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Methods used on the mandibular third molar to estimate age on adolescent asylum seekers in Norway

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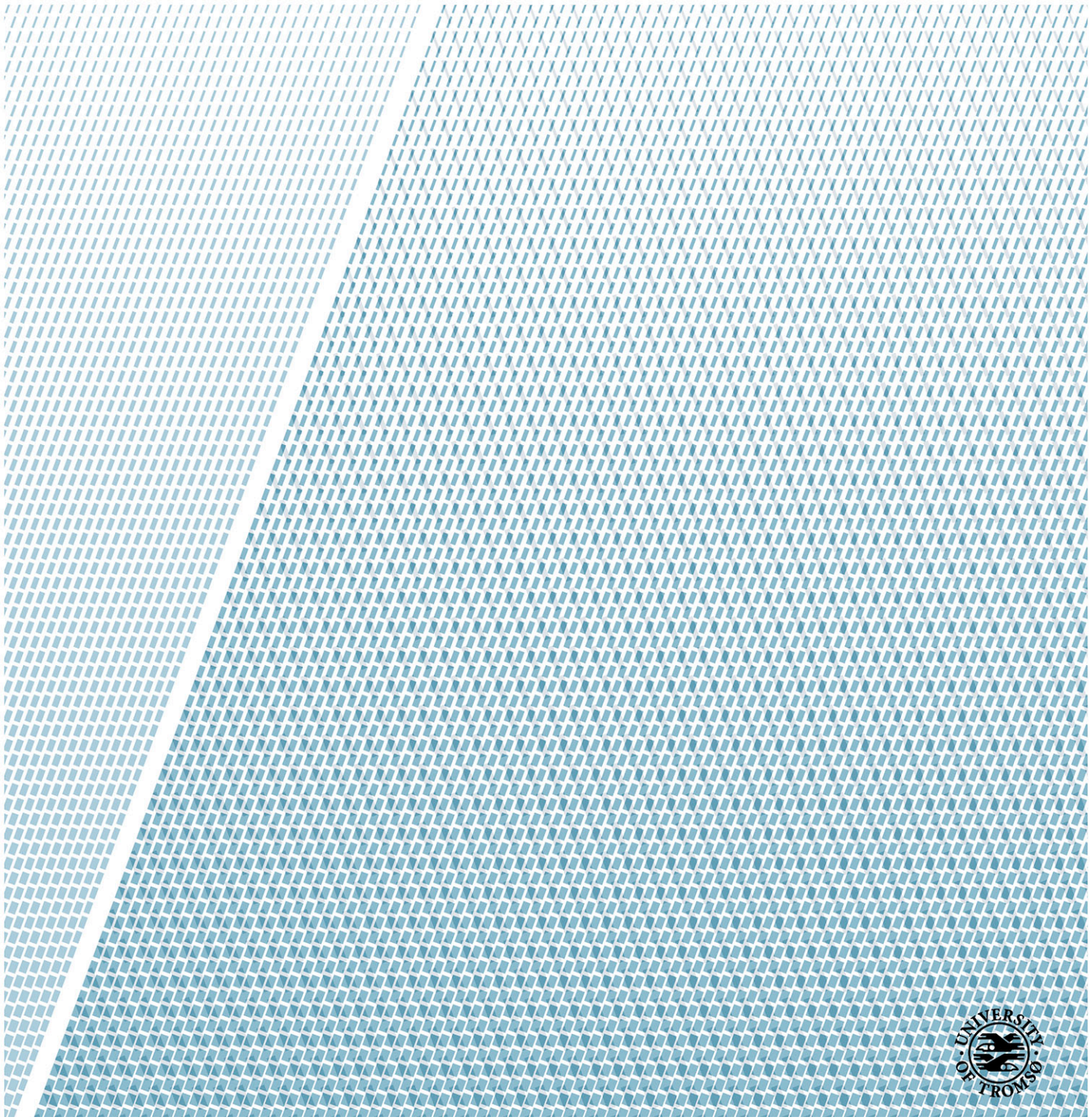

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Abstract

Globalization does not only lead to increased movement of goods, services and capital – an increasing number of people are also migrating either voluntarily or as refugees seeking asylum. Some arrive as unaccompanied minors, others claim to be minors, but the physical and mental appearances suggests otherwise. In Norway you are considered a minor if you are under 18 years of age, which will give you the rights and protection of a child, and the asylum application process will be expedited. For an unidentified foreigner to arrive in Norway age is crucial, and several methods have been developed to measure the alien's correct chronological age.

The growth potential of teeth and tooth buds are less susceptible to malnutrition, radioactivity or other socioeconomic factors compared to the skeleton. This opens the opportunity to estimate age based on teeth with less standard deviation than other methods. Tooth buds start developing *in utero* and the mineralization continues until late teens - early 20s. By clinical and radiographic examinations of teeth and tooth buds, the age of children, adolescents and young adults can be estimated.

Age estimation is important both for the individual and the society, and different methods are used for this purpose, many of them based on radiographic interpretation of tooth development. In Norway, the methods used for age estimation is Demirjian *et al.* for children up to 14 years of age, Haavikko for individuals up to 20 years of age, and Liversidge for individuals between 14 and 20 years of age. After the closure of the 3rd molar apex, Kvaal *et al's.* method is used. The latter method is not used in Denmark and Sweden, because it has shown to be very inaccurate. It has been argued that there is no ethnical variation in tooth mineralization, but in 2008, H.M. Liversidge found significant ethnical differences in human tooth mineralization.

Dental age estimation based on 3rd molar mineralization stages is considered to be inaccurate. Even though, for the 15- 25 years age group, it is worldwide found to be one of the most accurate methods of those available today.

1 Introduction

Globalization does not only lead to increased movement of goods, services and capital – an increasing number of people are also migrating either voluntarily or as refugees seeking asylum. In 2014, 11480 persons applied for asylum in Norway (1). Of these, 1204 were unaccompanied asylum seekers who claimed to be minors (2). Age is important for the asylum application process and the outcome (3). In Norway, an individual under the age of 18 is considered a child, and have rights according to the Convention on the Rights of the Child, ratified by Norway in 1991 (4). If it is impossible to locate the parents, a child can be given residency even though it is not considered a refugee. Furthermore, the application processing time is shorter for children (5). During the application process, unaccompanied children are assigned a representative to attend the asylum interview. If the age estimation confirms that the applicant is less than 18 years of age, he or she is assigned a lawyer. The lawyer may be present at the asylum interview if the child is most likely under 18. Children under 15 years of age are placed in a housing project where care is provided, while children between 15 and 18 live in centers for unaccompanied minors (6).

Article 7 of the Convention on the Rights of the Child (4) states that: *"The child shall be registered immediately after birth and shall have the right from birth to a name, the right to acquire a nationality and, as far as possible, the right to know and be cared for by his or her parents"*. In the industrialized world, identification papers are common, and for an individual to have a known birthday comes naturally. Births and deaths are not always well documented in developing countries. It can also be difficult and/or expensive to get the identification documents (ID), or an individual might have reasons to "lose" these ID-papers before seeking asylum in a new country. The Norwegian Directorate of Immigration (UDI) introduced age examination in 2003 (7), and in 2008 it was established by law. Age examination is performed not only on asylum applicants, but also in adopted children where there's no record of birth certificate, or the age is questionable (8).

When the police register the applicant at the very beginning of the asylum process, the officer should always evaluate if the given age seems accurate. Any doubt should be recorded along with the officer's subjective age estimation. Employees at transit centers are also requested to inform the UDI whether they find the given age of an applicant likely or not. In general, UDI

requests age examination of all asylum applicants with a given age between 14 and 18 years, as well as of applicants above 18 where behavior and visual appearances suggest that they are younger (9). It is important to inform the applicants about reasons for doing age estimation and how the examinations are conducted, and Unit for arrivals (ANK) at UDI collects the applicants' permissions of being subjected to medical and dental age estimation. If the applicant refuses and there is doubt about the age, it might have a negative impact on the application outcome (10).

Before the medical and dental examination, an interview is performed with a translator present, with questions to assess the applicant's age. If the applicant will be 18 in one month; it is obvious that the applicant is over 18; or the applicant's given age is 12-14 years old, which appears to be true, no further age examination is done after the interview (9). The reason for this must be documented, and the unit of child science in UDI (BFE) should be contacted.

In 2014, age examinations were performed on 964 individuals that claimed to be unaccompanied minors (UAM). A conclusion was reached for 963 UAM applicants. Of these, 404 were considered minors, there was doubt about 126 of the applicants, 99 were evaluated unlikely to be under 18, 197 were evaluated highly unlikely to be under 18 years of age, whereas 137 were evaluated adults at the time of application[1]. Table 1 sum up asylum decisions for unaccompanied minors by UDI from 2011 through 2014.

[1] Numbers provided from UDI upon request

Decisions	2011	2012	2013	2014
Asylum[2]	172	150	252	513
Other protection	285	215	154	132
Humanitarian grounds[3]	75	31	50	50
UAM limited[4]	30	35	17	21
Rejection	45	36	23	34
Dublin II convention[5]	107	128	53	15
Residences in safe 3rd country[6]	1	8	3	5
Withdrawn/dropped	43	52	37	44
Total	**758**	**655**	**589**	**814**

Table 1 Asylum Decisions for Unaccompanied Minors by The Norwegian Directorate of Immigration (UDI) (2011-2014)

[2] Asylum: The applicant is given refugee status.
[3] Humanitarian grounds: Protection, but not refugee status
[4] UAM limited: Limited residence due to doubt about the applicant's identity.
[5] Dublin II: Another collaborating country is responsible for the asylum application.
[6] Safe 3rd country: The applicant already has refugee status or residence permit in another EU/EEC.

The growth potential of teeth and tooth buds are less susceptible to malnutrition, radioactivity or other socioeconomic factors compared to the skeleton. This opens the opportunity to estimate age based on teeth with less standard deviation than other methods (11). Tooth buds start developing *in utero* and the mineralization continues until late teens - early 20s. By clinical and radiographic examinations measuring and counting alveolar erupted teeth, clinical erupted teeth, teeth not yet erupted, and tooth buds, the age of children, adolescents and young adults can be estimated (12).

In children, many teeth will be in the various developmental stages, giving the examiner multiple variables to predict the age, and the estimation is considered highly reliable. Hence, the estimation is less accurate in adolescents and young adults that counts only a few teeth not finally mineralized (13, 14). After closure of the apices of the 2nd molars, around the age of 15, only the 3rd molars are still in development (15). Thus, the dental age estimation of adolescents between 15 and 25 years of age are normally based on the 3rd molar development. The 3rd molars, which end their calcification around age 20, show the highest variability in morphology and age of eruption of all teeth, and are also most often missing (16).

Several atlases, such as "The London Atlas of Human Tooth Development and Eruption" (17), the chart in "The Development of The Human Dentition (18) and "Development of the Human Dentition: An Atlas" (19), are describing tooth mineralization stages and eruption time in the mouth. Atlases have their limitations and the method will be subjected to a high degree of inter-observer disagreement because it is almost impossible to determine clinical emergence in the mouth from a radiograph (20).

In this thesis we will present and discuss different methods used in Norway to estimate age by studying the development and maturation of the mandibular 3rd molars. We want to see if there are any significant ethnical variation in tooth mineralization and how dental age correlates to chronological age. Is the dental age estimation in Norway accurate enough?

2 Age estimation – clinical and radiographic examination

In Norway, the age examination includes radiographs of the carpus and teeth, and a clinical oral examination (21). The carpus radiograph is usually captured at Unilabs Norge AS, a private radiology and laboratory medicine company, upon request from the UDI. On the carpus radiograph, the form, bone size and epiphyseal ossification is assessed and compared to the Greulich Pyle atlas (22, 23). This atlas is based on data from middle class children in the US in the 1930s. They state that the skeleton is fully matured at an age of 17 years for girls and 18 years for boys. Within the 95 % confidence interval, the standard deviation is four years in girls and 5 years in boys (24). The Royal College of Paediatrics and Child Health (25) is a British college that conduct research and issue guidelines on pediatrics. They use the mean ages 15-16 years for girls and 16-17 years for boys, and point out that these ages only are indicative (26).

To secure a unified evaluation, the majority of the dental age examinations in Norway are done by a skilled team consisting of staff from the Faculty of Dentistry at the University of Oslo. The clinical dental examination should include (27) registrations of erupted and/or missing teeth, fillings, caries, attrition based on Johanson's method (28), tooth color based on Solheim's method (29), enamel hypoplasias, plaque, calculus and stains, gingival appearance and pocket depths, occlusion, malocclusion, rotations, overbite, overjet, and finally a visual age estimation. In addition, an orthopantomogram of the teeth is captured. If the root development is completed, two apical radiographs are taken of the maxillary central and lateral incisors.

3 Dental age estimation based on radiographs

At the time when age estimation was requested by law in Norway (2008), several methods for dental age estimation based on radiographs were used e.g. Demirjian *et al*. (30) Kullman *et al*. (31) Harris and Nortje (32) Haavikko (33) and Kvaal *et al* (34). Demirjian *et al's.* method from 1973 does not include the 3rd molar development. The method has later been updated by Levesque *et al.* (35) and modified to include the 3rd molar development and a more secure estimation of apex closure i.a. Prieto *et al*. (2005) (36), and Olze *et al*. (2005) (37). The studies by Haavikko (1970) (33), Kullman *et al.,* and Liversidge (2008) (38) are based on the stages described by Gleiser and Hunt (1955) (39). These stages initially described the development of the 1st molar, but in 1963 Moorrees *et al.* (40) modified these stages to apply to all teeth (40). If the 3rd molars are fully developed, Kvaal *et al's*. method measuring the size of the pulp chamber has been used.

3.1 Haavikko

In 1970 Kaarina Haavikko published a cross sectional, roentgenological study of 1162 individuals between 2 and 21 years of age, 615 boys and 547 girls, all from Helsinki (33). The orthopantomograms were taken at the University of Helsinki between 1965 and 1968. Of the studied population, 66 persons (5.4%) were excluded either because they were not considered healthy and normal, had permanent teeth extracted or their x-rays were indistinct.

The author collected the material and carried out the x-rays examination herself, determining the stage of formation, the alveolar eruption and the clinical eruption of all teeth. The method used to determine stages of tooth formation was a modified division by Gleiser and Hunt (39), where twelve stages are described; six related to the crown formation and six to the root formation. When a tooth has passed the beginning of a stage it is still considered to belong to this stage until it reaches the next stage. The results were divided into half-year age classes. She made separate tables for boys and girls, and the upper and lower jaw. There were no significant differences between the right and left side values, which were therefore combined.

3.2 Demirjian, A,Goldstein, H, Tanner, J.M.

Demirjian *et al.* (30) studied orthopantomograms of 2928 children between 2 and 20 years, 1446 boys and 1482 girls of French Canadian heritage in the Ste-Justine Hospital and the Growth Centre, Montreal in 1971. The aim of the study was to "*derive a method of estimating overall dental maturity or dental age, by a quantity based on the stages observed in each tooth"*. Only radiographs from healthy children with a complete mandibular dentition were chosen. One examiner trained three others, and the four examiners rated the same amount of radiographs from each age group. At the end of each day of studying the sample of orthopantomograms, each of the four observers studied 5 randomized radiographs as an inter-observer calibration. The results were discussed and they did not disagree in more than 10 per cent of the radiographs.

Demirjian *et al.* measured teeth using 8 stages of dental development based on Gleiser and Hunt (39) with one, two or three written criteria for each stage. They based the stages on change in form rather than change in size. The teeth were given maturity scores, and by using an appropriate table of standards it can be converted into a dental age. Boys and girls had different sets of scores (30). They found no significant differences in mineralization time between the mandibular right and left side, the left side was therefore chosen.

The authors studied a French-Canadian sample, and assumed that the tooth development would not vary much between ethnicities and populations.

3.3 Liversidge

H.M. Liversidge studied population differences in the mandibular 3rd molar in a cross-sectional study (38). The material studied was collected from several sources: radiographs of white and Bangladeshi children in London were gathered from radiographic archives at The Dental Institute of Barts and The London School of Medicine, whereas the radiographs of black and Cape-colored children, that is Indians and children of mixed race, were provided from the Dental School, University of Witwatersrand, Johannesburg, Medunsa Oral Science Department (now part of University of Limpopo) in Pretoria, and the collection of Professor

C. J. Nortjé, Department of Dental Radiology, Dental School, Tygerburg, Cape (University of Stellenbosch, now University of Western Cape).

Liversidge staged the mandibular 3rd molar according to Moorrees *et al.* (1963) (40) adding an additional first stage, *crypt,* and descriptive criteria. Radiographs of gross pathology and developmental anomalies were excluded. To correct intra-observer errors, 100 radiographs were studied two times giving a Cohen's kappa value (a measure of inter-rater agreement) of 0.77, which is excellent. For every stage, Liversidge defined the mean age as when half of the children at a given age had reached or passed the stage. Mean age differences within and between sexes and ethnicities were compared using t-test.

In Black children, Liversidge found that the crypt formation starts significantly earlier than in Whites, Cape Coloured and Bangladeshi's. In Blacks the crypt formation stages on average were 7.16 years, Bangladeshi's 8.24, and Whites and Cape Colored 9.06. She presented sex specific tables with mean age in entering development stages.

Her study showed that there was no statistically significant gender differences in average time of cusp tip initiation in any of the four ethnical groups. In white children, Liversidge found that boys were younger than girls when they reached six of the stages. In Bangladeshi children, boys were younger than girls for almost all stages. In contrast, the girls had earlier timing for almost all stages in Black children.

The initiation and completion of the mandibular 3rd molar were significantly earlier in Black children compared to Whites, Bangladeshi and Cape Colored, in all 15 stages. "*Among molars, there was surprisingly little variations in mean crown formation times" (quote: Reid, DJ, Dean MC. 2006. J Hum Evol 50:345)* (41). In almost all stages of development, the Black children from South Africa were significantly earlier in the formation of the mandibular 3rd molar compared to Whites and Bangladeshi in London and Cape Colored children in South Africa. For all groups the mean age of initializing mineralization was 7.97 – 9.74 years, the mean age of entering stage Ac was 19.27 – 20.88.

3.4 Kullman, Johanson and Åkesson

The aim of this study was to examine root development in the lower 3rd molar and how well these stages coincide with chronological age (31). Only Scandinavian children with Scandinavian names were accepted. 667 young adults were selected; 323 boys and 354 girls with at least one lower 3rd molar. There were two observers who were calibrated before the study. They staged the orthopantomograms independently, and were blinded for the chronological age and sex of the children. The two observers agreed in 84% of the cases. One of them overestimated and the other underestimated the age. Both observers found that boys entered stages 2, 4, 5, and 6 significantly earlier than girls. In boys the calcification of the roots started at age 15, and was completed at the age of 19. Girls started calcification of the roots 4 months later, and it was completed at the age of 20. This is in contrast to other permanent teeth where girls were in advance (33). Standard deviation for both sexes was 1-2 years. Since the sample in this study lies within 95 % confidence limit, the extreme cases in chronological age can differ with 7 years between the most retarded and most advanced children in the same dental stage. The authors found no differences in root development between right and left side.

3.5 Kvaal S.I, Kolltveit K.M, Thomsen I.O, Solheim T

The aim of this study was to find a method to estimate age in adults by measuring the pulp size in periapical radiographs. The material consisted of periapical radiographs of 100 individuals between 20 and 87 years from the Department of Oral Radiology, Faculty of Dentistry, University of Oslo (34). The mean age was 42.6 years.

The relationship between age and the pulpal size on periapical radiographs was used to estimate age. The mandibular lateral incisors, canines and first premolars, as well as the maxillary central incisors, lateral incisors, and second premolars were used. Only cases where measurement of all of these teeth was possible were selected. Persons with vestibular radiopaque fillings, crowns, visible radiographic pathological processes in the apical bone, root filled teeth, or where the mesio-distal plane of the tooth was not parallel to the film were excluded.

Two observers did the radiographic measurements. The age and gender of the individuals were unknown to the observers. Intra- and inter-observer variations were investigated with paired t-test and correlation coefficients. The observers measured maximum tooth length, pulp length, root length on the mesial surface from the enamel-cementum junction (ECJ) to root apex, midpoint between ECJ and midroot level, and root and pulp width at ECJ and midroot level. Based on these measurements, tooth/root length, pulp/root length, pulp/tooth length and pulp/root width were calculated. Paired t-test showed no significant differences between left and right side of the jaw. The ratio between tooth and root length was not significantly correlated with age, and therefore excluded. There was a stronger correlation between width ratio and age than between length ratio and age (except maxillary central incisors), but when the length ratio was combined with the width ratio, the correlation was higher.

The strongest coefficient was found when ratios from all six teeth were included ($r^2 = 0.76$), and the weakest when only mandibular canines were included ($r^2 = 0.56$). The standard error (SE) was lowest when all teeth from both jaws were included (SE = 8.6 years), and highest when only mandibular canines or only mandibular lateral incisors were included (SE = 11.5 years).

4 Discussion

4.1 Correlation between dental and chronological age

In 1985 Hägg *et al.* (13) studied and compared three different methods (30, 42, 43) for estimation of chronological age based on the first 7 teeth in children aged 3.5 to 12.5 years of age. The 3rd molar was not included in this study. They found a systematic overestimation of chronological age in the oldest groups using Demirjian *et al,* underestimation using Liliequist and Lundberg, and overestimation using Gustafson and Koch. The highest correlation between age estimation and chronological age was seen using Demirjian *et al.* in children aged 3.5 to 6.5 years old. The other methods showed less accuracy. As the individuals grow older, the variation increases. It is therefore argued that it's easier to estimate a precise chronological age in younger children with all three methods given the high number of teeth in development. One of the reasons, according to Levesque *et al.* (1980) (35), is that the earlier stages are shorter than the later.

Naik *et al.* (2014) (44) studied Demirjian *et al's.* (30) method on the mandibular right 3rd molar in 100 Indian children, and found a significant positive correlation between dental age and chronological age. They concluded that Demirijan *et al's.* method is a reliable guide for age estimation in the age group 7 to 24 years of age, even though the correlation between chronological age and dental age was better when the subject was under 16.

Olze et al (2005) (37) analyzed 420 orthopantomograms on the mandibular 3rd molar in German females aged 12-25 years of age, and used the stages defined by Gleiser and Hunt (1955) (39), Demirjian *et al.* (1973) (30), Gustavson and Koch (1974) (42), Harris and Nortje (1984) (32), and Kullman *et al.* (1992) (31). They concluded that the classification that achieved the highest values for both observer agreement and correlation between the age estimated and the true age was Demirjian *et al.* Gleiser and Hunt and Kullman *et al.* also achieved good results, whereas Harris and Nortje and Gustavson and Koch achieved less accurate results. Olze *et al.* concluded that the preferred method for forensic age estimation should be Demirjian et al. This comparison was done before Liversidge (2008) (38) published her findings.

Liversidge et al (2010) (45) tested 30 different published methods that used Demirijan and Morrees root stages. (20 based on Demirjians staging and 10 based on Moorrees staging, modified by Liversidge). The sample consisted of panoramic radiographs of 157 individuals (Bangladeshi and white Caucasian children), and bias (difference between dental age and real age) and accuracy of age estimation was calculated. The observer re-assessed 30 radiographs to calculate intra-observer-agreement of the staging, giving a Cohen's kappa value of 0.95 for Demirjian *et al's.* stages and 0.91 for Moorees *et al's.* stages. This means an almost perfect agreement in the root stage assessment. Most of the methods over-estimated the age of the younger individuals and under-estimated the age of older individuals. The bias was significant for all methods but 6. Only the methods from Levesque et al (1981) adapted for age estimation, Prieto *et al.* (2005), Olze *et al.* (2006), Orhan *et al.* (2006), Zeng *et al.* (2009), and Liversidge (2008), showed insignificant bias. Using a different study sample, they also calculated the probability of being at least 18 years old in different 3rd molar developmental stages, finding that the probability of being at least 18 years old in stage Ac was 0.945.

In a later publication Liversidge (2012) published a review of Demirjian *et al's.* method on dental maturity, and argue that one of it's strengths is that they quantifies dental maturity, corresponding it to chronological age, and that the method provides a good clinical tool to estimate the developing dentition of an individual child. The child is then compared to the 50th percentile. Liversidge used the original staging up to 2nd molar, and the age range was 2.1-17.9 years. The 3rd molar was excluded from this study.

Kullman *et al*. stated that precision is low for these kinds of studies due to the high standard deviations around mean age in different stages (31). In many of the methods tested, the standard deviation was up to 3 years, increasing in later mineralization stages (46).

4.2 Carpus radiography

For carpus radiograph age estimation, both the Greulich Pyle atlas and the guidelines from The Royal College of Paediatrics and Child Health have been used. The two methods disagree of the mean year of cartelization of the carpus maturation in boys and girls. Several scholars argue that the Geulich and Pyle atlas from the 1930s is outdated because children mature

earlier today than 80 years ago, and that bone age estimation is very inaccurate for individuals over 16 years of age and is not recommended (47).

4.3 Ethnicity

Olze *et al*. (2006) stated *"It may safely be concluded that population-specific standards would enhance the accuracy of forensic age estimates based on wisdom tooth mineralization in living subjects"* (48). In accordance with this suggestion, Liversidge in 2008 (38) found and presented for the first time ethnical differences in human tooth mineralization, showing that Black children from South Africa completed 3rd molar maturation earlier than White and Bangladeshi in London, and Cape Colored in Cape Town. Thus in Norway Liversidge's tables, which include separate tables for different ethnicities, are preferred over Kullman *et al's*., which are based on Scandinavian children.

4.4 Methods for dental age estimation used in Norway today

On younger individuals the methods used for age estimation is Demirjian *et al.* for children up to 14 years of age, Haavikko for individuals up to 20 years of age, and Liversidge for individuals between 14 and 20 years of age. After the closure of the 3rd molar apex, Kvaal *et al's.* method is used. In Denmark and Sweden Kvaal *et al's*. method is not utilized, because the ones responsible for age estimation in these countries found the method too inaccurate on the distinctive age group of unaccompanied minors (NOAS) (24). They have no alternative method to Kvaal *et al,* arguing that if the Kvaal *et al's* method has to be used, the individual is likely to be over 18 years old. In agreement with this, Liversidge (2010) (45) tested a sample of 1663 radiographs with the Demirjian *et al.* method for the probability of being at least 18 years of age by root formation stages of 3rd molar, and found that in stage R and A1/2 the probability of being at least 18 years was high. Furthermore, Kvaal *et al.* have stated that *"Examination of dental radiographs of fully developed teeth is rarely advocated for use in age estimation."* (34).

5 Conclusion

From a modern world perspective, living in such a well documented and regulated society, it's hard to accept that dental age estimation is allowed to have such a major impact on the fate of young asylum applicants.

In younger children with rapidly developing dentitions, more teeth can be evaluated and several teeth will be in early developmental stages. As the early stages have shorter time intervals than the later, age estimation based on them is more accurate. In addition carpus radiographs can be used as a complement to the dental age estimation, and further increase the accuracy.

In adolescents only the 3rd molar root is still yet to mineralize, and thus the only tooth to evaluate. The 3rd molar is the tooth with the highest variation in terms of agenesis, appearances, mineralization - and eruption time. The later erupting teeth and their root mineralization stages have a mean duration up to 3 years contributing to the inaccuracy of age estimation in adolescents. At this stage the skeleton is most likely to be fully developed, and we question the use of carpus radiography for age estimation in borderline cases.

It's in the best interest for the individual's wellbeing both physically and mentally, as well as for the society - to estimate the right age. In asylum seekers claiming to be under 18 years of age and the age given by the applicant is doubted, the age estimation is often based on the 3rd molar root. This makes a precise age evaluation almost impossible. The results of this estimation may influence the path for the asylum seeker, as if he or she will be considered a minor and be given the rights of the child or be treated as an adult, and is therefore is of crucial importance.

Some methods have shown ethnical variation in dental age, but it cannot be generalized. In 2014, most of the unaccompanied minors came from Eritrea and Afghanistan. In Norway, Liversidge's tables are used for dental age estimation in these nationalities. For more precise age estimation, studies from all asylum applicants' home countries should ideally have been

available. But still, even if this had been accessible, most countries have inhabitants of several ethnical groups, especially the home countries of many asylum applicants, making generalization problematic. Age estimation is also highly subjective and the inter-observer agreement may vary within the same method in many studies.

At the moment UDI do not have updated data on the resolutions where UDI overruled the results of the dental and medical age examination, but in 2010 and 2011 165 individuals were evaluated *"unlikely to be under 18 years old"* after the medical age examination, but of these, 67 were still considered minors by the UDI. In addition, 16 applicants were considered minors by the UDI, although the examiner was confident that these individuals were over 18 years old (49). These figures demonstrate that the UDI does not rely solely on the age estimations.

We questioned UDI about the inaccuracy of the age estimation methods in use, and their response was that it is necessary to estimate an age for the outcome of the asylum process. But trough a science project executed by Norwegian Computing Center, UDI investigates the possibility to perform age examinations differently.

Dental age estimation is claimed not to be science, but qualified guessing. In this thesis we have discussed various age estimation methods used on unaccompanied minors. Our subjective approach will be that the methods today is not accurate enough to determine the crucial outcome of an asylum process, and to judge if an individual is over or under 18 years of age. The high standard deviation in various studies makes the dental age estimation inaccurate, but still, it is the best method available today.

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