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Age estimation using Olze's method in an adult Brazilian population

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ABSTRACT

Objectives: Age estimation is important to set an anthropological profile in human remains, as well as in legal issues where the suspect or victim doesn't have documents that prove the real age. The age estimation, in adults, is a challenge, and it can be analyzed through some dental stages. This study aimed to test Olze's method in a Brazilian sample composed by adults, aged between 20 and 70 years old, both sex.
Methods: For experiments, 306 orthopantomography from Brazilian individuals between 20 and 70 years were selected. The dental involution through four different dental parameters were classified and the correlation between chronological age and the estimated age was examined by means of a multiple regression analysis.
Results: The results showed that up to 41 years old, the correlation between real age and the interval obtained was considered strongly positive (R = 0.8–1), and the percentage of matching was 78.78% for men and 71.21% for women. From 42 years old up, the correlation between real age and the estimation was considered null (R = 0) for both sex, and the percentage of matching was 17.24% for men and 6.89% for women.
Conclusion: It could be concluded that the method is effective for age estimation up to 41 years old, but has limitations to be used over this age in Brazilian people.

1. Introduction

Human identification involves constructing information regarding gender and age estimation, and each of them comprises specific methods and techniques used by the experts to set the anthropological profile.[1] And, when there is no information about age, it is necessary to use specific methods.

Age estimation methods in Dentistry are those that use direct (extracted teeth, histological analysis)[2] and indirect (x-rays and CTs)[3] exams. The main criterion used to estimate age in living people is the mineralization degree and teeth eruption. However, in older adults, this method is not effective, because all teeth are already formed and in position. It is known that teeth change naturally as the years go by, and these regressive changes (dental eruption, mineralization, and eruption)[4–6] can be used as parameters for age estimation.

The earliest scientific method on age estimation in adults was proposed by Gustafson,[7] using a formula to score, in a qualitative way, age related to dental changes, through histological analysis, which makes it impossible to be used in healthy teeth. Olze et al.[8] adapted Gustafson's method applying an indirect analysis through orthopantomography, using lower premolars, specifically in German population. So, this study aimed to test Olze's method for age estimation in a Brazilian sample.

2. Methods

The total sample comprised n = 306 orthopantomography from Brazilian individuals between 20 and 70 years old where 3 radiographs were selected for each age, equally divided in n = 153 men and n = 153 women. The x-ray images were obtained from the Laboratory of Analysis and Control of Dental Radiographic Images (USP – School of Dentistry of Ribeirão Preto).

The sample selection was performed by a Radiology Specialist. The inclusion criterion was the presence of lower premolar, at least one, and the exclusion criteria were low-quality images or the absence of all lower premolars. In this study, the exclusion criteria followed the proposal by Matsikidis[9]: crowned tooth or bridge abutment, filling,

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Table 1
Stage Classifications proposed by Olze et al.'s method.

Criteria stage	Secondary dentin formation	Cementum apposition	Periodontal recession	Attrition
0	Pulp horn reaches to above crown equator	No visible cementum apposition	No periodontal recession	No attrition, cusp tips present
1	Pulp horn reaches at maximum to crown equator	Beginning apical cementum apposition	Periodontal recession into cervical root third	Beginning attrition with loss of cusp tips
2	Pulp horn exceeds enamel–cementum boundary and falls short of crown equator	Clearly visible cementum apposition, reaching beyond the apex	Periodontal recession into middle root third	Attrition reaching into dentin
3	Pulp horn reaches at maximum to enamel–cementum boundary		Periodontal recession into apical root third	Attrition reaching into dentin with opening of pulp cavity

partial crown or inlay, post and core restoration, carious lesion, root filling, infected tooth, impacted tooth, retained root, apicectomy and attrition, orthodontic treatment, others pathologies affecting teeth and crown fracture. And, in order to avoid bias, the examiner did not have access to previous information related to birth or the sex, and the evaluation of the x-rays was performed in a randomized way.

Prior to the method application, the examiner received an intensive training in the Olze's method and the calibration procedure through a prior test was conducted, where 15 images including situations and possible scores were randomly analyzed, using the standard images available in the original paper.[8]

The method used was proposed by Olze et al.,[8] which takes into consideration the dental involution through four different dental parameters, scoring from 0 to 3: (I) formation of secondary dentine, (II) cement apposition, (III) periodontal recession, and (IV) attrition, which are based on the original study conducted by Gustafson,[7] adjusted for use in panoramic x-rays. The following stage classifications were used according to Table 1.

The correlation between chronological age and the estimated age was examined by means of a multiple regression analysis, with the same formulas proposed by Olze et al. for each sex were used according to the teeth used (lower first and second premolars), the completion of the formula according to each stage observed for each parameter according to Tables 2 and 3.

The intra-observer agreement, was also assessed and for this, 92 images (30% of the sample) were randomly selected and reevaluated by the examiner. The statistical analysis was performed using Pearson's correlation and multiple regression analysis obtained using different equations. Statistical analysis was performed using the SPSS software for Windows, version 12.0 (SPSS, Inc, Chicago, IL, USA), with significance level was set at 5%.

3. Results

The values obtained using the recommended formulas estimate the minimum and the maximum age. The first analysis of the results observed the correlation between the interval generated by the multiple regression analysis, and compared it to the real age of the research subjects, as shown in Figs. 1 and 2. It could be seen that, for both sex, the correlation between real age and the estimated age interval obtained by the method was considered strongly positive (R = 0.8–1) until the age of 41 (p = 0.001); from 42 to 70 years old, the correlation was considered null (R = 70) for both sex (p = 0.351).

Table 2
Regression equations, correlation coefficients (R), coefficients of determination (R2) and standard errors of estimate of multiple regression analyses with age as the dependent variable and dental age changes as independent variables for teeth 34, 35, 44 and 45, females.

Tooth	Formula	R	R^2	Standard error of estimate
34	Age = 18,21 + 3161 × CE + 2,4 × SE + 4448 × PE + 4,05 × AT	0,67	0,44	5,7
35	Age = 17,61 + 2596 × CE + 3065 × SE + 5031 × PE + 2,687× AT	0,68	0,47	5,5
44	Age = 19,11 + 2596 × CE + 2667 × SE + 4,3 × PE + 3,3 × AT	0,65	0,43	5,7
45	Age = 17,64 + 3336 × CE + 3161 × SE + 4722 × PE + 2943 × AT	0,69	0,48	5,4

Table 3
Regression equations, correlation coefficients (R), coefficients of determination (R2) and standard errors of estimate of multiple regression analyses with age as the dependent variable and dental age changes as independent variables for teeth 34, 35, 44 and 45, males.

Tooth	Formula	R	R^2	Standard error of estimate
34	Age = 18,43 + 1131 × CE + 4,19 × SE + 5202 × PE + 2881 × AT	0,70	0,48	5,4
35	Age = 18 + 1905 × CE + 3662 × SE + 5011 × PE + 3003 × AT	0,70	0,49	5,4
44	Age = 18,69 + 1292 × CE + 3813 × SE + 5533 × PE + 3,14 × AT	0,72	0,52	5,5
45	Age = 18,28 + 2018 × CE + 3185 × SE + 5433 × PE + 2879 × AT	0,73	0,53	5,3

When all the men's radiographs (n = 153) were analyzed, the percentage of matching was 43.79% (n = 67), and in regards to the women's radiographs (n = 153), the percentage of matching was 34.64% (n = 53). For males between 20 and 41 years old (n = 66), the Pearson's coefficient indicated strongly positive correlation, and the matching percentage was higher, 78.78% (n = 52). Above 41 years old for males (n = 87), the matching percentage was low, 17.24% (n = 15). For females between 20 and 41 years old (n = 66), the Pearson's coefficient indicated strongly positive correlation, and the matching percentage was higher, 71.21% (n = 47). Above 41 years old for females (n = 87), the matching percentage was low, 6.84% (n = 6).

When the mean statistical analysis was performed, there was no direct correlation between mean age and real age in both gender, being p = 0.195 for males and p = 0.297 for females. It could be observed that, for the male analysis, 86% of the means were below the real age, whereas for the female, they were 66%. The means were distributed as follows (Table 4). And regards to the agreement between intra observer analyses using Kappa test, the results were considered substantial (0.61–0.80).

4. Discussion

Gustafson's method[7] uses features as attrition, secondary dentine deposition, periodontitis, root reabsorption and translucence. Some of these factors have been studied, in isolated ways or in clusters,[8–12] and according to Reppien et al.,[14] it is still being used for age estimation and presents good results. Lucy and Pollard[13] says that there is an urgent need for a more rigorous study of the traits first tabulated by Gustafson and it's difficult to replicate the method because Gustafson didn't published all his data.

Another limitation of Gustafon's method is the required direct clinical examination.[7] Comparing adult age estimation methods, Sommer et al.[15] concluded that the ones that use extracted teeth are

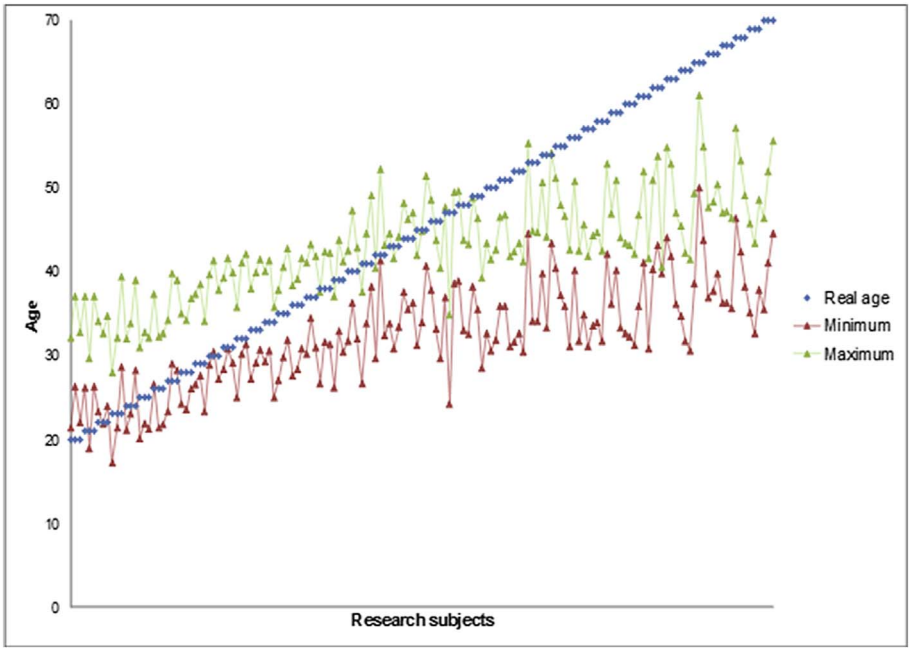

Fig. 1. Distribution of intervals and real age of all radiographs of males.

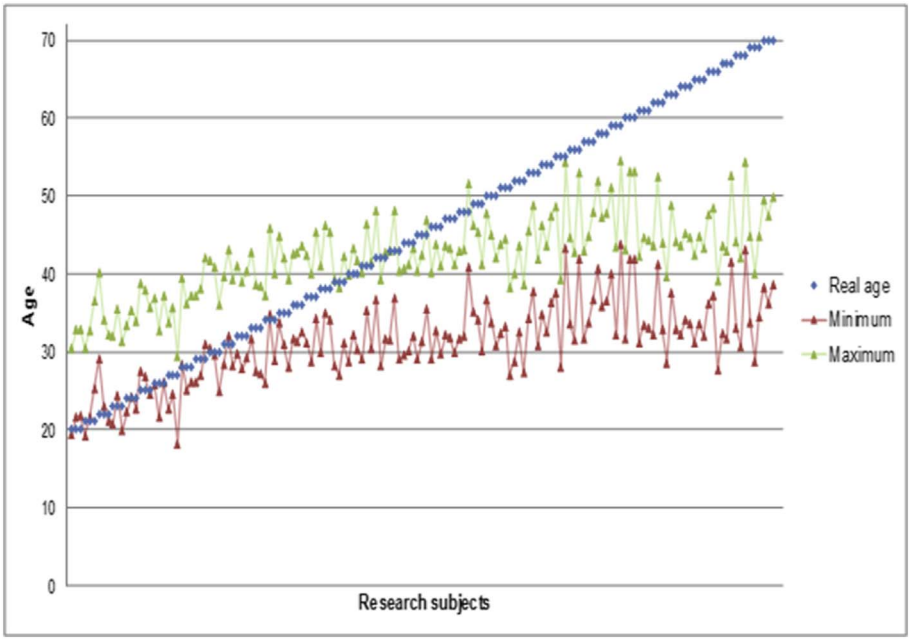

Fig. 2. Distribution of intervals and real age of all radiographs of females.

Table 4
Distribution of medians regarding real age.

Interval	Radiographs (n)	Above real age n (%)	Below real age n (%)
Male 20 a 41 years	66	46 (69.69%)	20 (30.3%)
Male 42 a 70 years	87	2 (2.29%)	85 (97.7%)
Female 20 a 41 years	66	50 (75.75%)	16 (24.24%)
Female 42 a 70 years	87	1 (1.14%)	86 (98.85%)

more reliable than the ones that do not. However, extracting teeth from individuals who have healthy teeth is not feasible. So, Olze et al.[8] proposed to modify Gustafson's method, through orthopantomography analysis, assessing only lower premolars, because some studies show that these teeth present a better relation to real age when compared with other dental groups.

Regarding dental involution analysis, the use of mandibular premolar is suggested because they are predominantly single-rooted teeth and have a large pulp area, and, due to the spinal column projection in the anterior region expected in panoramic radiographs, the pre-molars were the teeth chosen in Olze's method.[8]

In our results, it could be seen that from 20 to 41 years old, the method is effective when using the interval obtained. However, the analysis of the medians showed no correlation with real age. Above 42 years old, there was no correlation between the intervals and real age, and the number of matching was lower for both sexes. Luca[16] says that

these results can be explained because age estimation methods tend to be more reliable when applied to younger people, due to low individual variability of morphologic traits in children and young adults.

Corroborating our results, Liversidge et al.[17] found a low level of agreement in people older than 45 years old, due to human nature senescence. Bajpai et al.[18] tested both formulas in a five groups study with known age, including people from 21 to 70 years old, and they found significant results for all studied groups ($p < 0.001$), except in the experimental group from 61 to 70 years old. Other findings often seen in studies,[19–22] which also agree with the present research, are that underestimated ages are common in older individuals, and in our study, 98.85% of women older than 42 years old had their age underestimated (Table 4). Timme et al.[23] used Olze's method to prove the applicability and reliability of this method with a large cohort and a wide age range, including older individuals, and found that the method is feasible and reliable for dental age estimation in people up to 40 years old, but for age estimations concerning older age, the method appears to be inaccurate.

Originally, Olze's[8] method was developed and tested in German people, aged 15-40, but Timme et al.[23] studied German people to validated Olze's method in older people (aged 15-70) they showed a more precise regression formulae for their population and they suggested that the research should investigate the influence of ethnicity, dietary habits and modern health care on the degenerative characteristics in question. Our study was carried out using Olze's formulas[8] in Brazilian people aged from 20 to 70 years old, which could explain the high percentage of mismatch age estimation in elderly people. This factor can be found in some studies that apply formulas of methods created for populations different from the analyzed ones.[20,24,25]

5. Conclusion

It could be concluded that Olze's method, in Brazilian sample, is reliable when applied to individuals up to 41 years old of age, both sexes, although after 42 years old, the results showed that the method is inaccurate.

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