0
f	180	174	6	180	0	180	0	180	0
f	180	186	-6	180	0	180	0	180	0
f	181	174	7	180	1	180	1	180	1
m	184	186	-2	180	4	180	4	180	4
m	190	186	4	180	10	180	10	180	10
f	192	186	6	144	48	180	12	180	12
m	192	186	6	180	12	180	12	180	12
m	192	186	6	180	12	180	12	180	12
f	193	186	7	180	13	180	13	180	13
m	207	246	-39	180	27	180	27	180	27
m	214	198	16	180	34	180	34	180	34

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