DEVELOPMENT OF A DENTAL REFERENCE DATA SET FOR EMIRATI CHILDREN AND ADOLESCENTS BASED ON THE DEMIRJIAN'S METHOD

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ABSTRACT

Development of a dental reference data set for Emirati children and adolescents based on the Demirjian's method

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Background: The ability to predict the difference between chronological age (CA) and dental age (DA) is an important aid in the accurate diagnosis and treatment planning process in the pediatric population.

Aim: To establish a Dental Reference Data Set (DRDS) of Emirati children aged between 5 to 15 years.

Materials and Methods: Dental Panoramic Tomography (DPTs) of 139 Emirati children aged 5 to 15 were to conduct a retrospective case-note cross- sectional study and used to establish a DRDS. The Tooth Development Stages (TDS) system described by Demirjian (1973) was used to assess all the permanent teeth on the left side of the Mandible.

Results: The mean maturation score of the Emirati population compared was not statistically significant from that of the French-Canadian children (males P value = 0.723, females P value = 0.664). Emirati children's DA was higher compared to the Canadian standards. The mean difference between DA-CA in girls and in boys was 1.21 and 0.79 years respectively (p<0.001). Using a normalization methodology, self-weighted scores were developed for Emirati girls and

boys.

Conclusion: The results demonstrated that the Demirjianmethod was suitable for estimating the dental age in a group of Emirati children.

DEDICATION

I would like to dedicate my research to:

My Father's soul who believed in me since I was a little girl.

The one person who has made this all possible has been my mum, she has been a constant source of support and encouragement and has made an untold number of sacrifices for the entire family, and specifically for me to continue my postgraduate. she taught me to fight and work hard pursuing my dreams and to never underestimate my capabilities. She is a great inspiration to me. Hence, great appreciation and enormous thanks are due to her.

My beloved sisters: Sara, Shaima and Fatma. Thank You for believing in me. I wouldn't have made it without your support. Thank you for all the sacrifices you made for me.

My nephew Jaber and my nieces Meera, Shamma and Haya, thank you for your unconditional love.

DECLARATION

I declare that all the content of this thesis is my work. There is no conflict of interest with any other entity or organization

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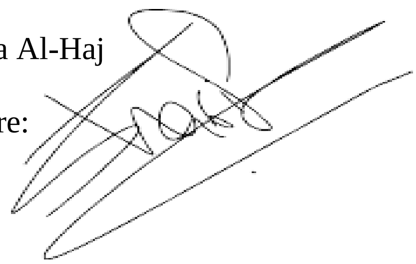
Signature: 

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ABBREVIATIONS

(DPT) - Dental Panoramic Tomography

(GCC) - Gulf Cooperation Council

(UAE) - United Arab Emirates

(ICRP) - International Commission on Radiological protection

(CA) - Chronological Age

(DA) - Dental Age

(MENA) - Middle East and North Africa

(GCP) - Good Clinical Practice

(DRDS) - Dental Reference Data Set

(DDH) - Dubai Dental Hospital

(D4W) - Dental for Windows (electronic dental records software)

(ASA) - American Society of Anesthesiologist

(PI) - Principal Investigator

(EA) - Experienced Assessor

(DOB) - Date of Birth

(TDSs) - Tooth Developmental Stages

1. INTRODUCTION

Age is a period of human life that is measured by the chronological passing of days, weeks, months, and years from birth. Biological age refers to how old a person seems; accordingly, biological age assessment can be achieved by various techniques including physical examination, hand-wrist radiographs, dental examination and also by using Dental Panoramic Tomography (DPT) images (1) In dental and medical practice, age estimation is regarded to be of outstanding importance. For example, the pediatric dentist and orthodontist must be capable of understanding a child's growth and developmental status represented by both the chronological and dental age as it important lead to a more accurate diagnosis and treatment planning.(2) In forensic medicine, age estimation is no longer only beneficial in the identification of deceased victims or human remains but additionally in age estimation of living individuals which would possibly be required in such cases that chronological age plays a necessary role, e.g. criminal liability, immigration, school attendance, and social benefits.(3)

Dental age assessment is commonly based on observing the stage of tooth eruption and the degree of mineralization of the developing teeth buds' enamel from radiographs. (4) The process of maturation is much more uniform, progressive, sequenced, and continuous compared to tooth eruption, and is much less affected by the endocrine disease, dietary deficiency conditions, and environmental changes. (5) For these reasons, a sequence of dental age estimation methods has been developed primarily based on the mineralization stage of tooth germs. (6)

Many authors have developed scoring methods to assess dental age using dental calcification stages of permanent teeth. Examples of these methods include Demirjian(7), Nolla(8) and Moorress (9) methods. The most widely used dental maturity staging system is the method developed by Demirjian in 1973 on a sample of French-Canadian children. (10, 11)

Demirjian et al. (1973) (7) method is based on eight stages of tooth mineralization, from calcification of the cusp to closure of the apex, on the seven left mandibular teeth and each tooth is given a score based on its phase of calcification. (7) Studies have been conducted since then internationally (12, 13) and in the Gulf Cooperation Council (GCC) countries (2, 5, 14, 15) to assess the dental ages of different populations. These studies have shown that there is a variation in the dental age of individuals belonging to different ethnic groups. (16) This has led to the need to develop separate studies according to ethnicity and race across the globe. To our knowledge, there is a lack of such studies in the United Arab Emirates (UAE), hence this study. Due to its perceived accuracy and feasibility in a developmental sample according to Maber et al. (17), the Demirjian method was selected for this present study.

2. REVIEW OF THE LITERATURE

2.1 Age

Age is known as the number of years of life that produce a life cycle for a human being. Anthropologists have been mainly involved in understanding the importance of the human species' life cycle features and splitting them into prenatal and postnatal phases [(1)].

Prenatal is before birth when the fetus is developed within nine months in the uterus; on the contrary, the postnatal stage is after birth and is characterized by five stages: infancy, childhood, juvenile, adolescence, and adulthood (1). Generally, the number of years a person can expect to live, called life expectancy, varies upon his health and average age of the population. The human face conveys a vital characteristic of the person; one can detect from a facial glance the gender, facial expression, emotional status, and age. Age estimation could be seen in various methods; one of them is guessing a person’s age by looking at his face. Wrinkles and features of the face give a significant indicator of age (18).

2.2 Scientific Methods of Age Assessment

For legal, social, and forensic purposes, chronological age estimate is crucial (19). Some commonly used techniques are:

2.2.1. Physical examination

Anthropometric data, such as height, weight, and body shape, as well as physically evident sexual maturity attributes, are reported in a corresponding physical examination (20).

2.2.2. Hand wrist radiographs

Hand radiography constitutes the second cornerstone of the calculation of forensic age. The scale and shape of the individual bone components and the epiphyseal plates' ossification state are standards for determining hand radiograms. The radiograph is then compared either with average age and sex radiographs (atlas method), or the maturity of the bone is selected for the chosen bones (single bone method) (21).

2.2.3. Dental examination using Dental Panoramic Tomography (DPTs)

Dental analysis indicates particular importance for age prediction for the developmental features of the third molars' eruptions and mineralization. Dental eruption evaluation differentiates between the alveolar eruption, gingival eruption, and occlusal plane as discussed by Jurca et al. 2014 (22).

2.3 Dental Age Assessment

The development of teeth in the mouth has been a straightforward way of determining children's age for decades. The past decade has seen the rapid development of dental age assessment methods in many studies as many authors developed methods (7), (8), (9) using dental calcification stages of permanent teeth. Historically, in the ancient Roman empire, the young men were considered mature enough to join the army after the second permanent molars erupt (23). The evaluation of the age of a child for the workplace was determined by the permanent appearance of the second molar. In the early 20th century, the same approach was used to test the age of school going children (8).

The appearance of the lower central incisor in children at around six months old is an informal yet culturally significant example of dental age assessments. However, tooth emergence is not an exact age evaluation process since it is difficult to evaluate the exact timing of dental

chronological age than clinical emergence (24). Calcification is independent of somatic development, although local and environmental variables can impact tooth eruption (25). The use of radiographs provides a detailed and lasting record of a moment in the gradual sequence of dental development, rather than emergence. A defined scale of maturity between early development and maturity may be mathematically manipulated to relate to chronological age (19). Cunha et al. (26) further added that children's dental age is usually determined from the radiological assessment of crown development and root growth of teeth.

There are dental atlases that used radiographs, in addition to tooth emergence, to give a detailed and permanent record in the progressive sequence of dental development as discussed in AlQahtani et al. 2010 (27) A keystone atlas named the “London atlas of human tooth development and eruption”. aimed to be a comprehensive evidence-based atlas to estimate age using both tooth development and alveolar eruption for human individuals between 28 weeks in utero and 23 years. It was based of archived material having a uniform age and sex distribution based on developing teeth from 72 prenatal and 104 postnatal skeletal remains of known age-at-death that were examined from collections held at the Royal College of Surgeons of England and the Natural History Museum, London, UK (M 91, F 72, unknown sex 13) in addition to dental radiographs of living individuals (M 264, F 264). The atlas showed that tooth formation was least variable in infancy and most variable after the age of 16 years for the development of the third molar (27).

2.4 Dental Radiographs

Radiographs in dentistry are essential and justified in most patients in modern dentistry. Thus, as such, radiographs are often referred to as the clinician’s primary diagnostic aid. Dental radiographs are commonly used diagnostic aids for determining caries, periodontal tissues, and teeth’s root development (28). Radiographs in dentistry are divided into extraoral and intraoral radiographs.

2.4.1 Intraoral Radiographs

Intraoral radiographs are one of the most important imaging techniques available to dentists as described by Panchbhai in 2011(28). The intraoral technique offers a picture of dental and jawbone diseases with high spatial resolution. Intraoral radiographs offer valuable information on bone structure and density. (28) They should be of acceptable quality to produce a diagnostic yield (29).

2.4.2 Extraoral Radiographs

One of the most commonly used radiographs examinations for oral and maxillofacial conditions is the dental panoramic tomography (DPT) radiograph. A DPT radiograph provides images for the maxillary and mandibular bones and the dentition extra orally, which means that both the image detector and the X-ray unit are positioned outside of the mouth. In order to create the optimal image clarity, the X-ray source and the image detector must be matched. Extraoral radiographs are collected in two ways: the first is to operate with a stationary X-ray source and image detector, and the second is to move the X-ray source and image detector in opposite directions in synchronicity (30). One of the proper tools for clinical research recognition, radiological pictures, has been used in the age estimation and DPTs are fundamental to assess dental age.

The expected developmental pattern of human teeth to accomplish dental growth can be applied at age estimation. Methods are mainly based on dental structure levels measured on radiographs that appear more suitable for age evaluation than bone formation since genes are more monitored than environmental dental growth and malformation (31).

In practice it is important to remember that a two-dimensional representation / projection of a three-dimensional object will never be a perfect representation. Overall, a DPT does not provide highly defined local detail but gives a very good overview of tooth development and root formation (32).

2.5 Methods of Age Assessment:

Different methods and theories exist in the literature regarding methods of age assessment including:

2.5.1 Nolla's Methods 1960:

Nolla's method divided dental development in 11 stages, which comprised of a range from "0' absence of the crypt until "11'' apical closure of single and multi-rooted teeth. To apply this method, a quadrant of the upper or lower jaw would be selected, or even the complete arch, either including or not including the third molar. Each tooth has an assigned stage, represented by punctuation; these punctuations are added, and scores (points) are obtained, which are then transformed into dental age (DA) by means of reference tables for each gender. (8)

2.5.2 Moorrees et al. method 1963:

Moorrees's method proposed assigning maturation stages for crowns and roots, and these can vary in number according to whether the tooth is single rooted or multi-rooted. Once the stage is selected, DA is inferred through graphs which allow to know the age in which the stage is observed for this particular tooth. This enables calculation through evaluation of a single tooth, or through average of corresponding ages to stages assigned to a group of teeth (9).

2.5.3 Demirjian method 1973:

Demirjian et al. method presents eight stages of maturation, named with letters from A to H which represent formation of all seven left side mandibular teeth. A punctuation corresponds to each stage, after that, points are added, and the resulting score is transformed into DA, using reference tables for each gender (7). This method will be detailed further in the Materials and Methods chapter.

2.5.4 Accuracy of Demirjian Method of Age Assessment:

Questions have been raised about the accuracy of different methods of age estimation, a study by Pertuz et al 2017(33) reported that Demirjian method was the most accurate compared to Nolla and Moorrees et al. method (33). The study concluded that in general, females reached maturation stages at earlier ages than males. The total sample revealed age overestimation for the Demirjian method (-0.14 ± 1.45), whereas a sub-calculation was observed for the Nolla and Moorrees et al method. This under estimation was greater for the Moorrees et al. method (2.63 ± 2.09) when compared to Nolla's method (0.42 ± 1.38) and differences between DA and CA were found to be statistically significant. What is known about Demirjian's method, is that because of its ease of application, simplicity and reproducibility of results, many researchers had adopted it in epidemiological studies. Thus, many Demirjian based studies had been conducted in populations around the world, internationally (34-36) and regionally (2, 27, 37).

2.6 Age Assessment Using Demirjian's Method in Various Populations

The first serious discussion and analyses of Demirjian method emerged during the 1970s(7) in the French-Canadian population, where they evaluated 2928 DPTs of 1446 boys and 1482 girls from age 3 to 17. The purpose of their study was to derive a method of quantity based overall estimation of dental maturity according to the development stages observed in each tooth. (7) Girls and boys were treated separately, which allowed for sex-tooth interaction. This resulted in DA that was higher for girls than boys in eruption of all teeth except the permanent first molar where girls exhibited a lower age (7).

There is a large volume of published studies describing the Demirjian method in different populations internationally; in the Middle East and North Africa region (MENA) (38) and regionally (GCC) (2, 31, 37). Below is a summary of some of the studies.

2.6.1. United Kingdom

In 1999 (39)a retrospective cross- sectional study published by Liversidge et al. with an objective to determine the standards of dental maturation of Demirjian et al. and to see if it is applicable to British children. A total 521 children aged between 4 to 9 years were assessed. The study results showed that British children were dentally advanced compared to the Canadian standards. With mean score DA was 0.51 more than the chronological age (CA) in girls while in boys it was 0.73 years. They concluded that the standard of dental maturation described by Demirjian et al. may not be suitable for British children (39). Another retrospective study was published in 2008 by Roberts et al. (34), with sample size of 1547 children (age range between 1.8 to 26.1 years). All the DPTs were obtained from Eastman Dental Hospital in London. The study showed that an average estimated dental age (DA) over estimated chronological age (CA) by 0.29 years, the maximum difference between estimated DA and CA was 1.65 years (34). A similar study published in 2009 by Mitchell et al. (40) aimed to determine reference data for dental age assessment of the 16-year threshold in British Caucasians using 1722 DPTs of individuals aged between 4 to 24 years. The results showed that the average difference between dental age and chronological age for individuals in the test sample was 0.27 years (3.24 months) in females and 0.23 years (2.76 months) in males (40).

2.6.2. Australia

Peiris et al. (41) published research in which they used the Demirjian method of age assessment to compare a British and an Australian population. A total of 77 DPTs each were obtained from Westmead, Australia and King’s College London. The results showed a significant difference between CA and DA of Australians patients with 0.82 years delay in DA compared to the UK.

These results indicated the need to develop a reference data set for Australian population (41). In 2010 a study conducted in Sydney by Blenkin et al. (42) to test the applicability of the Demirjian method using 1624 DPTS of girls and 1637 boys. The study resulted in consistent overestimates of chronological age in children under the age of 14 by as much as a mean of 0.99 years. Those that provided the most accurate age estimates were applicable to the age ranges 2–14 years, with R-square = 0.94 and a 95% confidence interval of 1.8 years. The Sydney-based standards provided significantly different and more accurate estimates of age for that sample when compared to the published standards of Demirjian. Similarly, another publication in 2013 by Flood et al (43), compared the accuracy of Demirjian method of age estimation in a South Australian population (age range of 4.9-14.5 years). A total of 405 DPTs were obtained from dental schools and clinics in Urban Adelaide. The results showed that differences between CA and DA were most frequently within 0 to 0.5 years in males, whereas for females resulted in the majority of individuals being overestimated by 0 - 0.5 years (43)

2.6.3. China

Chen et al. in 2010 (36) evaluated dental age assessment of Western Chinese children using the Demirjian method. DPTs of 445 children ranging from 8 to 16 years were assessed and the study showed that Western Chinese children are more dentally advanced compared to French-Canadian children by mean difference of DA and CA ranged from 0.0071 to 1.2500 years in girls and from -1.0000 to 1.3000 years in boys. The authors concluded that Demirjian method may not be suitable for Western Chinese children. (36)

Many published studies assessed the Demirjian method applicability in the MENA and GCC regions such as:

2.6.4. Turkey

The Turkish population was assessed using the Demirjian method as well. In 2019 Yilmaz et al. (44) published research that investigated the relationship between dental maturation and skeletal maturation using DPTs and hand wrist radiographs of 717 patients age ranging 10 to 15 years. They used two methods of dental age assessment: Demirjian and Nolla's methods. The results showed that all the teeth showed positive and statistically significant correlations between the two methods. The highest correlation was between the mandibular second premolar calcification stages and hand–wrist maturation stages. According to both dental age determination methods, the mandibular second premolar was prominent in determining the pubertal growth stages. They concluded that there was a positive relationship between dental calcification stages and skeletal maturation stages, in this study population. Dental calcification stages of the second mandibular premolar showed the highest positive correlation with the skeletal maturation stage (44).

2.6.5. Iran

A study was carried out to examine the accuracy of Demirjian's method for age estimation of Iranian children in 2018 (45). The goal of the analysis was to determine the accuracy of the Demirjian method for estimating dental age as applied to Iranian children and teenagers. They collected data of 158 children (81 female and 77 male) in total from Shiraz to investigate the chronological-dental relationship. A significant relation between age and chronological age was shown by the correlation coefficient between chronological and dental age. The result showed that at the time of dental development, the average chronological age difference between girls and boys was 0.77, meaning that girls reached every stage of dental development nine months earlier than males.

2.6.6. Saudi Arabia

In 2015(31) a study was carried out to examine the age assessment accuracy using Demirjian's method. This study included a total of 88 boys and 110 girls aging 4 to 16 years and had digital OPT and clinical records of the 198 western Saudi children of known chronological age and gender. The dental age assessment was done according to Demirjian's form. The findings revealed that the technique of Demirjian created substantial differences in the studied population between approximate age and chronological age. Western Saudi Arabia girls were 0.059 (SD ± 1.26) years on average for all ages and boys -0.66 (SD ± 1.14) years ahead of French-Canadian children. The findings indicated that Demirjian method's expectations for western Saudi Arabic children were somewhat different. But when testing small children, the precision of Demirjian's approach was high while children continue to develop, but it decreases for older children (37).

In addition, further dental age measurement of Saudi children and teenagers aged 3–15 years using Demirjian's technique was researched in 2019(46). The goal was to define the population-specific weighted values required to estimate dental age using the Demirjian approach for children between 3 and 15 years of age from Saudi Arabia. In the five regions of Saudi Arabia a total of 298 digitals OPT of children and young people were collected in the age group 3–15 years. The results showed that the mean dental age was 9.07 ± 1.96 years for the boys examined in the sample, and the mean chronological age was 8.49 ± 2.30 years. It was found that when used for Saudi Arabic children, there was a change in Demirjian norms. Therefore, it must include population-specific weighted values for more precise age projections.

2.6.7. Kuwait

In 2009 Qudeimat et al. (2) published a retrospective cross-sectional study of dental age assessment for Kuwaiti children using Demirjian's method to test the validity of the standards of dental maturation of Demirjian et al when applied to Kuwaiti children. Using DPTs of a sample size of 509 Kuwaiti children (263 girls and 246 boys) aged range between 3 and 14 years. results showed that there were a statistically significant differences in the mean of dental maturation between Kuwaiti and French – Canadian children with (p value < 0.0001), Kuwaiti children were dentally delayed compared to the Canadian children. The mean delay in girls was 0.67 year and in boys it was 0.71 year. They concluded that the standards of dental maturation described by Demirjian and Goldstein (1976) may not be suitable for Kuwaiti children (2).

2.6.8. Egypt

In 2019 (38) Moness Ali et al stated that Demirjian’s method may be not suitable for Egyptian children after the publication of a retrospective cross-sectional study of 160 DPTs for Egyptian children aged between 3 to 10 years old who attended Minia University Dental Hospital. Dental age was overestimated in Egyptian children compared with French-Canadian children with range of 0.18 – 1.19 for males and from 0.08 to 0.87 years for females.

To date, no studies have been performed to investigate the validity of the Demirjian method to assess dental age in the Emirati population of the UAE. However, the UAE does not have a homogenous population, as it is home to more than 200 nationalities and ethnic groups. The unique makeup of the UAE society requires further attention.

2.7 The UAE Emirati Population Demography and Geography

The UAE lies on the Arabian Gulf, bordered by Oman and Saudi Arabia. It comprises seven emirates: Abu Dhabi, Dubai, Sharjah, Ajman, Ra's Al-Khaymah, Al-Fujairah, and Umm Al-Quwain.

On Thursday, January 21, 2021, the current United Arab Emirates population was estimated to be 9,956,592 based on the latest UN data elaboration by Worldometer(47). The vast majority live in the Emirate of Dubai. See Figure 1 (adapted from Global Media Insight website 2021)(48).

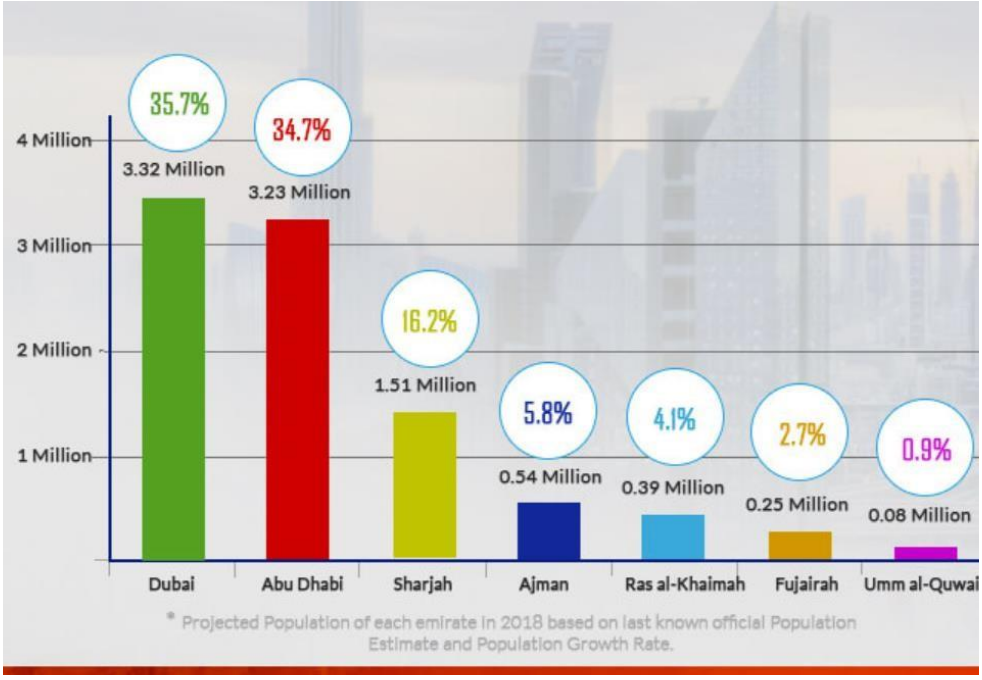

Figure 1: Population of each Emirate (48).

Most of the people of the UAE are aged between 25 and 54 years. The median age in the UAE is 32.6 years and 86.4 percent of the population is urban (47). The child population under the age of 14 is thought to be 1.36 million. See Figure 2(48).

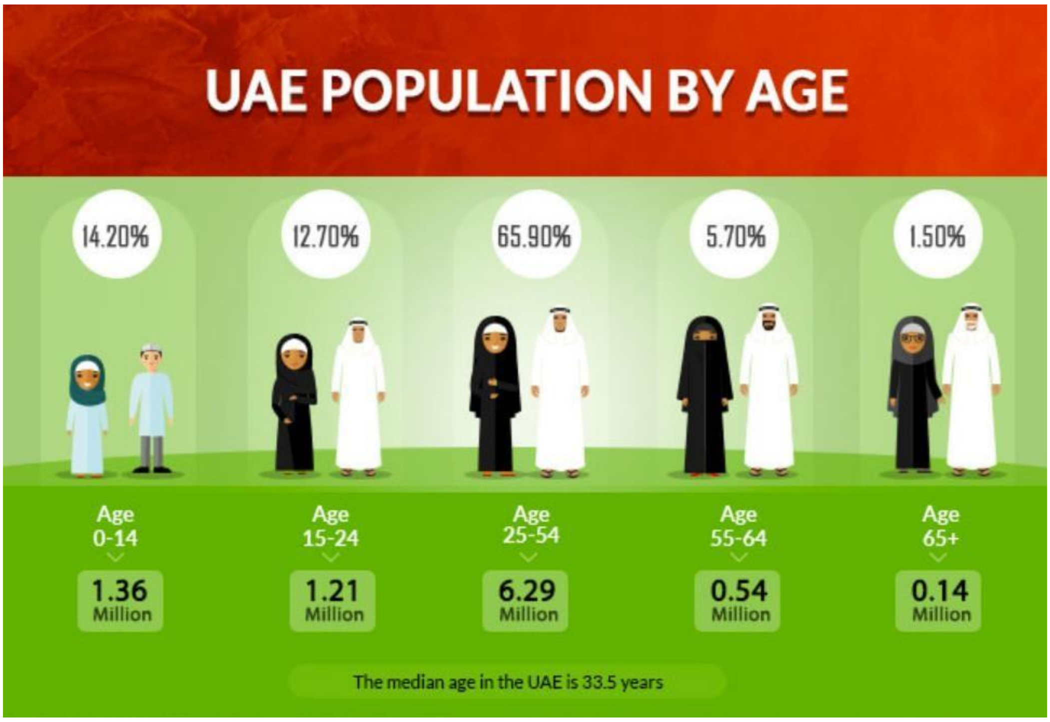

Figure 2: UAE population by age [48].

The local society was, and still is strongly based of tribal ties. This suggests that nearly each person within the society belongs to one of the 70 tribes which can presently be distinguished within the UAE (49). They took ownership of this land during progressive waves of population migration and development, which brought in other Middle Easter tribes from other nations such as Yemen, Oman as well as by way of Central and Northern Arabia (50). It is noteworthy to mention that intermixing has likely to have occurred with adjoining Middle Easterners of the same landmass such as with Persians in addition to others such and with East Africans of the historical Omani Empire regions. Persian intermixing came about from the substituting Middle Easterner and Persian domination of both coasts of the Gulf. As they form a unique ethnic mix, they may have their own unique blend of characteristics. Due to that, investigating the dental age assessment method for this population in this growing part of the world may be of great value (51).

2.8 Ethnicity of the Emirates Population

As highlighted above the population of the UAE could be a mixture of diverse ethnic groups. As it stands now, 11.48 % are UAE nationals and within this national group there are subgroups of distinctive ethnic origins (52).The expatriate community in the UAE consists of a different of large and small ethnic groups that make up 38.55%, 33.96 % and 27.49 % of the total population, representing most of the Arabs, Asians (Indians, Pakistanis, and Filipinos), and Western populations(53). See Figure 3(48)

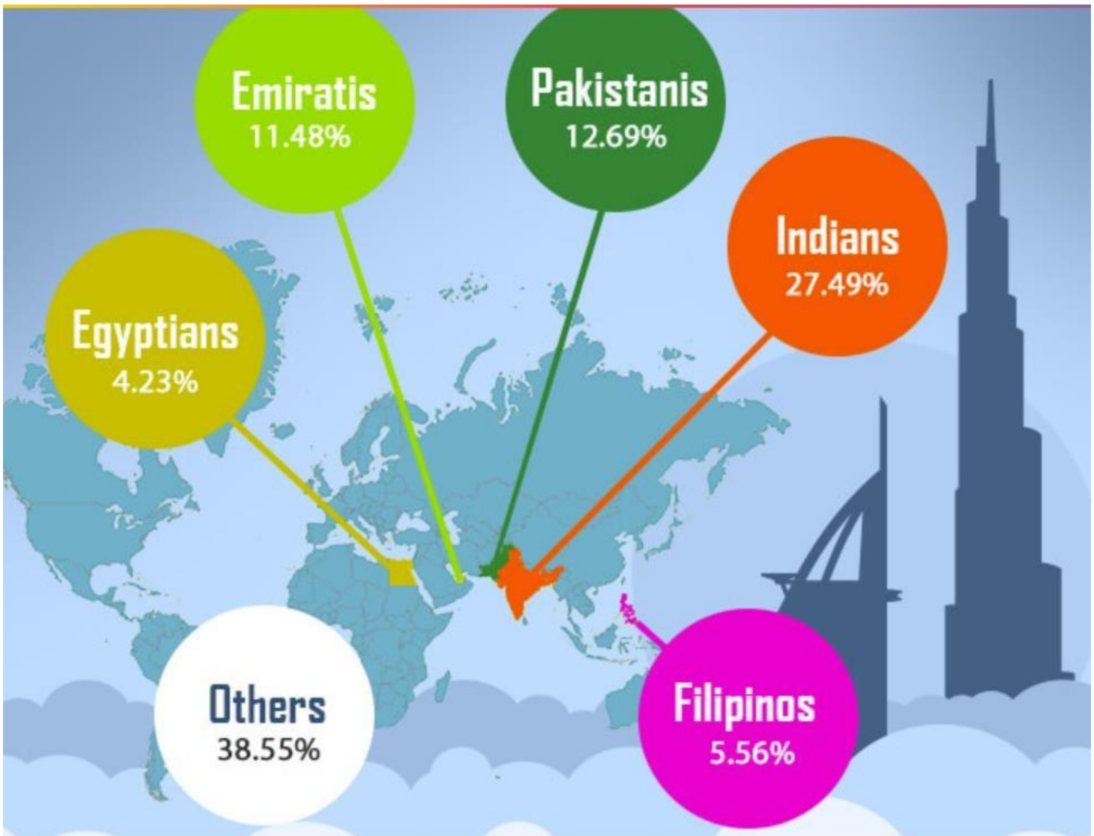

Figure 3: Expat population in UAE[48].

2.9 Marriages in the Emirati Population

In 1997, An analysis was performed on the prevalence of inbreeding and consanguine marriages in the UAE. The research was carried out in the cities of Al Ain and Dubai. The data of 2033 married UAE women aged 15 years and over have been collected. The consanguinity of each woman and her husband and the consanguinity of her parents were documented. The result showed that the consanguinity rate was high (50.5%) with an inbreeding coefficient of 0·0222. Between first cousins was the most popular form of consanguine marriage (26.2%). In comparison with other cultures, double first cousin marriages were found normal (3.5%). In one generation the levels of consanguinity in the UAE grew from 39% to 50·5%(54).

These factors have an effect on tooth development and may show differences in chronological age compared to dental age (3). As the Demirjian's method is a widely used method for age estimation around the globe due to its high accuracy (6, 55), we decided to use the Demirjian's method for this research. To our knowledge no research was conducted to assess age in the UAE's Emirati population, especially those living in its most populous Emirate, namely Dubai.

2.10 The Null Hypothesis:

There is no difference in the Chronological Age (CA) and Dental Age (DA) in Emirati children, based on the Demerjian's method.

3. AIM

To create a Dental Reference Data Set (DRDS) for Emirati children and adolescents between 5 to 15 years using Demirjian's method from a subgroup of patients attending a postgraduate dental institute in Dubai, UAE.

3.1. Specific Aims

1. To compare the chronological age (CA) of the above subjects with their dental age (DA) as assessed from already obtained DPT radiographs.
2. To determine differences in the Demirjian's scores between UAE boys and girls of the same chronological age.
3. To compare the results with other regional and international data.

4. MATERIALS AND METHODS

In this chapter the study methodology is described. A study flowchart is presented in Figure 4.

4.1.Type of Study

This is a retrospective case-note cross-sectional study of group of UAE patients belonging to the Emirati subpopulation aged between 5 to 15 years and had attended Dubai Dental Hospital (DDH) in Dubai, UAE. The study patients were selected from those who had required a dental panoramic radiograph (DPT) for established disease diagnosis and treatment planning. Thus, the patients were not exposed to radiation for the purpose of this study. The DPTs were obtained from a period from January 1st, 2015, until January 25th, 2021 from DDH's dental electronic records (D4W©). The chronological age of each subject was calculated using the date of birth at the date of taking the DPT.

4.2.Inclusion and Exclusion Criteria

These are summarized in Table 1 below.

4.3.1 Inclusion Criteria	4.3.2 Exclusion Criteria
Fit and healthy children with the absence of systemic diseases (ASA I).	Individuals with medical conditions and dentofacial anomalies that could influence dental development.
Children and young adults aged from 5-15 years who have had DPTS that were indicated and justified independent of this study.	Children and young adults younger than 5 and older than 15 years old.
Dated DPT radiographs of diagnostic quality (Grade 1) that had a clear date of birth.	Poor quality DPTs or incomplete patient records.
No history of any orthodontic treatment, dental extractions of permanent teeth, or dental trauma.	Patients with a history of orthodontic treatment, dental extractions, or dental trauma.
Emirati children by identification card	Non-Emirati children

Table 1: Inclusion and exclusion criteria

4.3.Sample Size

Base on the hypothesis testing that no different Δ

$$H_0: \mu_{1-}\mu_2 = 0$$

versus

$$H_A: \mu_{1-}\mu_2 \neq 0$$

$$n = 2\,(\frac{Z_{1-\alpha/2} + Z_{1-\beta\,2}}{\Delta})$$

Where α is a significance level and $Z_{1-\alpha/2}$ is the value from standard normal distribution holding 1- $\alpha/2$ below it, $1-\beta$ is a selected power and $Z1{-}\beta$ is the value from standard normal distribution holding $1-\beta$ below it, and Δ is the difference in the means, define as follow: Using the above equation and the data from Kermani et al. (13) Study, where Dental Age was Δ = 0.77. According to the selection of the power, we could have different scenarios of sample size, see the table below

Power	α	$(z_{1-\alpha/2} + z_{1-\beta})^2$	Sample size
0.80	0.01	31.5	106
	0.05	26	88

The planned sample of this study consisted of at least 106 DPTs based on the above power calculation.

4.4.Dental Panoramic Tomography Radiographs (DPTs)

The digital radiographs in DDH are all taken with Veraviwe Pocs© 3D R100© panoramic system, images processed using I-DIXEL 3DXD version 4.3.4 software©, with a resolution of 0.125 mm Voxel per side of the image were chosen. Therefore, there was one source for all the radiographs used in the study and were all viewed using the same computer monitor, a Lenovo© monitor with screen resolution of 1920 x 1080 pixels. The search for these DPTs was conducted by searching the D4W system for all patients aged 5-15 who were Emirati and had a DPT taken, this was conducted by DDH IT staff.

4.5.Examiner Calibration

4.5.1. Inter-examiner Reliability

One examiner (SA, the principal investigator-PI) was calibrated by an experienced assessor (EA) in how to estimate the chronological and dental age from the records and DPT, using the Demirjian method on ten random DPTs. Two assessments to calculate maturation scores and dental age was conducted a week apart (see section 4.7. 2 for details). Cohen's coefficient kappa scores were assessed. Comparisons of the PI and EA scores were analyzed (See results).

4.5.2. Intra-examiner Reliability

Ten randomly selected radiographs were scored as above one week after initial examination by the PI, the difference in dental development stage scoring between the two readings tested for significance with the Kappa test. (See Results)

4.6. Process of the Study

See Figure 4 for the detailed process of the study.

1. A standard clinical and radiographical examination was conducted at DDH independent of the study, including DPT. The DPT was accessed by the PI after obtaining permission from the Clinical Director of the Hospital supported by the ethical approval of the IRB.
2. The DPTs were all viewed on the same monitor (Lenovo© monitor with screen resolution of 1920 x 1080 pixels).
3. Chronological age in years and months of each subject was calculated using the dateof birth as per the radiograph. The dates of birth were blinded from the assessor at the time of assessment.
4. DPTs of 139 Emirati children ages between 5 and 15 were assessed. If there were more than one DPT per child were present, the image with better quality and resolution was chosen. If two were with good quality the most recent one was chosen.
5. The tooth development stages system described by Demirjian *et al*. 1973[(7)] was used to assess all seven left mandibular teeth (I_1, I_2, C, P_1 ,P_2 ,M_1 and M_2). If the left side was not clear, then the right side was assessed.
6. The data obtained was analyzed and used to establish Emirati self-weighted scores.

Step 1

Patient date of birth (DOB)

Step 2

Dated Diagnostic DPT

Step 3

Seven permanent teeth (31, 32, 33, 34, 35, 36, 37) of mandible left side were used

Step 4 (Fig 5. and Table 2)

The Tooth Developmental Stages (TDSs) were assessed using the 8-stage system (“A” to “H”) of tooth calcification from the tip of the cusp to the closure of the apex

Step 5 (Table 3)

Record findings in "Recording Development Staging" table

Step 6 (Fig 6)

Stages were subsequently converted to scores by using conversion tables "self weighted score" specific to gender

Step 7

The scores for each tooth were added, resulting in a total maturity score

Step 8 (Fig 7 and 8)

Total maturity score was transformed into dental age using standard tables given for eachgender separately

Figure 4: The flow chart

4.6.1. Assigning the Ratings

All left mandibular permanent teeth were rated in the following order: Central Incisor (I1), lateral Incisor (I2), Canine (C), 1st Bicuspid (P1), 2nd Bicuspid (P2), 1st Molar (M1), 2nd Molar (M2). Teeth development stages were rated on a scale of A to H. The rating is illustrated in Figure 5 and described in Table 2.

4.6.2. Scoring System (Table 3)

1. Each tooth was given a rating.
2. This rate was then converted into a score using Figure 6 for boys or girls as appropriate.
3. The scores of all seven teeth were added together to give a maturity score.
4. The maturity score was plotted on the centile charts (Figure 7), boys or girls as appropriate, where the age of the child is known.
5. The maturity score was converted directly into a dental age either by reading off on the horizontal scale the age at which the 50th centile attains that maturity score value, or by using Figure 8, which has been constructed by these means.

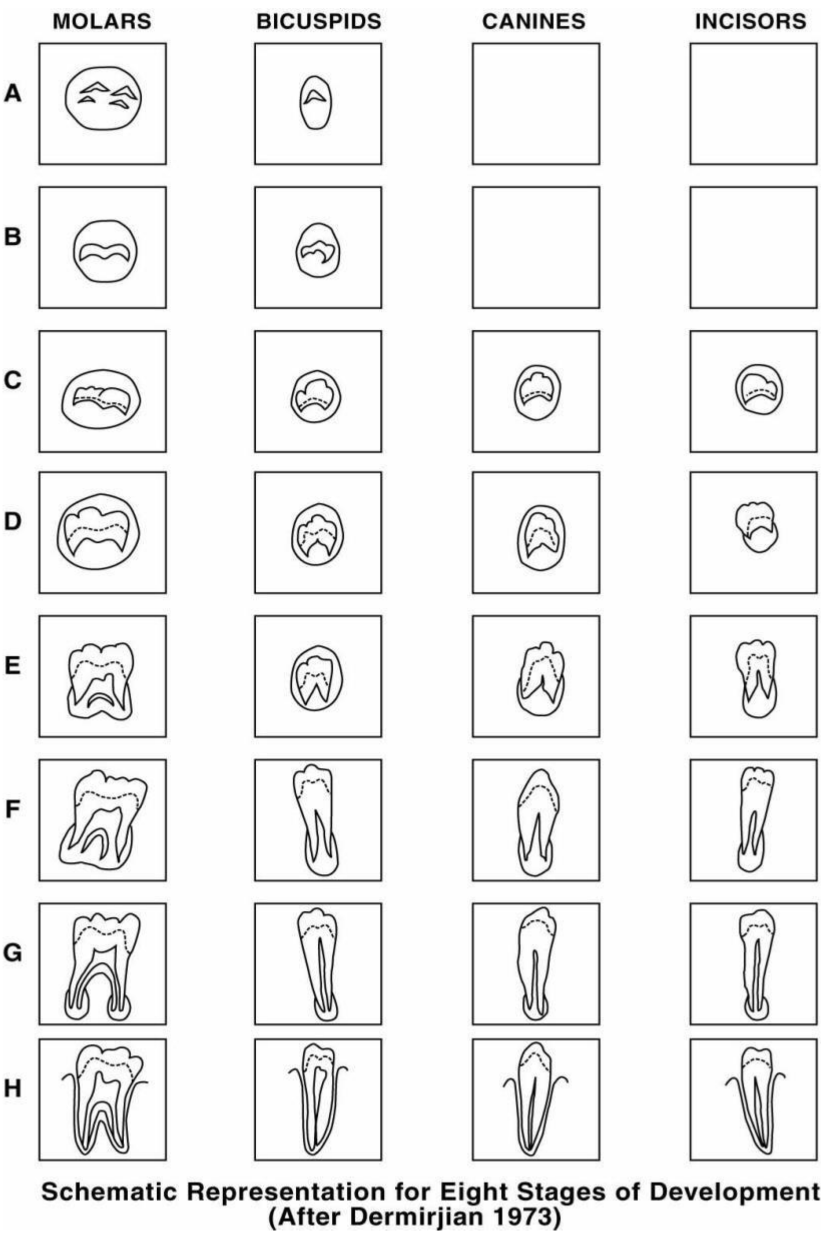

Figure 5: Dental development stages [(7)]

Tooth Development Stage (TDS)	**Single Rooted Teeth and Multi-Rooted Teeth [Descriptions]**
A	In both uniradicular and multiradicular teeth, a beginning of calcification is seen at the superior level of the crypt in the form of an inverted cone or cones. There is no fusion of these calcified points.
B	A fusion of the calcified points forms one or several cusps, which unite to give a regularly outlined occlusal surface.
C	**a.** Enamel formation is complete at the occlusal surface. Its extension and convergence toward the cervical region are seen. **b.** The beginning of a dentine deposit is seen. **c.** The outline of the pulp shape has a curved shape at the occlusal border.
D	**a.** The crown formation is complete down to the cementoenamel junction. **b.** The superior border of the pulp chamber in uniradicular teeth has a definite curved form, being concave towards the cervical region. The projection of the pulp horns, if present, gives an outline like an umbrella top. In molars, the pulp chamber has a trapezoid form. **c.** The beginning of root formation is seen in the form of a radiopaque spicule.
E	UNIRADICULAR TEETH **a.** The walls of the pulp chamber now form straight lines, whose continuity is broken by the presence of the pulp horn, which is larger than in the previous stage. **b.** The root development is still less than the crown. MULTIRADICULAR TEETH **a.** The initial formation of the radicular bifurcation is seen in the form of either a calcified point or a semilunar shape. **b.** The root length is still less than the crown height.
F	UNIRADICULAR TEETH **a.** The walls of the pulp chamber now form a more or less isosceles triangle. The apex ends in a funnel shape. **b.** root development is equal to or greater than the crown. MULTIRADICULAR TEETH **a.** The calcified region of the bifurcation has developed further down from its semilunar stage to give the roots a more definite and distinct outline, with funnel-shaped endings. **b.** The root length is equal to or greater than the crown height
G	**a.** The walls of the root canals are now parallel (the distal root of molars) **b.** The apical ends of the root canals are still partially open.
H	**a.** The apical end of the root canal is completely closed (distal root in molars) **b.** The periodontal membrane has a uniform width around the root and apex

Table 2: Written anatomical descriptions of Demirjian's TDS [7]

<table>
<tr><td colspan="8">File number: Gender:
Date of birth:

OPG date:</td></tr>
<tr><td>Demirjian</td><td colspan="7"></td></tr>
<tr><td>Tooth #</td><td>31</td><td>32</td><td>33</td><td>34</td><td>35</td><td>36</td><td>37</td></tr>
<tr><td>SW score</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Maturity score:

Dental Age:

Chronological Age:</td></tr>
</table>

Table 3: Recording tooth development stages (TDS)

Self-Weighted Scores for Dental Stages
7 Teeth (Mandibular Left Side)

Boys

Tooth	Stage 0	A	B	C	D	E	F	G	H
M_2	0.0	2.1	3.5	5.9	10.1	12.5	13.2	13.6	15.4
M_1				0.0	8.0	9.6	12.3	17.0	19.3
PM_2	0.0	1.7	3.1	5.4	9.7	12.0	12.8	13.2	14.4
PM_1			0.0	3.4	7.0	11.0	12.3	12.7	13.5
C				0.0	3.5	7.9	10.0	11.0	11.9
I_2				0.0	3.2	5.2	7.8	11.7	13.7
I_1					0.0	1.9	4.1	8.2	11.8

Girls

Tooth	Stage 0	A	B	C	D	E	F	G	H
M_2	0.0	2.7	3.9	6.9	11.1	13.5	14.2	14.5	15.6
M_1				0.0	4.5	6.2	9.0	14.0	16.2
PM_2	0.0	1.8	3.4	6.5	10.6	12.7	13.5	13.8	14.6
PM_1			0.0	3.7	7.5	11.8	13.1	13.4	14.1
C				0.0	3.8	7.3	10.3	11.6	12.4
I_2				0.0	3.2	5.6	8.0	12.2	14.2
I_1					0.0	2.4	5.1	9.3	12.9

NB: Stage 0 is no calcification

Figure 6: The original self-weighted scores as per Demirjian *et al*. [(7)]

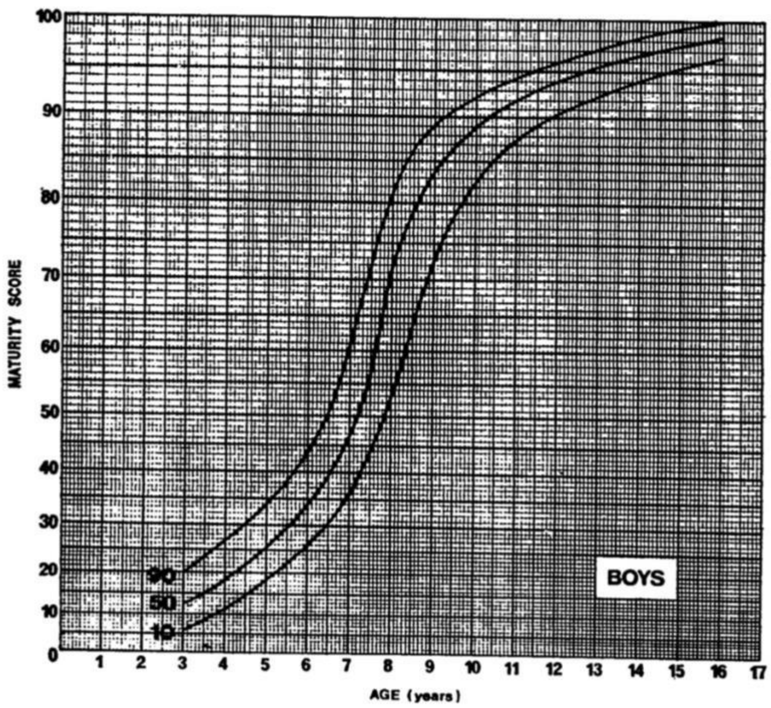

FIG. 2. Dental maturity percentiles (7 teeth).

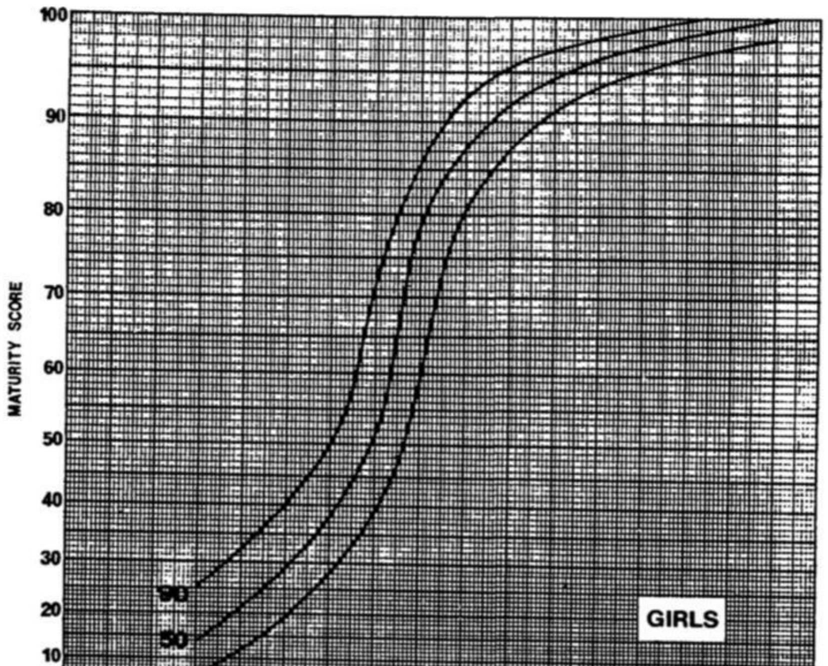

Figure 7: Dental maturity score according to Demirjian *et al.* [(7)]

Conversion of Maturity Score to Dental Age (7 Teeth)

Age	Score	Age	Score	Age	Score	Age	Score
			Boys				
3.0	12.4	7.0	46.7	11.0	92.0	15.0	97.6
.1	12.9	.1	48.3	.1	92.2	.1	97.7
.2	13.5	.2	50.0	.2	92.5	.2	97.8
.3	14.0	.3	52.0	.3	92.7	.3	97.8
.4	14.5	.4	54.3	.4	92.9	.4	97.9
.5	15.0	.5	56.8	.5	93.1	.5	98.0
.6	15.6	.6	59.6	.6	93.3	.6	98.1
.7	16.2	.7	62.5	.7	93.5	.7	98.2
.8	17.0	.8	66.0	.8	93.7	.8	98.2
.9	17.6	.9	69.0	.9	93.9	.9	98.3
4.0	18.2	8.0	71.6	12.0	94.0	16.0	98.4
.1	18.9	.1	73.5	.1	94.2		
.2	19.7	.2	75.1	.2	94.4		
.3	20.4	.3	76.4	.3	94.5		
.4	21.0	.4	77.7	.4	94.6		
.5	21.7	.5	79.0	.5	94.8		
.6	22.4	.6	80.2	.6	95.0		
.7	23.1	.7	81.2	.7	95.1		
.8	23.8	.8	82.0	.8	95.2		
.9	24.6	.9	82.8	.9	95.4		
5.0	25.4	9.0	83.6	13.0	95.6		
.1	26.2	.1	84.3	.1	95.7		
.2	27.0	.2	85.0	.2	95.8		
.3	27.8	.3	85.6	.3	95.9		
.4	28.6	.4	86.2	.4	96.0		
.5	29.5	.5	86.7	.5	96.1		
.6	30.3	.6	87.2	.6	96.2		
.7	31.1	.7	87.7	.7	96.3		
.8	31.8	.8	88.2	.8	96.4		
.9	32.6	.9	88.6	.9	96.5		
6.0	33.6	10.0	89.0	14.0	96.6		
.1	34.7	.1	89.3	.1	96.7		
.2	35.8	.2	89.7	.2	96.8		
.3	36.9	.3	90.0	.3	96.9		
.4	38.0	.4	90.3	.4	97.0		
.5	39.2	.5	90.6	.5	97.1		
.6	40.6	.6	91.0	.6	97.2		
.7	42.0	.7	91.3	.7	97.3		
.8	43.6	.8	91.6	.8	97.4		
.9	45.1	.9	91.8	.9	97.5		

Conversion of Maturity Score to Dental Age 7 Teeth (Mandibular Left Side)

Age	Score	Age	Score	Age	Score	Age	Score
			Girls				
3.0	13.7	7.0	51.0	11.0	94.5	15.0	99.2
.1	14.4	.1	52.9	.1	94.7	.1	99.3
.2	15.1	.2	55.5	.2	94.9	.2	99.4
.3	15.8	.3	57.8	.3	95.1	.3	99.4
.4	16.6	.4	61.0	.4	95.3	.4	99.5
.5	17.3	.5	65.0	.5	95.4	.5	99.6
.6	18.0	.6	68.0	.6	95.6	.6	99.6
.7	18.8	.7	71.8	.7	95.8	.7	99.7
.8	19.5	.8	75.0	.8	96.0	.8	99.8
.9	20.3	.9	77.0	.9	96.2	.9	99.9
4.0	21.0	8.0	78.8	12.0	96.3	16.0	100.0
.1	21.8	.1	80.2	.1	96.4		
.2	22.5	.2	81.2	.2	96.5		
.3	23.2	.3	82.2	.3	96.6		
.4	24.0	.4	83.1	.4	96.7		
.5	24.8	.5	84.0	.5	96.8		
.6	25.6	.6	84.8	.6	96.9		
.7	26.4	.7	85.3	.7	97.0		
.8	27.2	.8	86.1	.8	97.1		
.9	28.0	.9	86.7	.9	97.2		
5.0	28.9	9.0	87.2	13.0	97.3		
.1	29.7	.1	87.8	.1	97.4		
.2	30.5	.2	88.3	.2	97.5		
.3	31.3	.3	88.8	.3	97.6		
.4	32.1	.4	89.3	.4	97.7		
.5	33.0	.5	89.8	.5	97.8		
.6	34.0	.6	90.2	.6	98.0		
.7	35.0	.7	90.7	.7	98.1		
.8	36.0	.8	91.1	.8	98.2		
.9	37.0	.9	91.4	.9	98.3		
6.0	38.0	10.0	91.8	14.0	98.3		
.1	39.1	.1	92.1	.1	98.4		
.2	40.2	.2	92.3	.2	98.5		
.3	41.3	.3	92.6	.3	98.6		
.4	42.5	.4	92.9	.4	98.7		
.5	43.9	.5	93.2	.5	98.8		
.6	45.2	.6	93.5	.6	98.9		
.7	46.7	.7	93.7	.7	99.0		
.8	48.0	.8	94.0	.8	99.1		
.9	49.5	.9	94.2	.9	99.1		

Figure 8: Conversion of dental maturity score to dental age (for boys and girls) according to Demirjian *et al.*[7]

4.6.3. Example of a Completed “Maturity Score” and “Dental Age” Calculation

Using a DPT for a said male patient:

File number: 19825 **Gender:** M
Date of birth: 22/12/2011
DPT date: 18/01/2020

Demirjian							
	31 F	**32 F**	**33 E**	**34 E**	**35 D**	**36 G**	**37 D**
	4.1	**7.8**	**7.9**	**11**	**9.7**	**17**	**10.1**

Maturity score: 67.6
Dental Age: 7.8
Chronological Age: 9

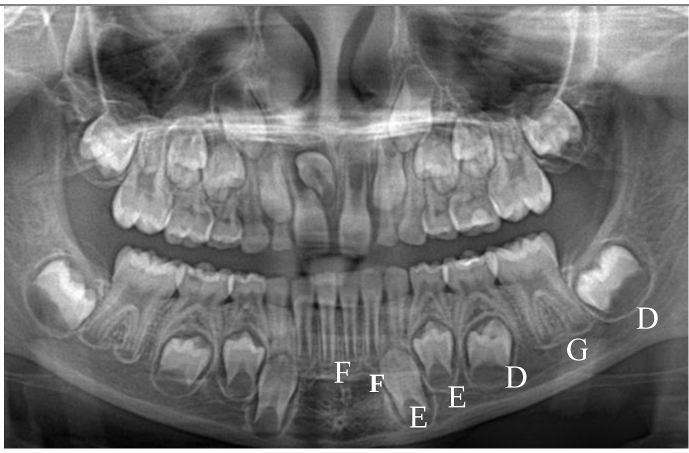

Figure 9: A completed example

In the above male example (Figure 9) each tooth was given a rating according to Table 2. This rate was then converted into a score using Figure 6 for boys. The scores of all seven teeth were added together to give a maturity score that is equal to 67.9. The maturity score was converted directly into the dental age (7.8) either by reading off on the horizontal scale the age at which the 50th centile (Figure 7) attains that maturity score value, or by using Figure 8, which has been constructed by these means. Chronological age was calculated by subtracting date of birth from DPT date.

4.7.Statistical Analysis:

Data was entered into the computer using IBM-SPSS for Windows version 25.0 (SPSS Inc., Chicago, IL). Categorical variables were described by using proportion and continuous variables (Chronological age, Dental age, and year score of maturity) were described by a measure of tendency and measure of dispersion. Dental age (DA) was calculated from reference tables (Demirjian and Goldstein 1976) by normalization of the values and compared to chronological age (CA) for boys and girls separately. Kolmogorov-Smirnov was used to test the normality of continuous variables. The Mann-Whitney test was used to compare the means between the two groups. The association between two ages was performed by the Spearman correlation coefficient. A P-value of less than 0.05 was considered significant in all statistical analyses.

4.8.Ethical Approval

Ethical approval (Appendix 1) was conducted in full conformance with principles of the "Declaration of Helsinki", Good Clinical Practice (GCP), and within the laws and regulations of the UAE/DHCC. Ethical approval was obtained from the Research Ethics Review Committee in Hamdan Bin Mohammed College of Dental Medicine and the IRB of Mohammed Bin Rashid University of Medicines and Health Sciences. (Ethical approval number: MBRU-IRB 2020-019)

5. RESULTS

5.1.Calibration

Intra and inter examiner calibrations were calculated using Cohen's Kappa. The intra examiner Kappa score for the tooth developmental stages was 0.820 demonstrating an almost perfect agreement. The inter examiner *K*appa score for the tooth developmental stages was 0.71, demonstrating good agreement.

5.2.Demographics of the DPTs Accessed

Radiographs of 139 Emirati children aged between 5 to 15 were assessed by the principal investigator (PI) to create Dental Reference Data Set (DRDS). There were 62 (44.6 %) males and 77 (55.4 %) females. The dates of birth were blinded from the assessor at the time of assessment. Table 4 summaries the distribution of different age groups and gender in the study population (n=139). There was a total of 11 subgroups. Group 1 had the lowest number due to the policy of radiation in Dubai Dental Hospital to not expose patients to unnecessary radiation in young age (4.1 - 5.4). See Table 4 for details.

Group	Age distribution	Gender	Distribution	Total
1	5- 5.4	M	1	4
		F	3	
2	5.5-6.4	M	2	5
		F	3	
3	6.5-7.4	M	4	12
		F	8	
4	7.5-8.4	M	8	19
		F	11	
5	8.5-9.4	M	12	22
		F	10	

6	9.5-10.4	M	4	11
		F	7	
7	10.5-11.4	M	11	21
		F	10	
8	11.5-12.4	M	8	18
		F	4	
9	12.5-13.4	M	6	10
		F	4	
10	13.5-14.4	M	2	9
		F	7	
11	14.5-15.7	M	4	7
		F	3	

Table 4: Distribution of age and gender in the study population

5.3.Data Analysis of Chronological and Dental Ages

The methods used in order to estimate the dental age by means of a score obtained with the Demirjian's method were similar to those employed by researchers to evaluate the dental ages of children from Central Poland (56).

Where S.D: standard deviation; n: number of subjects; t: result of t-test; p: probability.

Gender	Score sum	Mean	S. D	n	Difference	S.D of the difference	t	p
Females	S1	89.673	± 11.6171	77	76	-0.5773	-0.436	0.664
	S2	90.25	± 12.63					
Males	S1	87.947	± 11.1967	62	61	0.5068	0.356	0.723
	S2	87.44	± 12.31					

Table 5: t-Test comparison of mean maturity score obtained in the present study (S1) with the mean maturity score sum according to Demirjian 1973 (S2) in the total groups of femalesand males.

It was found that both in females and in males the mean total score calculated in the present study was not significantly different compared with the mean score according to Demirjian's study in 1976; where in males the P-value was 0.723 and in females the P-value was 0.664. Emirati population had a tendency of earlier maturity scores compared to Canadian – French children. This result concluded that Demirjian standards in the population he used were similar to those of the present study, thus Demirjian's method would be suitable for this Emirati-child population.

Testing of normality was conducted for both Emirati children CA and their calculated DA. Continuous variables (maturity score, dental age, and chronological age) were described by a measure of tendency and measure of dispersion. Shapiro–Wilk was used to test the normality of continuous variables. The student's t-test was used to compare variables. Pearson product-moment correlation coefficient was also performed.

		Shapiro-Wilk		
	Gender	Statistic	df	Sig.
DA	Male	.948	62	**.010**
	Female	.916	76	**.000**
CA	Male	.987	62	.769
	Female	.982	76	.341

Table 6: Test of normality using Shapiro-Wilk statistics.

Shapiro-Wilk test showed that the chronological age (CA) was found to be normally distributed in both genders, while it was not the case for the dental age (DA). As normal distribution was robust still, parametric statistics were used in the present for comparing the two ages.

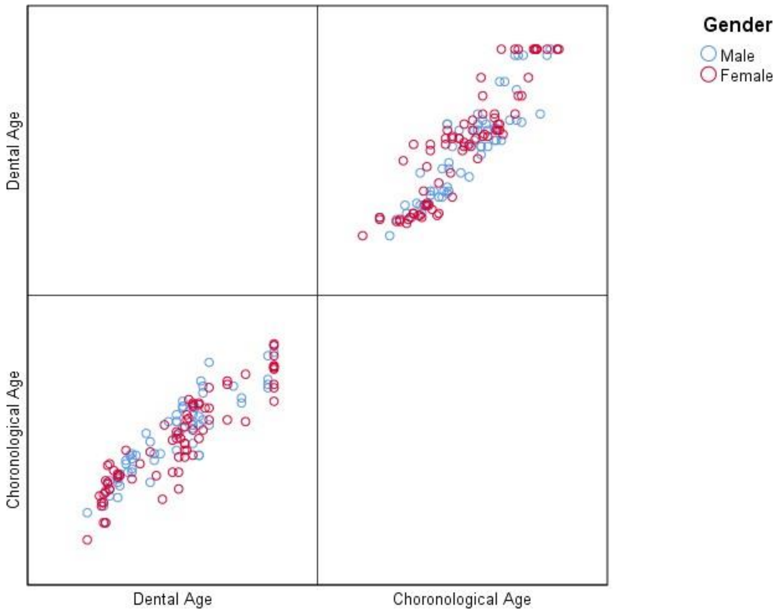

Figure 10: Matrix of correlation between chronological and dental age by gender.

Figure 10 shows a clustered plot graph demonstrating the correlation between DA and CA among females (red) and males (blue). There was a high correlation coefficient between DA and CA which demonstrated a positive correlation. This meant that when the CA increased in both males and females, the DA also increased. This was very significant. (p<0.01).

	male	Female
	DA	CA
DA		0.912**
CA	0.907**	

** *p*-value <0.01

Table 7: *P* value of difference DA and CA

The general male correlation coefficient between chronological age and dental age was 0.907(*p*-value <0.001) while the female one was 0.912.

	CA	DA	Difference (DA -CA)	SD	P-value
Male	10.29	11.08	0.79	0.13	<0.01
Female	10.05	11.27	1.21	1.16	<0.001
Overall	**10.16**	**11.17**	**1.01**	**0.10**	**<0.001**

Table 8: Comparison between the sample's (N=139) mean chronological age and dental ageby gender using t-test.

Using independent T-test the comparison between CA and DA by gender concluded that the mean value of CA in males was 10.29 years and their DA was 11.08. This indicted that the DA was higher with mean difference of 0.79 (±0.13) years. This meant that DA age in a 10 year and three-month-old male in this sample was that of an 11-year-one-month old. While the mean value of CA in females was 10.05 and DA was 11.27. This indicated that the DA was higher with a mean difference of 1.21(±1.16) years. This meant that DA age in a 10-year-old female in this sample was that of an 11 year three-month-old. Overall comparison of CA and DA difference was 1.01 (±0.1) years where DA was always higher compared to the CA, using the Demirjian method.

Differences between the mean DA and CA were estimated for the subgroups from the overall study sample (n=139) using the Demirjian's method (Mann-Whitney stats) were assessed. See Table 9. The results from this table showed that when using the Demerjian's method (based on a French-Canadian population) to assess the DA of Emirati children there were similar differences between the calculated mean DA and CA for those Emirati children in most age groups. This was highlighted in most subgroups, bar two (the "11.5-12.4" and the "14.4-15.7" subgroups). This difference was statistically significant (p<0.0001), except groups aged 11.5-12.4 years (p=0.215) and group aged 14.5– 15.7 (p=0.497). Thus, there was a clear overestimation of the Emirati children DA based on Demirjian's methods. This can graphically be represented in Figure 11. The two groups that had a confidence interval tangent the "zero difference” line had an almost identical DA and CA. While the other groups demonstrated a clear overestimation of the DA when compared to the CA.

Age groups (years)	Number	DA - CA	CI	P-value
4.1-5.4	4	2.59	2.59 – 2.47	**< 0.001**
5.5-6.4	5	1.3	1.104 – 1.496	**< 0.001**
6.5-7.4	12	1.43	0.616 – 2.25	**0.003**
7.5-8.4	19	0.973	0.501 – 1.445	**< 0.001**
8.5-9.4	22	1.045	0.458 – 1.632	**0.001**
9.5-10.4	11	1.136	0.537 – 1.179	**0.002**
10.5-11.4	21	1.086	0.679 – 1.500	**< 0.001**
11.5-12.4	18	0.328	-2.09 – 0.865	0.215
12.5-13.4	10	1.240	0.229 – 2.249	**0.022**
13.5-14.4	9	1.144	0.352 – 1.937	**0.01**
14.5-15.7	7	0.257	-0.614 – 1.128	0.497

Table 9: Differences between the mean dental age estimated using Demirjian's method andthe chronological age of the subgroups from the overall study sample (n=139) using Mann-Whitney method.

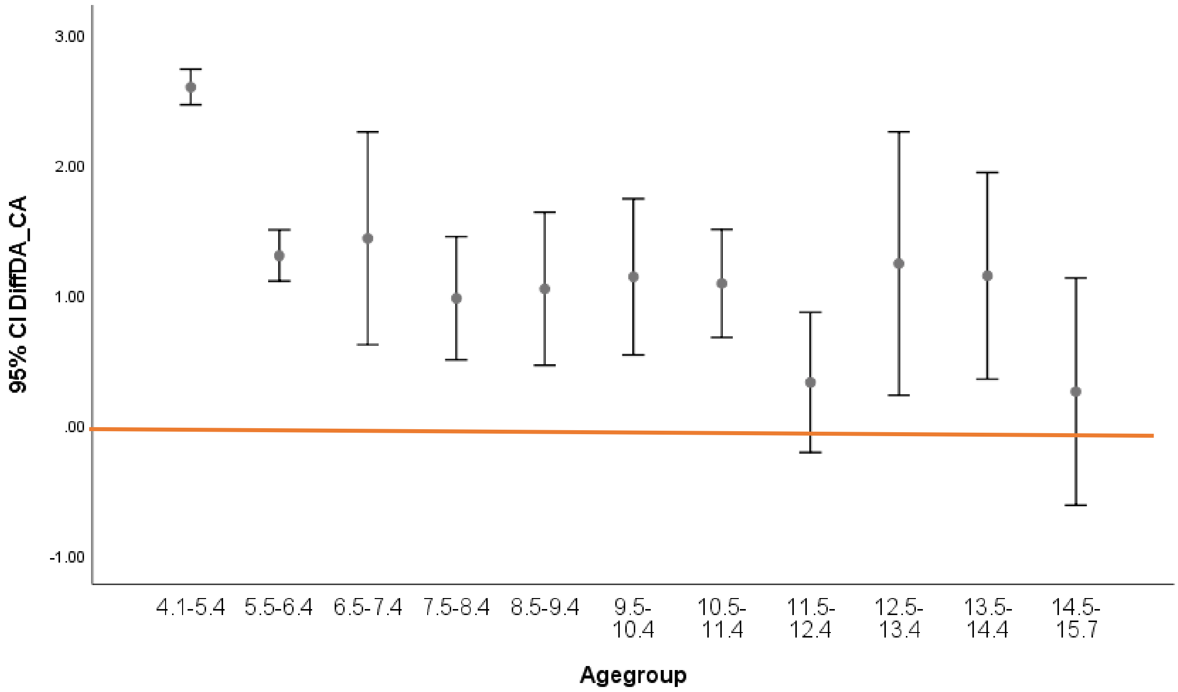

Figure 9: Error graph to show the overall difference between DA and CA by age groups. The Y axis is the 95% confidence interval of the difference between CA and DA. The X axis is the age groups divided according to CA. only 2 age groups (11.5-12.4 and 14.5-15.7) are not significant.

Age groups (years)	Boys	DA - CA	CI	P-value
4.1-5.4	1	NA	NA	NA
5.5-6.4	2	1.300	-1.241 – 3.841	0.097
6.5-7.4	4	1.175	0.521 - 1.830	**0.011**
7.5-8.4	8	0.849	0.299 – 1.398	**0.008**
8.5-9.4	12	0.95	0.161 – 1.739	**0.023**
9.5-10.4	4	0.600	-1.392 - 259	0.408
10.5-11.4	11	0.882	0.437 – 1.326	**0.001**
11.5-12.4	8	0.125	-0.659 – 0.909	0.717
12.5-13.4	6	1.117	-0.358 – 2.591	0.109
13.5-14.4	2	0.500	-19.830 – 20.83	0.807
14.5-15.7	4	0.025	-1.930 – 1.980	0.97

Table 10: Differences between the mean dental age estimated using Demirjian’s method and the chronological age of the study sample males (n=62).

The mean difference in males were statistically significant in groups 6.5-7.4 (P-value 0.011), 7.5-8.4 (P-value 0.008), 8.5-9.4 (P-value 0.023), and 10.5-11.4 (P-value 0.001) the remaining groups were not statistically significant.

Age groups (years)	number	DA - CA	CI	*P*-value
4.1-5.4	3	2.593	2.332 – 2.854	**0.001**
5.5-6.4	3	1.300	1.052 – 1.548	**0.002**
6.5-7.4	8	1.561	0.248 – 2.874	**0.026**
7.5-8.4	11	1.064	0.267 – 1.860	**0.014**
8.5-9.4	10	1.159	0.104 – 2.213	**0.035**
9.5-10.4	7	1.443	0.987 – 1.898	< **0.001**
10.5-11.4	10	1.31	0.512 – 2.108	**0.005**
11.5-12.4	10	0.490	-0.373 – 1.353	0.231
12.5-13.4	4	1.423	-1.154 – 3.999	0.177
13.5-14.4	7	1.329	0.754 – 1.903	**0.001**
14.5-15.7	3	0.567	-0.374 – 1.507	0.122

Table 11: Differences between the mean dental age estimated using Demirjian's method and the chronological age of the study sample females (n=77)

The mean difference in females were statistically significant in all age groups except 11.5-12.4 (P-value 0.231), 12.5 -13.4 (P-value 0.177), and 14.5-15.7 (P-value 0.122). As shown in the Error graph below (Figure 12) that we have more significant differences in the subgroups of females of the sample than the males.

The above results suggested that the Demirjian method reference data set (based on the French-Canadian population) tended to generally, although not exclusively, deliver higher scores of the DA for the Emirati children sub-population studied. This necessitated the creation of a self-weighted score tailored to the Emirati sample in this study.

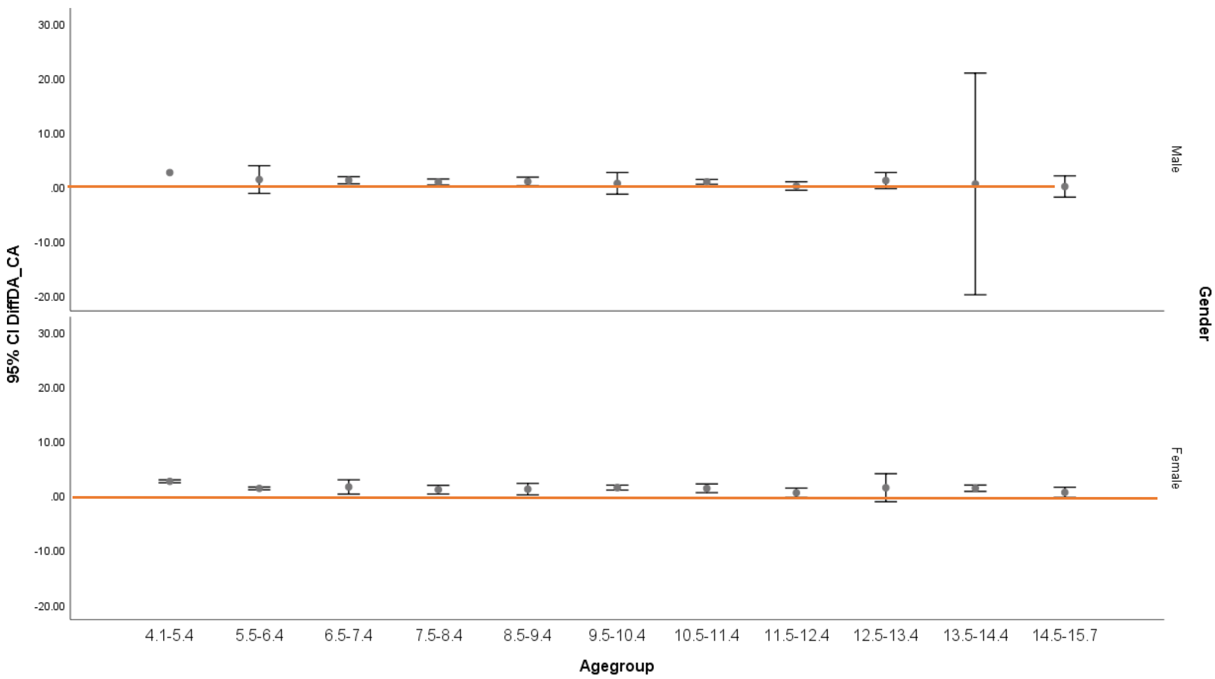

Figure 10: Error graph to show the general difference between DA and CA by age groups andgender

5.4. Creation of Self-Weighted Scores based on the Emirati Population DPTs

Demirjian's standard used to evaluate the dental age were clearly appropriate for Emirati population (see table 6), but to be able to achieve a more specific and reliable age estimate from Emirati DPTs (and based on the Demerjian method), new self-weighted values were calculated based on a normalization process, where dental ages per tooth and per stage were calculated for Emirati children. The calculations started off by using the lowest DA corresponding to the self-weighted score given for each stage (based on Demerjian's -Figure 6), but this calculation relied on Emirati DPTs. Thus, a process of normalization of the values was conducted for each value [for each tooth (I1, I2, P1, P2 M1, M2 and per each formation stage A, B, C, D, E, F, G, H)].

Each stage has a number, or a self-weighted score. Occasionally, a self-weighted stage was not listed in the self-weighted table of Demirjian's (Figure 6) suitable for the Emirati population, so a process of normalization was required to create this sample's values through a simple process of calculation. Normalization was conducted due to some missing measurements in the Canadian French population tables. The corresponding base values were calculated, and the rest were compared. To explain this further; 1) for each formation stage of the tooth, Demirjian method gave a self-weighted score. 2) Emirati children's own self-weighted score were calculated. This is seen in example below:

Data obtained from Emirati DPTs were subdivided into groups of DAs that showed same stage formation of a tooth. For example, tooth I1 in males "stage F" was repeated in three of the Emirati DPTs with the lowest DA of 7.7 that led to a self-weighted score according to Demirjian (Figure 6) of 4.1. The following age after 7.7 in the Emirati DPTs sample (that had I1 in males and stage F self-weighted score of 4.1) was 7.9. Because the self-weighted score was the same for two different DAs the process of normalization was conducted.

Another example: Tooth I2 "stage E" in males had 2 different DAs in our sample that were 6.8 and 7.9 years according to Demirjian table. When the lowest DA (i.e., 6.8) self-weighted score was extracted from Demrjian's table it was found to be 5.2. For the following DA (i.e., 7.9) the normalization process took place as follows:

For I2 stage E in males a DA of 6.8 corresponded to self-weight score of 5.2

For I2 stage E in males a DA of 7.9 corresponded to self-weighted score of X $X = 7.9 \times 5.2 / 6.8$ (normalization)

$X = 6.04$ which is the new corresponding self-weighted score taken from our sample.

Based on the above, conversion of the self-weighted scores was conducted for all tooth development stages and teeth in the sample of our study (see Table 12).

I_1				
	Male		Female	
G	DA	I_1	DA	I_1
	7.6	**8.2**	7.6	**9.3**
	7.7	8.31	7.7	9.42
	8.3	8.96	7.8	9.54
	8.4	9.06	7.9	9.67
	8.7	9.39	8.1	9.91
	8.8	9.49	8.3	10.16
	9.2	9.93	8.8	10.77
	9.7	10.47		
H				
	8.7	**11.8**	8.3	**12.9**
	8.9	12.07	8.4	13.06
	9	12.21	8.7	13.52
	9.9	13.43	9	13.99
	10.1	13.69	9.4	14.61
	10.4	14.11	9.9	15.39
	10.8	14.65	10.2	15.85
	11.2	15.19	10.5	16.32
	11.5	15.6	10.6	16.47
	12	16.28	11	17.1
	12.1	16.41	11.2	17.41
	12.3	16.68	11.3	17.56
	12.4	16.82	11.4	17.72
	12.5	16.95	11.6	18.03
	12.8	17.36	11.7	18.18
	14	18.99	11.8	18.34
	14.4	19.53	12	18.65
	15.7	21.29	12.3	19.12
	16	21.7	12.5	19.43
			12.6	19.58
			12.8	19.89
			13.7	21.29
			14.6	22.69
			16	24.87
F				
	7.7	**4.1**	6.8	**5.1**
	7.9	4.21	7.4	5.55
			7.5	5.63
			7.7	5.77
E	6.8	**1.9**		

I_2				
	Male		Female	
	DA	I_2	DA	I_2
G	8.4	**11.7**	7.6	**12.2**
	8.7	12.11	7.9	12.68
	8.8	12.26	8.1	13
	9	12.54	8.3	13.32
	9.2	12.81	8.4	1348
	9.7	13.51	8.7	13.97
	9.9	13.79	8.8	14.13
	8.4	11.7	10.5	16.86
H				
	8.9	**13.7**	9	**14.2**
	9.9	15.24	9.4	14.83
	10.1	15.55	9.9	15.62
	10.4	16.01	10.2	16.09
	10.8	16.62	10.6	16.72
	11.2	17.24	11	17.36
	11.5	17.7	11.2	17.67
	12	18.47	11.3	17.82
	12.1	18.63	11.4	17.99
	12.3	18.93	11.6	18.3
	12.4	19.09	11.7	18.46
	12.5	19.24	11.8	18.62
	12.8	19.7	12	18.93
	14	21.55	12.3	19.41
	14.4	22.17	12.5	19.72
	15.7	24.17	12.6	19.88
	16	24.63	12.8	20.19
			13.7	21.62
			14.6	23.04
			16	25.24
F				
	7.6	**7.8**	7.5	**8**
	7.7	7.9	7.6	8.11
	7.9	8.11	7.7	8.21
	8.3	8.52	7.8	8.32
	8.4	8.62	7.9	8.43
			8.3	8.85
E				
	6.8	**5.2**	6.8	**5.6**
	7.9	6.04	7.4	6.09
			7.5	6.17

C				
	Male		Female	
	DA	C	DA	C
G				
	9.9	**11**	10.5	**11.6**
	10.8	12	10.6	11.17
	12	13.33	11.3	12.48
	12.1	13.44	11.4	12.59

	12.3	13.67	11.6	12.82
	12.4	13.78	11.7	12.93
	12.5	13.89	11.8	13.04
	12.8	14.22	12	1326
			12.3	13.59
			12.6	13.92
H				
	14	**11.9**	12.5	**12.4**
	14.4	12.24	12.8	12.7
	15.7	13.35	13.7	13.6
	16	13.6	14.6	14.48
			16	15.87
F				
	8.3	**10**	7.4	**10.3**
	8.4	10.12	7.5	10.44
	8.7	10.48	7.6	10.58
	8.8	10.6	7.7	10.72
	8.9	10.72	7.8	10.86
	9	10.84	7.9	10.99
	9.2	11.08	8.1	11.27
	9.7	11.69	8.3	11.55
	9.9	11.93	8.4	11.69
	10.1	12.17	8.7	12.11
	10.4	12.53	8.8	12.25
	11.2	13.49	9	12.53
	11.5	13.86	9.4	13.08
			9.9	13.78
			10.2	14.2
			11	15.31
			11.2	15.59
E				
	7.7	**7.9**	6.8	**7.3**
	7.9	8.11	7.5	8.05
			7.6	8.16
			7.7	8.27
			7.8	8.37
			8.3	8.91
D				
	6.8	**3.5**		
	7.6	3.91		

P_1				
	Male		Female	
	DA	P1	DA	P1
G				
	9.9	**12.7**	11.2	**13.4**
	11.5	14.75	11.6	13.88
	12.3	15.78	11.8	14.12
	12.4	15.91	12	14.36
	12.5	16.04	12.3	14.72
	12.8	16.42	12.5	14.96
			12.6	15.08
			12.8	15.31
H				

	14	**13.5**	13.7	**14.1**
	14.4	13.89	14.6	15.03
	15.7	15.14	16	16.47
	16	15.43		
F				
	8.7	**12.3**	7.8	**13.1**
	8.8	12.44	8.3	13.94
	9.7	13.71	8.8	14.78
	10.1	14.28	9.4	15.79
	10.8	15.27	9.9	16.63
	11.2	15.83	10.5	17.63
	11.5	16.29	10.6	17.8
	12	16.97	11	18.47
	12.1	17.11	11.2	18.81
			11.3	18.98
			11.4	19.15
			11.6	19.48
			11.7	19.65
E				
	7.7	**11**	7.4	**11.8**
	7.9	11.29	7.5	11.96
	8.3	11.87	7.6	12.12
	8.4	12	7.7	12.28
	8.7	12.43	7.8	12.44
	8.9	12.71	7.9	12.6
	9	12.86	8.1	12.92
	9.2	13.14	8.3	13.24
	10.4	14.86	8.4	13.39
			8.7	13.87
			9	14.35
			10.2	16.26
D				
	6.8	**7**	6.8	**7.5**
	7.6	7.82	7.6	8.38
	7.7	7.92		

P2				
	Male		Female	
	DA	P2	DA	P2
G				
	11.5	**13.2**	11.2	**13.8**
	12.8	15.36	11.6	14.29
	14	16.8	12	14.79
	14.4	17.28	12.3	15.16
			12.6	15.25
			13.7	16.88
H				
	15.7	**14.4**	14.6	**14.6**
	16	14.67	16	16
F				
	8.8	**12.8**	8.3	**13.5**

	9.7	14.11	8.8	15.5
	9.9	14.4	9.4	17.55
	10.8	15.71	9.9	18.49
	11.2	16.29	10.2	19.98
	11.5	16.73	10.5	19.61
	12	17.45	10.6	19.78
	12.1	17.6	11	20.54
	12.3	17.89	11.2	20.91
	12.4	18.04	11.3	21.1
	12.5	18.18	11.6	21.66
			11.7	21.84
			11.8	22.02
			12	22.39
			12.5	23.32
E			12.8	23.87
	7.9	**12**	7.5	**12.7**
	8.3	12.61	7.6	12.87
	8.4	12.76	7.7	13.04
	8.7	12.22	7.8	13.21
	9	13.67	7.9	13.38
	9.2	13.97	8.3	14.05
	10.1	15.34	8.7	14.73
	10.4	15.8	11.4	19.3
D				
	6.8	**9.7**	7.4	**10.6**
	7.6	10.84	7.5	10.74
	7.7	10.98	7.6	10.89
	7.9	11.27	7.7	11.03
	8.4	11.98	7.8	11.18
	8.7	12.41	8.1	11.6
	8.9	12.7	8.4	12.03
	9	12.83	9	12.89
C				
			6.8	**6.5**

M_1				
	Male		Female	
	DA	M_1	DA	M_1
G				
	7.7	**17**	7.5	**14**
	7.9	17.44	7.6	14.19
	8.3	18.32	7.7	14.37
	8.4	18.55	7.8	14.56
	8.7	19.21	7.9	14.75
	8.8	19.43	8.1	15.12
	8.9	19.65	8.3	15.49
	9	19.87	8.4	15.68
	9.9	21.86	8.7	16.24
	10.1	22.29	8.8	16.42
			9.4	17.75
			10.6	19.79
H	9	**19.3**	8.3	**16.2**
	9.2	19.73	9	17.57
	9.7	20.8	9.9	19.32

	10.1	21.66	10.2	19.91
	10.4	22.3	10.5	20.49
	10.8	23.16	11	21.47
	11.2	24.02	11.2	21.86
	11.5	24.66	11.3	22.06
	12	25.73	11.4	22.25
	12.1	25.95	11.6	22.64
	12.3	26.38	11.7	22.83
	12.4	26.59	11.8	23.03
	12.5	26.81	12	23.42
	12.8	27.45	12.3	24.01
	14	30.02	12.5	24.4
	14.4	30.88	12.6	24.59
	16	34.3	12.8	24.98
	15.7	33.66	13.7	26.74
			14.6	28.5
			16	31.23
F				
	7.6	**12.3**	6.8	**9**
	7.7	12.46	7.4	9.79
			7.6	10.06
E				
	6.8	**9.6**		

M_2				
	Male		Female	
	DA	M_2	DA	M_2
G				
	12.4	**13.6**	11.4	**14.5**
	12.5	13.71	12	15.26
	12.8	14.04	12.3	15.64
	14	15.35	12.6	16.2
	14.4	15.79	12.8	16.28
	15.7	17.21	13.7	17.43
			14.6	18.57
H				
	16	**15.4**	16	**15.6**
F				
	9.7	**13.2**	10.6	**14.2**
	10.8	14.7	11	14.74
	11.5	15.65	11.2	15
	12	16.33	11.6	15.54
	12.1	16.47	11.7	15.67
	12.3	16.74	11.8	15.81
			12	16.08
			12.5	16.75
E				
	8.4	**12.5**	8.3	**13.5**
	9.2	13.69	8.8	14.31
	9.9	14.73	10.2	16.59
	10.1	15.03	10.5	17.08
	10.4	15.48	11.3	18.38
	11.2	16.67	11.6	18.87

	11.5	17.11		
	12	17.86		
D				
	7.6	**10.1**	7.4	**11.1**
	7.7	10.23	7.5	11.25
	7.9	10.5	7.6	11.4
	8.3	11.03	7.7	11.55
	8.4	11.16	7.8	11.7
	8.7	11.56	7.9	11.85
	8.8	11.69	8.1	12.15
	8.9	11.83	8.3	12.45
	9	11.96	8.4	12.6
	10.1	13.42	8.7	13.05
			9	13.5
			9.4	14.1
			9.9	14.85
C				
	6.8	**5.9**	6.8	**6.9**
	7.7	6.68	7.6	7.71
			7.7	7.81
			7.9	8
B				
			7.5	**3.9**

Table 12: Modified conversion of Self Weighted Scores in relation to DA from French Canadian to Emirati population. The bold numbers represent the self-weighted score on Demirjian for the lowest DA in our sample, where the rest were calculated by normalization.

After obtaining the new self-weighted scores (Table 12), the mean value of self-weighted scores of each tooth and stage in the Emirati sample were calculated. For instance, the tooth I1 stage F, in males had a self-weighted score of 4.1 and 4.21 and were repeated (frequency) in three DPTs in the sample. To create the mean value of the Emirati self-weighted scores, the sum of those numbers was divided by their frequency. For example: I1 stage F in males repeated three times: once 4.1 self-weight score and twice 4.21. There were added up and divided by three. Thus (4.1+4.21+4.21) / 3 = 4.17. Therefore 4.17 represented the new mean self-weighted score value of tooth I1 stage F in the Emirati sample. This process was repeated for each tooth and for each stage according to gender. These new values (shown in Table 13) were calculated and presented in terms of the mean value, standard error, standard deviation and total number of boys and girls and combined groups in ‘a tooth formation stage’ for each tooth. The “essence” of these values that represent the reference data set for Emirati children sample are presented in Table 14 for both males and females.

		Males				Females				Both Males & Females			
Tooth	**Stage**	**Mean**	**SE**	**SD**	**N**	**Mean**	**SE**	**SD**	**N**	**Mean**	**SE**	**SD**	**N**
I_1													
	E	1.9			1	5.52	0.11	0.24	5	1.9			1
	F	4.17	0.04	0.07	3	9.42	9.42	0.05	15	5.02	0.26	0.72	8
	G	9.16	0.20	0.65	11	19.28	0.46	3.45	57	9.31	0.09	0.46	26
	H	16.26	0.40	2.72	47				77	17.92	0.34	0.35	104
I_2													
	E	5.62	0.42	0.59	2	5.95	0.18	0.31	3	5.82	0.18	0.41	5
	F	8.24	0.12	0.34	8	8.29	0.06	0.22	12	8.27	0.06	0.27	20
	G	12.72	0.29	0.95	11	13.47	0.47	1.42	9	13.06	0.27	1.21	20
	H	19.10	0.43	2.75	41	20.05	0.43	3.14	53	19.63	0.31	3.0	94
C													
	D	3.5			2					3.5			2
	E	8.01	0.06	0.12	4	8.2	0.16	0.45	8	8.13	0.11	0.38	12
	F	11.66	0.27	1.44	28	12.06	0.36	1.72	23	11.84	0.22	1.57	51
	G	13.42	0.17	0.75	19	12.83	0.13	0.64	26	13.08	0.11	0.74	45
	H	12.99	0.22	0.67	9	14.74	0.31	1.38	20	14.2	0.27	1.45	29
P													
	D	7.58	0.29	0.50	3	8.09	0.29	0.51	3	7.83	0.22	0.53	6
	E	12.36	0.23	0.93	16	12.86	0.24	1.06	19	12.64	0.17	10.02	35
	F	15.52	0.36	1.65	21	18.06	0.42	1.96	22	16.82	0.34	2.21	43
	G	15.16	0.41	1.46	13	14.56	0.13	0.54	17	14.82	0.19	1.06	30
	H	14.74	0.25	0.76	9	15.85	0.25	0.99	16	15.45	0.21	1.45	25
P_2													
	C					6.5			1	6.5			1
	D	11.52	0.34	1.03	9	11.25	0.23	0.73	10	11.38	0.20	0.87	19
	E	13.56	0.35	1.26	13	13.89	0.52	1.81	12	13.38	0.31	1.53	25
	F	16.61	0.30	1.58	28	20.92	0.43	2.31	29	18.8	0.39	2.93	57
	G	15.88	0.64	1.58	6	15.57	0.30	1.03	12	15.5	0.29	1.22	18
	H	14.96	0.06	0.14	6	15.57	0.19	0.67	13	15.23	0.17	0.76	19

M_1													
	E	9.6			1					9.6			1
	F	12.38	0.8	0.11	2	9.61	0.32	0.55	3	10.72	0.70	1.56	5
	G	19.28	0.36	1.52	18	15.21	0.31	1.40	21	17.09	0.40	2.51	39
	H	26.55	0.61	3.9	41	24.76	0.55	3.98	53	25.54	0.42	4.02	94
M_2													
	B					3.9			1	3.9			1
	C	6.29	0.39	0.55	2	7.63	0.19	0.42	5	7.24	0.29	0.77	7
	D	11.17	0.27	1.11	17	12.23	0.25	1.05	18	11.71	0.20	1.20	35
	E	15.61	0.39	1.4	13	16.7	0.77	2.3	9	16.06	0.40	1.85	22
	F	15.77	0.30	1.18	15	15.44	0.16	0.67	18	15.59	0.16	0.94	33
	G	15.28	0.43	1.55	13	16.43	0.31	1.21	15	15.89	0.28	1.47	28
	H	15.4			2	15.6	0	0	11	15.57	0.02	0.8	13

Table 13: Mean self-weighted scores of Emirati children (boys and girls) per tooth formationstage.

Generally, the mean ages of children for most teeth developmental stages were earlier in boys as compared to girls except on the tooth M1 where teeth development stages were earlier in girls compared on boys.

<u>It is important to detail the above table to understand the character of the above self-weighted scores. The description of Table 13 follows:</u>

Tooth I1 (lower left central incisor) stage E had a mean value of 1.9 in males and 5.52 in females showing earlier development in boys. Stage F had a mean value of 4.17 in males and 9.42 in females which indicated earlier eruption in boys. Stage G mean value in males was 9.16 and females was 19.28 showing that earlier tooth development occurred in males.

Tooth I2 (lower left lateral incisor) stage E in males mean value was 5.62 and females 5.95 indicating early development in males that than females. Stage F males mean value was 8.24

and females and 8.29 in males thus demonstrating that development was earlier in males than females. Stage G mean value of males was 12.72 and in females was 13.47, again earlier in males. Stage H in males the mean value is 19.10 and in females is 20.05; thus, again earlier in males compared to females.

Tooth C (lower left canine) stage D mean value in males was 3.5 and no females had stage D of tooth C. Stage E mean value in males was 8.01 and in females was 8.2 (slightly earlier in males than females). Stage F showed mean value of 11.66 in males and 12.06 in females (again males earlier tooth formation that females). Stage G mean value in males was 13.42 and in females was 12.83 (early in males compared to females). Stage H of tooth C had a mean value of 12.99 in males and was earlier in tooth formation compared to females where the mean value was 14.74.

Tooth P1(lower left first premolar) stage D had mean value of 7.58 in males and 8.09 in females (males were earlier in tooth formation than females). Stage E mean value in males was 12.36 and females was 12.86 (males slightly earlier than females). Stage F 15.52 mean value in males compared to 18.06 in females (males were earlier). Stage G mean value of 15.16 in males and 14.56 in females. In comparing between them, female mean value was less for this stage which meant female in tooth P1 stage G was earlier in tooth formation than males. Stage H mean value in males was 14.74 which was earlier than female with mean value of 15.85.

Tooth P2 (lower left second premolar) stage C only one male from this study sample scored C with a mean value of 6.5 in females. Stage D males mean value was 11.52 and in females was 11.25 (slightly earlier in females than in males). Stage E 13.56 mean value of males and 13.89 in females (earlier tooth formation in males compared to females). Stage F mean value was 16.61 in males and 20.92 in females (males earlier than females in tooth formation). Stage G mean value in males was 15.88 and females mean value was 15.57 (females were earlier in tooth formation). Stage H 14.96 males mean value and 15.57 females mean value (males were earlier in tooth formation than females for this stage).

Tooth M1 (lower left first molar) stage E tooth formation had a mean value of 9.6 in males. Stage F mean value in males was 12.38 and females is 9.61 (females were earlier than males in tooth formation). Stage G mean value of 19.28 in males and 15.21 in females. This showed that females had earlier tooth formation than males). Stage H males mean value was 26.55 and females was 24.76 (females were earlier in tooth formation than males for this stage).

Tooth M2 (lower left second molar) stage B 3.9 female mean value. Stage C 6.29 males mean value and 7.63 females (earlier tooth formation in males compared to females). Stage D 11.17 mean value in males and 12.23 in females showed earlier tooth formation in males. Stage E mean value of males was 15.61 and was earlier in tooth formation compared to mean value of females 16.7. Stage F mean value of males was 15.28 and females 15.44 (males were earlier than females in tooth formation). Stage G mean value of males was 15.28, earlier tooth formation compared to mean value of females 16.43. Stage H 15.4 mean value of males and 15.6 mean value of females thus this showed earlier tooth formation in males compared to females for this stage.

The above self-weighted scores can be summarized in Table 14.

Male

	A	B	C	D	E	F	G	H
M_2			6.29	11.17	15.61	15.77	15.28	15.4
M_1					9.6	12.38	19.28	26.55
P_2				11.52	13.56	16.61	15.88	14.96
P_1				7.58	12.36	15.52	15.16	14.74
C				3.5	8.01	11.66	13.42	12.99
I_2					5.62	8.24	12.72	19.10
I_1					1.9	4.17	9.16	16.26

Female

	A	B	C	D	E	F	G	H
M_2		3.9	7.63	12.23	16.7	15.44	16.43	15.6
M_1						9.61	15.21	24.76
P_2			6.5	11.25	13.89	20.92	15.57	15.57
P_1				8.09	12.86	18.06	14.56	15.85
C					8.2	12.06	12.83	14.74
I_2					5.95	8.29	13.47	20.05
I_1					5.52	9.42	19.28	

Table 14: Simplified Self-Weighted scores calculated specifically for the sampled Emirati population 7 teeth (Mandibular left side).

6. DISCUSSION

This study represented, as far as the authors know, the first attempt to assess chronological and dental ages specific to Emirati-child population using their DPTs and based on the Demirjian standards. It was found that those standards are applicable to this population, and that Emirati children's dental maturity was early compared to their French- Canadian counterparts but there was no significant difference found. Based on the above and within the limitation mentioned below, this study successfully developed self-weighted scores specific to this population.

Dental age is defined as the estimated age of the subject based on the level of tooth mineralization or calcification during the developmental process (57). In dentistry and medicine, two methods are commonly used to assess dental age: Assessment of tooth eruption by tooth counting and assessment of mineralization of permanent teeth by DPTs. The latter's use was considered the basis of this present study. Because relying on the date of eruption of permanent teeth varies widely among children of the same ethnic background, making it an unreliable method of estimating age (58-60). Other modified methods (35) are based on radiographic shape criteria and root length ratio, using relative value to crown height, therefore shortened or lengthened projections of developing teeth will not affect the reliability of the assessment(7). Other advantages of the later method include reliability and feasibility to estimate an individual's age because teeth can be preserved for a long time after all other tissues have disintegrated (61). The developmental stages of permanent teeth were considered as valuable indicators of the dental age for this study's Emirati population, given the scarcity of other available age indicators.

Our study sample was larger than that of Pratyusha et al. study in India, for example (35), but may be small compared to other similar studies (2, 39, 43) but relatively equal to those of other studies (45, 62) Thus, it may be considered adequate and representative to the smaller UAE population. These studies included a cross-sectional study that compared DAs with CAs in 162 Somali and white Caucasian children residing in Sheffield in the UK (63). Likewise, Prabhakar et al. tested the applicability of Demirjian's method among 151 Indian children living in Davangere(64). They found that the Davangere children were dentally more advanced, like our study, but they also found that that Demirjian's method was not applicable to their study group due to an overestimation of CA compared to DA. Other studies, (65, 66) with larger sample sizes than ours, including those that surveyed older age groups, recommended creation of an adaptive tool to avoid the overestimation observed using Demirjian's method.

Various methods of determining chronological and radiographical stages have been used for dental age estimation (7-9). Demirjian's eight-stage method was and is still one of the principal methods used to quantify the degree of maturity (33). It is one of the simplest, practical and widely used methods (7). Recent studies have confirmed that Demirjian's classification system performs well in terms of both observer agreement and correlation between estimated and true age (6, 67-70). The main objective of this study was to try to determine the dental age of Emirati children by applying Demirjian method. (7), which was originally applied to a French-Canadian population. Due to ethnic differences in the two population groups (i.e., the French-Canadian population and the Emirati population), the reproducibility and accuracy of this method was tested, in which intra-examiner reliability was calculated by re-evaluating 10 radiographs and the kappa test yielded a value of 0.82. Values between 0.820 and 0.71 indicate high agreement between the two assessments. DA and CA were found to have a statistically significant difference (0.79 [SD ± 0.13 P-value <0.01] years in males and 1.21 [SD ± 1.16 P-value <0.001] years in females) in our research. The majority of the children's DAs were clearly higher than the CA. This suggested that children in the UAE matured dentally quite early. Other research had found similarly statistically important differences (of 0.73 and 0.51 years) in the

UK in 1999(39) , (0.27 and 0.23 years) in UK in 2009(40) , (0.5 and 0.5years) in Australia in 2013(43) , (1 – 1.3 and 0.0071 – 1.25 years) in China in 2010(36) , (0.71 and 0.67 years) in Kuwait in 2009(2) , (0.66 and 0.059 years) in Saudi Arabia in 2015(5) in both in boys and girls respectively. It should be noted, however, that when attempting to compare the results of this study with previous research on the accuracy of dental age determination methods, it became clear that such comparisons are complicated by differences in sample sizes, age structures, groupings, and statistical analyses used, which make direct comparisons difficult (6).

Our results revealed a difference between the DA and the CA of 0.79 years in the male group, this was much higher than those results obtained using similar age groups of Serbians (71) (0.45 years), Dutch(72) (0.4 years), and French (73) (0.47 years) males. In the female group, a mean difference of 1.21 years was calculated. This was again much higher than those reported among females living in Norway (69) (0.3 years). The reverse observations were reported for South Indians (68) (3.04 years in males and 2.82 years in females). This region has historic geographical links to the UAE and may explain the similar upward scores (74). Overall, however, the differences in age estimation between this study and those of other studies may be related to differences in the sample size, age groups, and studied populations. Other factors, such as socioeconomic status, nutrition, and dietary habits, may also affect the outcomes (75).

In our study, the pattern of mean DA–CA against CA in females was different from that in males of similar age groups (i.e.: mean DA - CA in age group 6.5-7.4 in females is 1.561 and in males is 1.175) (see Tables 10 and 11). The mean difference between DA and CA in males decreased with age (except in age group 12.5 – 13.4 of males), while it fluctuated in age groups of females. In this case, the mean DA–CA decreased (Table 9). In a study of 521 children aged between 4 and 9 years of age, Liversidge et al. (39) found that the mean DA–CA in boys decreased with age, while it peaked in the middle age group (6.00–6.99 years) in girls.

Although the populations examined in these two studies were of different age groups, the patterns were similar. For most maturation events, the pace of maturation is faster in girls (76). This is consistent with the findings of this study, where girls were more dentally advanced than boys at most tooth formation stages (77). In another study of 509 children aged between 3 and 14 years of age, Qudeimat et al. (2) found that the standards of dental maturation described by Demirjian may not be suitable for Kuwaiti children and creation of a completely separate reference data set using a non-linear regression model was necessary. which disagreed with the current study. Because of the acceptability of the Demerjian's norms, this present study created a reference data set based on the normalization process of Demirjian's norms, but applicable to the age range and maturity of Emirati children of this study's sample.

As stated in earlier studies (69, 73, 78), the difference in dental maturation between groups using a single score such as Demirjian's does not provide a clear picture of where and how these differences occur. Demirjian's scoring system relies on weighted scores of tooth formation stages. Differences in the timing of one or more of these stages relative to other stages or teeth are usually hidden (79). Due to this, self-weighted scores based on normalization, were created for this Emirati population (Table 14). This was different to that study of 160 children in Minia Egypt (38), where the Demirjian scores were not deemed suitable, and they created a reference data set independent of the Demerjian standard, based on a log regression formula. This was also the case for Qudeimat et al. in 2009(2).

When comparing the mean ages of Emirati children with those of children from Australia, Belgium, Canada, England, Finland, France, South Korea and Sweden as presented in a meta-analysis study by Liversidge et al. (2006) (80), it is worth mentioning that for most of the teeth there seems to be a close similarity in children's mean ages in a given tooth formation stage. Appreciating the limitation of such comparison due to the difference in the sample size of the current study (139 DPTs) and that of the previous study (that assessed 9002 DPTs), Liversidge et al. showed no clear difference in the timing of formation. The differences found in our study may be mostly related to the small sample size.

Finally, in the UAE, as in many other countries around the world, dental radiographs are performed as part of diagnosis and/or treatment planning. It would be difficult to assess how a larger and evenly distributed sample (from other UAE Emirates for example) would have affected the results of this study. One drawback of this study was that, rather than being chosen at random, all subjects were patients who had been treated at Dubai Dental Hospital. Hence, they may not represent the general population of the UAE. However, Dubai is the most populous emirate in the UAE, and many UAE nationals from other emirates may seek dental treatment in Dubai. This meant that this study may have potentially included Emiratis from the remaining six emirates, however this data was not included. Asking about the child's Emirate of origin was omitted from this retrospective study since it's not documented in patients file and may be considered a limitation.

7. CONCLUSIONS

Within the limitation of this research, and in the UAE Emirati child sample studied:

- The findings revealed that the Demirjian method was appropriate for estimating the dental age of Emirati children, between the ages of 5 and 15.
- Using the Demirjian method, the difference in the Chronological Age (CA) and DentalAge (DA) in Emirati children was 1.01 (± 0.1) years. The DA was always higher compared to the CA. This suggested that overall, these children matured early.
- The mean DA-CA differences in the Demirjian's scores in males and in females of the same chronological age were 0.79 (± 0.13) and 1.21 (± 1.16) respectively.
- Self-weighted scores corresponding to their ages were created by the process of normalization of the Demirjian's standards, based on this population's data.

Further suggested research:

Access children from all over the UAE Emirates. This will enable analysis of DPTs from Emirati children from the other Emirates not included in this study

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9. APPENDICES

APPENDIX 1

IRB approval

28 April 2020

Dr Sharifa AlHaj
Pediatric Dentistry Resident
HBMCDM

RE: MBRU-IRB-2020-019

Dear Dr Sharifa,

Thank you for submitting to the IRB study titled "Development of a Dental Reference Data Set for Emirati Children and Adolescents based on the Demirjian's Method" for exempt review. The Board has reviewed the same at its meeting of 28 April 2020 and has agreed to approve the same.

The study can now commence. Any change in protocol must be notified to the Board.

For any questions, please contact the Institutional Review Board irb@mbru.ac.ae.

Thank you for your interest in MBRU's IRB.

Sincerely,

لجنة أخلاقيات البحوث
INSTITUTIONAL REVIEW BOARD

Professor Alexander Milosevic
Deputy Chairman, MBRU-IRB

RE: MBRU-IRB-2019-022 Page **1** of **1**

APPENDIX 2

Raw Data

Patient #	Gender	Dental Age	Choronological Age	I1	I2	C	P1	P2	M1	M2	Maturity score	I1	I2	C	P1	P2	M1	M2
1	F	7.9	7.1	9.3	8	10.3	11.8	12.7	14	11.1	77.2	G	F	F	E	E	G	D
2	M	12.3	10.9	11.8	13.7	11	12.7	12.8	19.3	13.2	94.5	H	H	G	G	F	H	F
3	F	11.6	9	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F
4	M	9	9.2	11.8	11.7	10	11	9.7	19.3	10.1	83.6	H	G	F	E	D	H	D
5	M	8.9	9.1	11.8	13.7	10	11	9.7	17	10.1	83.3	H	H	F	E	D	G	D
6	F	11.2	10.5	12.9	14.2	10.3	13.4	13.8	16.2	14.2	95	H	H	F	G	G	H	F
7	F	7.7	7.6	9.3	8	7.3	11.8	10.6	14	11.1	72.1	G	F	E	E	D	G	D
8	F	11.6	9.4	12.9	14.2	11.6	13.4	13.8	16.2	13.5	95.6	H	H	G	G	G	H	E
9	M	10.1	9.2	11.8	13.7	10	12.3	12	19.3	10.1	89.2	H	H	F	F	E	H	D
10	F	7.6	6.3	9.3	12.2	7.3	7.5	10.6	14	6.9	67.8	G	G	E	D	D	G	C
11	F	7.6	6.8	9.3	8	10.3	11.8	12.7	9	6.9	68	G	F	F	E	E	F	C
12	F	8.1	8.2	9.3	12.2	10.3	11.8	10.6	14	11.1	79.3	G	G	F	E	D	G	D
13	M	12	10.7	11.8	13.7	11	12.3	12.8	19.3	13.2	94.1	H	H	G	F	F	H	F
14	M	12.8	10.9	11.8	13.7	11	12.7	13.2	19.3	13.6	95.3	H	H	G	G	G	H	G
15	F	7.8	7.4	9.3	8	10.3	11.8	10.6	14	11.1	75.1	G	F	F	E	D	G	D
16	F	7.9	7.1	9.3	12.2	10.3	11.8	12.7	14	6.9	77.2	G	G	F	E	e	G	C
17	F	12	9.11	12.9	14.2	11.6	13.4	13.8	16.2	14.2	96.3	H	H	G	G	G	H	F
18	M	10.8	11.1	11.8	13.7	11	12.3	12.8	19.3	13.2	94.1	H	H	G	F	F	H	F
19	F	11.3	7.11	12.9	14.2	11.6	13.1	13.5	16.2	13.5	95	H	H	G	F	F	H	E
20	F	12.3	12.2	12.9	14.2	11.6	13.4	13.8	16.2	14.5	96.6	H	H	G	G	G	H	G
21	M	7.9	6.7	4.1	5.2	7.9	11	9.7	17	13.2	68.1	F	E	E	E	D	G	D
22	M	7.7	7	8.2	7.8	7.9	11	9.7	12.3	5.9	62.8	G	F	E	E	D	F	C
23	M	9	8.9	11.8	11.7	10	11	12	17	10.1	83.6	H	G	F	E	E	G	D
24	M	8.7	8.8	8.2	11.7	10	12.3	12	17	10.1	81.3	G	G	F	F	E	G	D
25	F	12	12.2	12.9	14.2	11.6	13.4	13.8	16.2	14.2	96.3	H	H	G	G	G	H	F
26	M	9.9	9.9	11.8	13.7	11	12.7	12.8	17	12.5	91.5	H	H	G	G	F	G	E
27	M	9	8.3	11.8	11.7	10	11	12	17	10.1	83.6	H	G	F	E	E	G	D
28	F	7.7	6.9	9.3	8	10.3	11.8	10.6	14	6.9	70.9	G	F	F	E	D	G	C
29	F	7.7	5.11	5.1	8	10.3	11.8	12.7	14	11.1	73	F	F	F	E	E	G	D
30	F	10.5	6.5	12.9	12.2	11.6	13.1	13.5	16.2	13.5	93	H	G	G	F	F	H	E
31	M	11.5	10.7	11.8	13.7	10	12.7	13.2	19.3	12.5	93.2	H	H	F	G	G	H	E
32	M	8.3	7.5	8.2	7.8	10	11	12	17	10.1	76.1	G	F	F	E	E	G	D
33	F	7.5	6.3	5.1	8	10.3	11.8	12.7	14	3.9	65.8	F	F	F	E	E	G	B
34	F	9	7.7	12.9	14.2	10.3	11.8	10.6	16.2	11.1	87.1	H	H	F	E	D	H	D
35	F	11.7	11.2	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F
36	F	11.7	9.4	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F
37	F	8.3	7.8	12.9	12.2	7.3	11.8	12.7	14	11.1	82	H	G	E	E	E	G	D
38	M	8.3	7.7	8.2	7.8	10	11	12	17	10.1	76.1	G	F	F	E	E	G	D
39	M	12	9.8	11.8	13.7	11	12.3	12.8	19.3	13.2	94.1	H	H	G	F	F	H	E
40	M	8.7	8.6	11.8	11.7	10	11	9.7	17	10.1	81.3	H	G	F	E	D	G	D
41	M	12.5	12.8	11.8	13.7	11	12.7	12.8	19.3	13.6	94.9	H	H	G	G	F	H	G
42	F	9.9	9.3	12.9	14.2	10.3	13.1	13.5	16.2	11.1	91.3	H	H	F	F	F	H	D
43	F	11.4	10.1	12.9	14.2	11.6	13.1	12.7	16.2	14.5	95.2	H	H	G	F	E	H	G
44	F	11.3	9	12.9	14.2	11.6	13.1	13.5	16.2	13.5	95	H	H	G	F	F	H	E
45	M	12.3	9.1	11.8	13.7	11	12.7	12.8	19.3	13.2	94.5	H	H	G	G	F	H	F
46	F	12	10.6	12.9	14.2	11.6	13.4	13.8	16.2	14.2	96.3	H	H	G	G	G	H	F
47	F	9.4	8.6	12.9	14.2	10.3	13.1	13.5	14	11.1	89.1	H	H	F	F	F	G	D
48	M	12.8	14.6	11.8	13.7	11	12.7	13.2	19.3	13.6	95.3	H	H	G	G	G	H	G
49	M	12.3	9.1	11.8	13.7	11	12.7	12.8	19.3	13.2	94.5	H	H	G	G	F	H	F
50	M	8.4	7.3	8.2	7.8	10	11	12	17	12.5	78.5	G	F	F	E	E	G	E
51	M	11.5	12.3	11.8	13.7	10	12.3	12.8	19.3	13.2	93.1	H	H	F	F	F	H	F
52	F	11.8	12.4	12.9	14.2	11.6	13.4	13.5	16.2	14.2	96	H	H	G	G	F	H	F
53	M	11.2	9.4	11.8	13.7	10	12.3	12.8	19.3	12.5	92.4	H	H	F	F	F	H	E
54	F	11.7	11.5	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F
55	F	13.7	13.3	12.9	14.2	12.4	14.1	13.8	16.2	14.5	98.1	H	H	H	H	G	H	G
56	F	11	8.1	12.9	14.2	10.3	13.1	13.5	16.2	14.2	94.4	H	H	F	F	F	H	F
57	M	12	10.9	11.8	13.7	11	12.3	12.8	19.3	13.2	94.1	H	H	G	F	F	H	F
58	F	7.5	6.1	5.1	5.6	7.3	11.8	10.6	14	11.1	65.5	F	E	E	E	D	G	D
59	F	12.5	10.6	12.9	14.2	12.4	13.4	13.5	16.2	14.2	96.8	H	H	H	G	F	H	F
60	M	9.2	9.1	8.2	11.7	10	11	12	19.3	12.5	84.7	G	G	F	E	E	H	E
61	M	14.4	12.2	11.8	13.7	11.9	13.5	13.2	19.3	13.6	97	H	H	H	H	G	H	G
62	F	16	13.1	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
63	M	11.2	11.1	11.8	13.7	10	12.3	12.8	19.3	12.5	92.4	H	H	F	F	F	H	E
64	F	8.4	7.9	12.9	12.2	10.3	11.8	10.6	14	11.1	82.9	H	G	F	E	D	G	D
65	M	15.7	13.6	11.8	13.7	11.9	13.5	14.4	19.3	13.6	98.2	H	H	H	H	H	H	G
66	M	8.3	6.6	8.2	7.8	10	11	12	17	10.1	76.1	G	F	F	E	E	G	D
67	F	16	14.3	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
68	F	16	14.3	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
69	F	6.8	4.1	5.1	5.6	7.3	7.5	6.5	9	6.9	47.9	F	E	E	D	C	F	C
70	F	14.6	11.1	12.9	14.2	12.4	14.1	14.6	16.2	14.5	98.9	H	H	H	H	H	H	G
71	M	12	11.5	11.8	13.7	11	12.3	12.8	19.3	13.2	94.1	H	H	G	F	F	H	F
72	F	16	13.3	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
73	F	16	14.4	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
74	M	12.1	11.9	11.8	13.7	11	12.3	12.8	19.3	13.2	94.1	H	H	G	F	F	H	F
75	M	9.7	10.4	8.2	11.7	10	12.3	12.8	19.3	13.2	87.5	G	G	F	F	F	H	F
76	F	16	14.2	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
77	F	12.3	12.1	12.9	14.2	11.6	13.4	13.8	16.2	14.5	96.6	H	H	G	G	G	H	G
78	F	12.3	10.1	12.9	14.2	11.6	13.4	13.8	16.2	14.5	96.6	H	H	G	G	G	H	G
79	F	12	12	12.9	14.2	11.6	13.4	13.5	16.2	14.5	96.3	H	H	G	G	F	H	G
80	M	10.4	9.2	11.8	13.7	10	11	12	19.3	12.5	90.3	H	H	F	E	E	H	E
81	F	11	10	12.9	14.2	10.3	13.1	13.5	16.2	14.2	94.4	H	H	F	F	F	H	F
82	M	14	13.2	11.8	13.7	11.9	13.5	13.2	19.3	13.6	97	H	H	H	H	G	H	G
83	F	11.6	9.8	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F

84	83	F	11.6	9.8	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F
85	84	M	12.5	11.2	11.8	13.7	11	12.7	12.8	19.3	13.6	94.9	H	H	G	G	F	H	G
86	85	F	7.6	5.11	9.3	8	7.3	7.5	10.6	14	11.1	67.8	G	F	E	D	D	G	D
87	86	F	16	15	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
88	87	F	14.6	13.9	12.9	14.2	12.4	14.1	14.6	16.2	14.5	98.9	H	H	H	H	H	H	G
89	88	M	10.1	8.8	11.8	13.7	10	12.3	12	17	12.5	89.3	H	H	F	F	E	G	E
90	89	M	15.7	15	11.8	13.7	11.9	13.5	14.4	19.3	13.6	98.2	H	H	H	H	H	H	G
91	90	F	16	14.4	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
92	91	F	8.8	10	9.3	12.2	10.3	13.1	13.5	14	13.5	85.9	G	G	F	F	F	G	E
93	92	F	7.8	8.5	9.3	8	7.3	13.1	12.7	14	11.1	75.5	G	F	E	F	E	G	D
94	93	F	12.8	13.11	12.9	14.2	12.4	13.4	13.5	16.2	14.5	97.1	H	H	H	G	F	H	G
95	94	F	10.2	7.9	12.9	14.2	10.3	11.8	13.5	16.2	13.5	92.4	H	H	F	E	F	H	E
96	95	F	11.8	11.3	12.9	14.2	11.6	13.4	13.5	16.2	14.2	96	H	H	G	G	F	H	F
97	96	M	16	15.2	11.8	13.7	11.9	13.5	14.4	19.3	15.4	100	H	H	H	H	H	H	H
98	97	M	8.8	8.11	8.2	11.7	10	12.3	12.8	17	10.1	82.1	G	G	F	F	F	G	D
99	98	M	8.4	8	8.2	11.7	10	11	9.7	17	10.1	77.7	G	G	F	E	D	G	D
100	99	M	11.5	12	11.8	13.7	10	12.3	12.8	19.3	13.2	93.1	H	H	F	F	F	H	F
101	100	F	12.8	11.9	12.9	14.2	12.4	13.4	13.5	16.2	14.5	97.1	H	H	H	G	F	H	G
102	101	M	12.1	12	11.8	13.7	11	12.3	12.8	19.3	13.2	94.1	H	H	G	F	F	H	F
103	102	F	11.6	9.8	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F
104	103	F	7.4	6.7	5.1	5.6	10.3	11.8	10.6	9	11.1	63.5	F	E	F	E	D	F	D
105	104	F	10.6	10.9	12.9	14.2	11.6	13.1	13.5	14	14.2	93.5	H	H	G	F	F	G	F
106	105	M	16	15.6	11.8	13.7	11.9	13.5	14.4	19.3	15.4	100	H	H	H	H	H	H	H
107	106	M	7.9	7.6	4.1	7.8	7.9	11	12	17	10.1	69.9	F	F	E	E	E	G	D
108	107	M	12.3	11.4	11.8	13.7	11	12.7	12.8	19.3	13.2	94.5	H	H	G	G	F	H	F
109	108	F	13.7	11.2	12.9	14.2	12.4	14.1	13.8	16.2	14.5	98.1	H	H	H	H	G	H	G
110	109	F	12.6	11.9	12.9	14.2	11.6	13.4	13.8	16.2	14.5	96.9	H	H	G	G	G	H	G
111	110	M	9.9	7.5	11.8	11.7	10	12.7	12.8	17	12.5	88.5	H	G	F	G	F	G	E
112	111	F	8.7	9.4	12.9	12.2	10.3	11.8	12.7	14	11.1	85	H	G	F	E	E	G	D
113	112	M	7.6	6.1	8.2	7.8	3.5	7	9.7	12.3	10.1	58.6	G	F	D	D	D	F	D
114	113	M	11.2	11.5	11.8	13.7	10	12.3	12.8	19.3	12.5	92.4	H	H	F	F	F	H	E
115	114	M	14.4	12.5	11.8	13.7	11.9	13.5	13.2	19.3	13.6	97	H	H	H	H	G	H	G
116	115	F	13.7	13.5	12.9	14.2	12.4	14.1	13.8	16.2	14.5	98.1	H	H	H	H	G	H	G
117	116	M	15.7	13.3	11.8	13.7	11.9	13.5	14.4	19.3	13.6	98.2	H	H	H	H	H	H	G
118	117	F	16	15.7	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
119	118	F	16	12.3	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
120	119	M	12	10.9	11.8	13.7	11	12.3	12.8	19.3	13.2	94.1	H	H	G	F	F	H	F
121	120	F	8.3	7.9	9.3	8	10.3	11.8	13.5	16.2	13.5	82.6	G	F	F	E	F	H	E
122	121	F	12.8	11.2	12.9	14.2	12.4	13.4	13.5	16.2	14.5	97.1	H	H	H	G	F	H	G
123	122	F	11.2	10.1	12.9	14.2	10.3	13.1	13.5	16.2	14.2	94.4	H	H	F	F	F	H	F
124	123	F	7.9	8.6	9.3	8	10.3	11.8	12.7	14	11.1	77.2	G	F	F	E	E	G	D
125	124	F	11.6	10.8	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F

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123	122	F	11.2	10.1	12.9	14.2	10.3	13.1	13.5	16.2	14.2	94.4	H	H	F	F	F	H	F
124	123	F	7.9	8.6	9.3	8	10.3	11.8	12.7	14	11.1	77.2	G	F	F	E	E	G	D
125	124	F	11.6	10.8	12.9	14.2	11.6	13.1	13.5	16.2	14.2	95.7	H	H	G	F	F	H	F
126	125	M	12.4	13.5	11.8	13.7	11	12.7	12.8	19.3	13.6	94.6	H	H	G	G	F	H	G
127	126	M	11.2	11.1	11.8	13.7	10	12.3	12.8	19.3	12.5	92.4	H	H	F	F	F	H	E
128	127	M	11.2	10.3	11.8	13.7	10	12.3	12.8	19.3	12.5	92.4	H	H	F	F	F	H	E
129	128	M	15.7	13.1	11.8	13.7	11.9	13.5	14.4	19.3	13.6	98.2	H	H	H	H	H	H	G
130	129	F	11.3	10.4	12.9	14.2	11.6	13.1	13.5	16.2	13.5	95	H	H	G	F	F	H	E
131	130	F	8.3	8	9.3	12.2	10.3	13.1	12.7	14	11.1	82.7	G	G	F	F	E	G	D
132	131	M	12.5	13.2	11.8	13.7	11	12.7	12.8	19.3	13.6	94.9	H	H	G	G	F	H	G
133	132	F	12	12.1	12.9	14.2	11.6	13.4	13.5	16.2	14.5	96.3	H	H	G	G	F	H	G
134	133	M	6.8	5.7	1.9	5.2	3.5	7	9.7	9.6	5.9	42.8	E	E	D	D	D	E	C
135	134	F	11.3	8.1	12.9	14.2	11.6	13.1	13.5	16.2	13.5	95	H	H	G	F	F	H	E
136	135	M	11.5	11.9	11.8	13.7	10	12.3	12.8	19.3	13.2	93.1	H	H	F	F	F	H	F
137	136	M	7.7	5.11	4.1	7.8	7.9	7	9.7	17	10.1	63.6	F	F	E	D	D	G	D
138	137	F	7.8	7.5	9.3	8	7.3	11.8	12.7	14	11.1	74.2	G	F	E	E	E	G	D
139	138	F	16	15.6	12.9	14.2	12.4	14.1	14.6	16.2	15.6	100	H	H	H	H	H	H	H
140	139	M	9	8.1	11.8	11.7	10	11	12	17	10.1	83.6	H	G	F	E	E	G	D
141																			
142																			

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