

A COMPARISON BETWEEN DENTAL MATURITY RATE IN THE SWEDISH AND KOREAN POPULATIONS USING A MODIFIED DEMIRJIAN METHOD

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ABSTRACT

Several studies have examined variations in the rate of dental development in children from different populations using the Demirjian method for age estimation in children. Most of them have shown a more or less consistent difference between the French-Canadian population, used to construct the original method, and the population studied. In most instances the Canadian population was lagging behind in the dental development, varying from a few months up to about 1 year. In an earlier study⁹ we have showed that there may be problems with the Demirjian method and a modification using a cubic regression model was suggested instead of the manually fitted original model. With this new model the rate of dental development between the Swedish and Korean populations was compared. There were highly statistically significant differences for both boys and girls, demonstrating that Swedish boys are about 2 months, and girls about 6 months earlier in their dental development at certain ages when compared to Korean children.

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Keywords: Age determination, children, dental development, ethnic groups

INTRODUCTION

Several studies¹⁻⁶ have examined variations in the rate of dental development in children from different populations using the Demirjian method for age estimation in children.^{7,8} Most of these studies have shown a more or less consistent difference between the French-Canadian population, used to construct the original method, and the population under investigation. In most studies the Canadian population was lagging behind in the dental development, varying from a few months up to about a year, especially so between the ages of 6 and 10 years.

The reason for this difference is difficult to understand. A genuine genetic difference is unlikely, since the genetic distance between for example the Scandinavian and the French-Canadian populations is otherwise not especially pronounced.

In earlier studies on age estimation of children^{4,9} it appeared that the description of the original method was not detailed enough to allow exact reproducibility, and the shape of the curves that described the relationship between age and dental maturation differed considerably at certain ages. The original method was therefore modified by introducing a mathematical model to be used instead of the

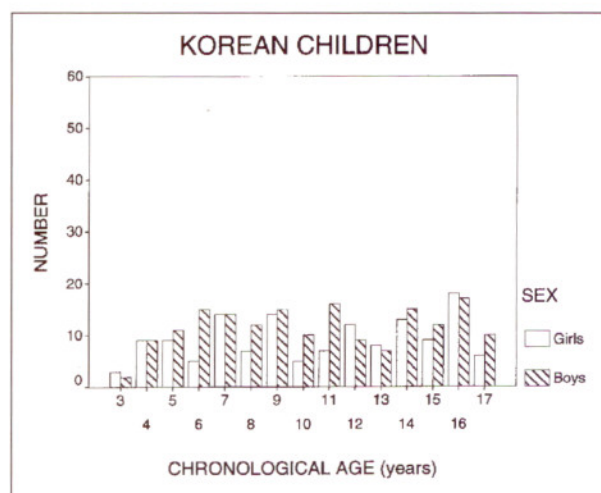
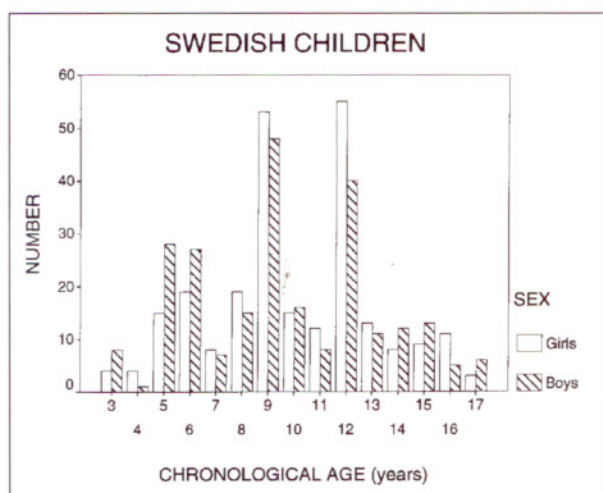
original, manually fitted, model to correlate dental development with chronological age.⁹ It was found that a cubic function gave a highly acceptable model of the relationship, which, for the first time, also makes it possible to compare different populations with regard to possible differences in the rate of dental development, with statistical methods.

The aim of this study was to compare the rate of dental development in two geographically different populations, that is Swedes and Koreans, using the modified Demirjian method.

MATERIAL AND METHODS

Dental panoramic radiographs were obtained from 485 Swedish and 310 Korean children of both genders, all being healthy and with a full set of permanent mandibular teeth.

The Swedish sample consisted of 242 girls (mean age 10.0, range 2.6 - 17.2 years) and 243 boys (mean age 9.6, range 2.8 - 17.2 years) living in various parts of the country. The sample was collected from the files of a number of specialist clinics of orthodontics or paedodontics. Part of the sample (197 individuals aged 5, 6, 9 and 12 years \pm one month) has been used previously.^{4,10,11} The additional sample,



Figs. 1a and 1b: Age and gender distributions of the Swedish and Korean children

collected from the files of the Department of Oral Radiology at the Dental School, Huddinge, Sweden, was evenly distributed by age. The samples were drawn sequentially from the files provided the child had a typical Swedish name to ensure genetic homogeneity. The age and gender distributions are shown in Fig. 1a.

The Korean sample consisted of 137 girls (mean age 10.6, range 3.0 - 17.0 years) and 173 boys (mean age 10.4, range 3.1 - 17.2 years) living in and around the city of Kwangju in the Republic of South Korea. The panoramic radiographs were collected from the files of the Dental College of Chosun University, Kwangju and age and gender distributions are shown in Fig 1b.

The radiographs were examined on a light table with the aid of a magnifying glass and a pair of callipers. The development of each tooth was compared with the radiographic images, drawings and descriptions given by Demirjian *et al.*,⁷ and given a score of A through H. This score was translated into a numerical "self-weighted score for dental development" according to the table in the updated report by Demirjian and Goldstein.⁸ These scores for the seven mandibular teeth were then added together, giving the "maturity score".

The "maturity score" was then correlated with the chronological age with the aid of a cubic function⁹ using the GraphPad Prism¹² statistical program. Comparison between maturation rates in the two

populations was made by comparing the entire curves using an F test. The F ratio was calculated using the following equation:

$$F = \frac{(SS_{\text{combined}} - SS_{\text{separate}}) / (DF_{\text{combined}} - DF_{\text{separate}})}{(SS_{\text{separate}} / DF_{\text{separate}})}$$

Where SS_{combined} is the sum of squares for the combined two populations, SS_{separate} the total of the sum of squares for each of the two populations, DF_{combined} the degree of freedom for the combined two populations, and DF_{separate} the total of the degrees of freedom for each of the two populations.

To determine the corresponding p values the F distribution was used with 4 degrees of freedom in the numerator, and 418 and 371 degrees of freedom in the denominator for boys and girls respectively.

RESULTS

Figs. 2a - 2d show the total maturity score plotted against chronological age for the two ethnic groups separated by gender. A cubic function gave an apparently good fit of the plots in both populations, and this function therefore appeared justifiable in the study.

The constants and factors of the cubic functions, separated for ethnic group and gender, are shown in Table 1 where it appears that the square of the correlation coefficient (R^2) is high, and the model explains most of the correlation. There are no differences between the two populations in this respect.

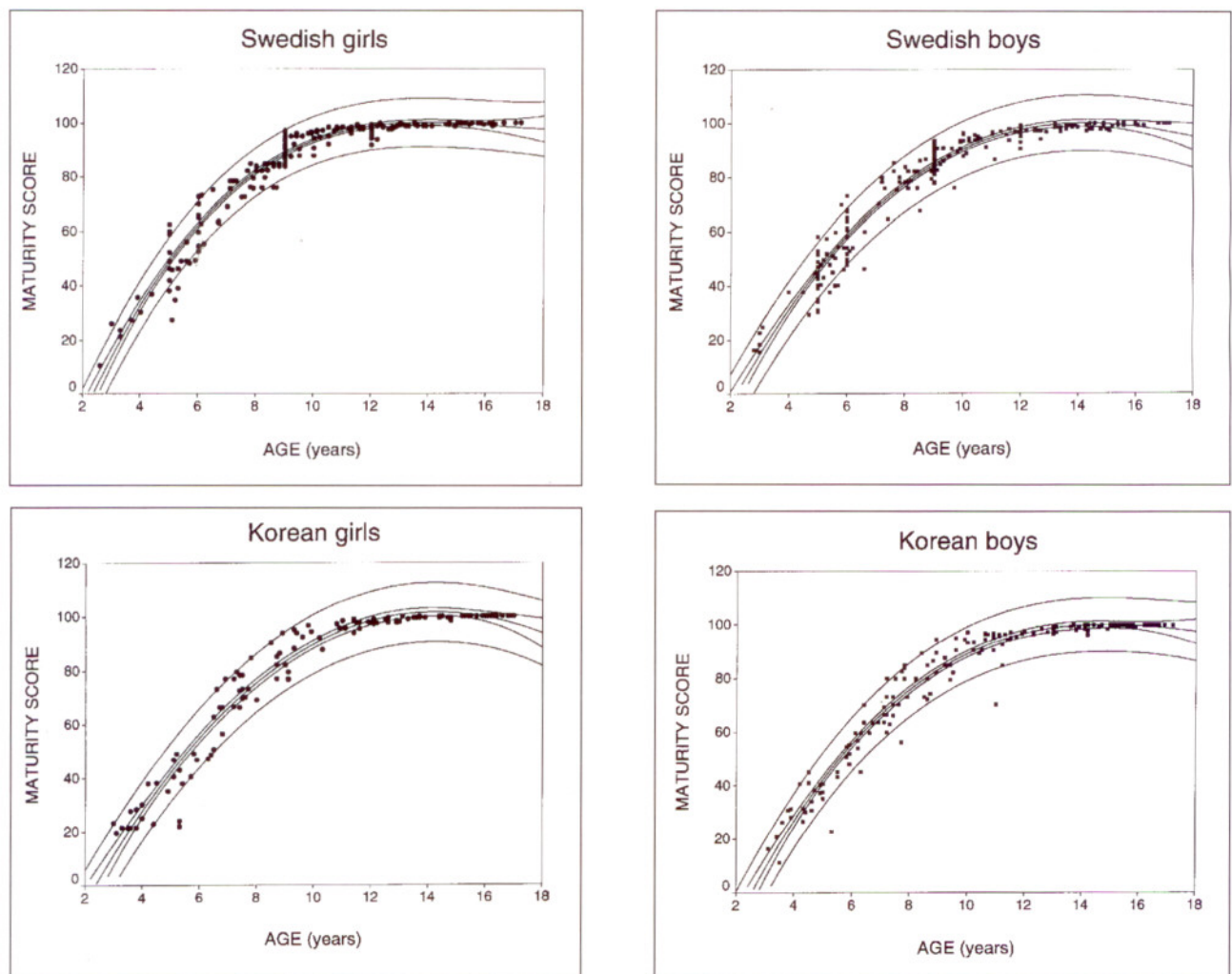


Fig 2a -2d: Scatterplots of maturity score against chronological age using a cubic function ($y = a + bx + cx^2 + dx^3$).

In Figs. 3a - 3b the plots and the corresponding regression curves for the two populations are superimposed. The regression curves for the Korean children are consistently shifted to the right of the curves of the Swedish children indicating that there is a slight general difference in the rate of dental development between the Swedish and Korean children. The Swedish boys are 1 - 2 months ahead of their Korean counterparts over all ages, whereas the Swedish girls appear to be up to 6 months ahead of the Korean girls over all ages, but especially so between the ages of 6 and 12 years.

In Figs. 4a and 4b the plots have been removed to display the regression curves together with their 95% confidence interval at group and individual levels. The F tests showed a statistically significant difference between the two populations at $p < 0.005$ ($F = 3.79$) and $p < 0.0001$ ($F = 15.97$) for boys and girls respectively.

DISCUSSION

The method by Demirjian and co-workers^{7,8} for age estimation in children was an important development when published more than 25 years ago. It has been used world-wide since then, but a series of studies¹⁻⁶ has demonstrated that the ages of the individuals in the tested populations will be regularly over-estimated, which would mean that their dental development is earlier than that of the French-Canadian children on which the method was originally constructed. These findings, together with the fact that the description of the original method is not detailed enough to allow exact reproducibility, made it important to look further into the relationship between the dental development (here described as maturity score) and chronological age. In an earlier study⁹ we found that a cubic function could be used as a model for this relationship and therefore could be suitable for the comparison of

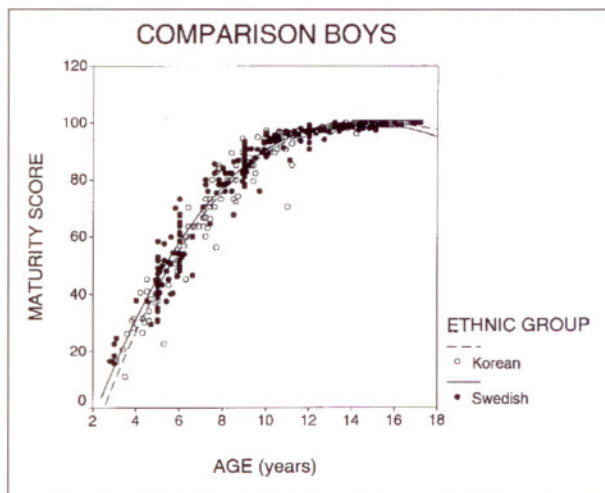
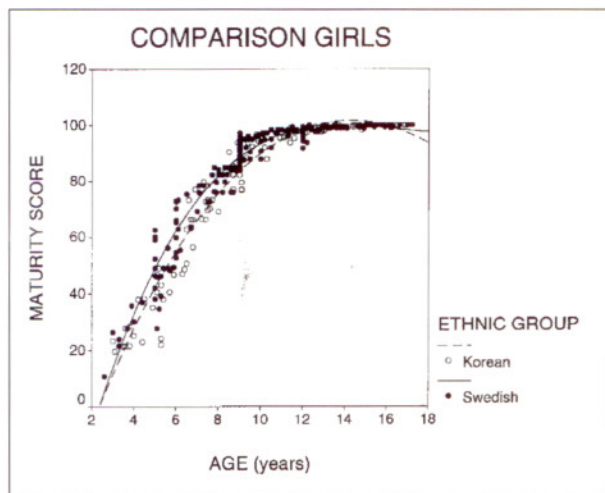


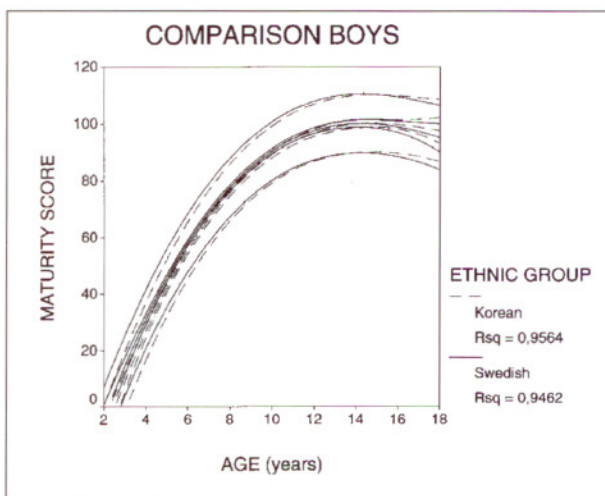
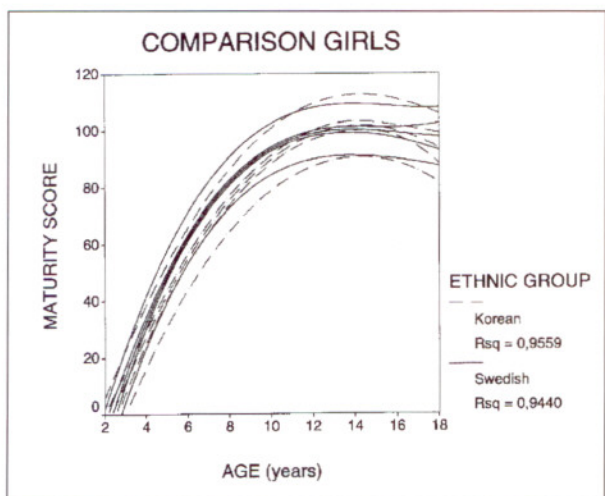
Fig.3a and 3b: Comparison of scatterplots of maturity score against chronological age for girls and boys respectively. Filled plots represent Swedish children and open plots Korean children

different populations. A model based on a mathematical function also has the advantage of describing confidence intervals around an estimate, and thus comparing different populations with established statistical methods.

It seems that the present results, using the cubic function, are scientifically better founded than are most of the results of earlier studies¹⁻⁶ using the original Demirjian method.^{7,8} For the first time differences can be examined over the whole age scale, and not only as a mean value over several years, or only at certain ages. When comparing the Swedish and Korean populations with the modified method it was found that both Swedish boys and girls are

earlier in their dental development than their Korean counterparts. The difference was only 2 – 3 months for boys, but up to half-a-year for girls, especially between the ages of 6 and 12 years.

Further studies have to confirm whether it is possible to demonstrate the difference between the French-Canadian children and most other populations with this modified method. It is possible that the shape of the maturity curve differs between populations, in which case other models have to be searched for. Unfortunately the French-Canadian population used in the original study cannot be tested since the raw data have never been published.



Figs.4a and 4b: Same as Figs.3a and b, where the individual plots have been removed to display the lines for predictions. Inner pair of lines denotes mean regression prediction and outer pair individual regression prediction at a confidence interval of 95%

Table 1:

CORRELATION TABLE: Dependant variable = maturity score, independent variable = age

Swedish	girls	.944	238	1336.79	.000	-63.683	31.683	-1.9534	.0396	4918
Korean	girls	.956	133	960.47	.000	-49.043	23.0579	-1.0121	.0095	4006
Swedish	boys	.946	239	1401.23	.000	-49.486	25.1161	-1.3161	.0204	6500
Korean	boys	.956	169	1235.64	.000	-60.314	27.3991	-1.5056	.0261	4318
Combined populations	girls	.942	375							10460
	boys	.949	412							11220

It seems unlikely that the difference, although statistically significant, between populations would be particularly important at individual level, since the individual variation is so large that it may mask smaller ethnic differences. It has been shown¹⁰ that there are individual variations of up to two years around a certain stage of development, and on the other hand, that the developmental stage (on the scale A through H) of an individual tooth may vary up to five stages at a certain age.

In conclusion, using a cubic function to describe the relationship between dental development and chronological age, it seems that there are only minor, although statistically highly significant, differences in the rate of dental development between Swedish and Korean children. The Swedish girls seem to be, on average, six months ahead of the Korean girls between the ages of 6 and 12 years, and the boys a couple of months earlier. However, these ethnic differences are much smaller than the individual variations within the populations.

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