Estimation of age-at-death in adults and validation of a forensic international methodology using single-rooted teeth: A preliminary Latin-American approach.

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INTRODUCTION

In forensic sciences, age estimation during the identification process of deceased individuals is a type of information that contributes, but is not limited to, the classification of possible candidate bodies for the individualization of corpses against a lists of missing persons, as well as to the corroboration of genetic information in case of presumed false positives, or the construction of demographic profiles after the discovery of human remains in a massive manner. In adults, biological age can be estimated from the degenerative changes that occur in the skeletal system over the years. Root Dentin Translucency (RDT) is a dentinal degenerative process that appears since the young adulthood as a result of the accumulation of hydroxyapatite crystals in the dentinal tubules. Lamendin's technique (Lamendin et al., 1992) is a procedure that quantifies RDT and periodontal regression in order to develop an age estimation method in adults.

Lamendin technique was introduced in the Latin American context at the beginning of the 2000's in countries such as Argentina, Colombia and Guatemala; since then, this technique became popular in several other Latin American countries such as Peru, Honduras, Mexico and Brazil. Recently, Parra et al. (2020) developed a Bayesian regression model using Lamendin technique from a database of 693 individuals from different populations around the world. In their proposal, the authors focus on a methodology that is applicable in different contexts and situations.

OBJECTIVE

This investigation aims to verify the levels of applicability of the international model developed by Parra et al., (2020) and to compare it with the results obtained from other two methods, using samples from different Latinoamerican countries.

MATERIALS AND METHODS

The sample consist of individuals of known age and sex from six Latin American countries. The ages of the individuals vary between 18 and 96 years old, with an average age of 46.68 years and a standard deviation of 17.44 years. Table 1 shows the distribution of the sample (N=596) by sex, according to the country of origin.

Table 1. Distribution by sex and country of origin.

	Sex					
		Female		Male		Total
Country of origin	n	%	n	%	n	%
Argentina	60	10,07	82	13,76	142	23,83
Colombia	36	6,04	114	19,13	150	25,17
Perú	41	6,88	113	18,96	154	25,84
Ecuador	30	5,03	50	8,39	80	13,42
Guatemala	18	3,02	2	0,34	20	3,36
México	28	4,70	22	3,69	50	8,39
Total	213	35,74	383	64,26	596	100,00

The measurements of the variables were made following the technique of Lamendin et al. (1992). All measurements were made using a digital caliper (with values expressed in millimetres).

The degree of correlation between dental variables and chronological age was evaluated. For the estimation of age, Lamendin et al. (1992) [LBHTNZ], Prince y Ubelaker (2002) [PU], and the proposal based on a bayesian model developed by Parra et al. (2020) [FIDB], were applied. Estimated age and chronological age were compared to evaluate the difference in the estimations. Subsequently, the analysis was divided considering sex, age and dental surface (labial or lingual) to assess the impact of these factors on the estimates. The significance level used in all statistical tests was 0.05.

The calculation of the method by Parra et al., (2020) (See Fig.1.) was carried out using System R version 4.0.1. IBM SPSS version 25 was used for data processing and statistical analysis.

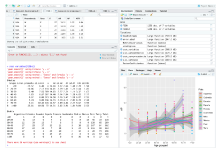

Fig. 1. Forensic International Databank (FIDB).

RESULTS

Spearman's correlation coefficient reported that RDT and PR correlated significantly with age (RDT=0,660 and PR=0,517)

The results of the analysis provided statistically significant differences for the results of the three methods between the estimated and the documented ages. The mean age differences were 4.28 (FIDB), 2.18 (LBHTNZ) and 1.28 (PU) years (Table 2). On the other hand, the absolute mean error in the estimates were 9.81 (FIDB), 9.64 (LBHTNZ) y 9.42 (PU) years.

Table 2.					Wilcoxon signed-Rank test		
	Dif.	S.D Dif.	Dif. Abs.	S.D. Dif Abs.	z	gl	p
FIDB	4,28	12.78	9.81	8.32	-9.04	595	0.00*
LBHTNZ	2,18	13.33	9.64	8.15	-4.23	595	0.00*
PU	1,28	13.13	9.42	7.85	-2.68	595	0.00*

Table 2. Comparison between estimated age and documented age for the analyzed methods.

Regarding the influence of sex on estimates, the comparisons did not show any statistically significant differences (Table 3).

Table 3.		Wilcoxon signed-Rank test		
	Dif.	z	gl	p
FIDB	-0.79	-1.49	596	0.13
LBHTNZ	-1.85	-0.89	596	0.37
PU	-1.89	-1.64	596	0.10

Table 3. Comparison of errors in the estimates between sexes.

No differences were found between estimates obtained with the measurements taken on the labial or lingual surface, except for Lamendin method (Table 4).

Table 4.				Wilcoxon signed-Rank test		
	Mean estimated age	Dif.	S.D Dif.	z	gl	p
FIDB Lingual – FIDB Labial	39.26 38.59	0.67	4.54	1.56	245	0.11
LBHTNZ Lingual – LBHTNZ Labial	41.84 41.24	0.60	3.11	2.29	245	0.02*
PU Lingual – PU Labial	42.90 42.44	0.46	3.27	1.63	245	0.10

Table 4. Comparison of errors in the estimates between labial and lingual surface.

RESULTS

Only the proposals developed by Parra et al. (2020) in the 30-39 age group did not yield statistically significant differences between the estimated age and the chronological age. (Table 5).

Table 5.							Wilcoxon signed-Rank test		
		n	Dif.	S.D Dif.	Abs. Dif.	S.D. Dif Abs.	z	gl	p
<29	FIDB	106	-6.18	7.66	7.51	6.34	6.94	106	0.00*
	LBHTNZ	106	-11.31	5.30	11.31	5.29	8.93	106	0.00*
	PU	106	-12.05	5.32	12.05	5.2	8.93	106	0.00*
30-39	FIDB	124	-0.56	7.71	6.36	4.35	0.43	124	0.66
	LBHTNZ	124	-4.66	5.27	5.54	4.32	7.71	124	0.00*
	PU	124	-5.45	5.37	6.09	4.69	8.41	124	0.00*
40-49	FIDB	144	3.82	8.43	7.30	5.65	-6.05	144	0.00*
	LBHTNZ	144	1.64	6.09	4.85	4.02	-4.76	144	0.00*
	PU	144	0.87	5.93	4.48	3.96	-3.37	144	0.00*
50-59	FIDB	92	7.14	8.80	9.53	6.10	-6.38	92	0.00*
	LBHTNZ	92	6.67	6.99	8.36	4.82	-6.66	92	0.00*
	PU	92	5.91	6.68	7.66	4.54	-6.49	92	0.00*
60-69	FIDB	51	14.77	12.29	16.97	8.94	-5.65	46	0.00*
	LBHTNZ	51	15.79	8.57	16.49	7.12	-6.08	46	0.00*
	PU	51	14.38	8.82	15.38	6.89	-5.81	46	0.00*
70-79	FIDB	46	13.37	13.37	20.41	8.92	-5.31	45	0.00*
	LBHTNZ	46	21.92	7.67	21.92	7.67	-5.90	45	0.00*
	PU	46	20.52	8.06	20.25	8.06	-5.90	45	0.00*
>80	FIDB	33	28.36	9.14	28.36	9.14	-5.01	32	0.00*
	LBHTNZ	33	31.33	6.76	31.33	6.76	-5.01	32	0.00*
	PU	33	30.11	6.93	30.11	6.93	-5.01	32	0.00*

Statistically significant differences between the estimated age and the chronological age were found for all methods except for the LBHTNZ and PU methods in the Colombian sample, PU in the Peruvian sample, and all three methods in the Guatemalan sample (Table 6).

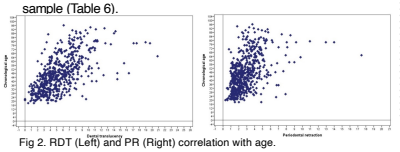

Fig 2. RDT (Left) and PR (Right) correlation with age.

RESULTS

Table 6. Results of the comparisons between estimated age and documented age for each method in the analyzed samples.

Table 6		n	Dif.	S.D Dif.	Abs. Dif.	S.D. Dif Abs	Wilcoxon signed-Rank test		
							z	gl	p
Argentina	FIDB	142	10.31	16.03	15.96	10.52	-6.47	142	0.00*
	LBHTNZ	142	10.94	16.38	16.53	10.67	-6.57	142	0.00*
	PU	142	9.56	16.49	15.84	10.53	-5.94	142	0.00*
Colombia	FIDB	150	3.85	13.70	10.65	9.40	-2.24	150	0.02*
	LBHTNZ	150	2.50	15.30	12.38	9.27	-0.87	150	0.38
	PU	150	1.53	14.97	12.13	8.84	-0.36	150	0.71
Peru	FIDB	154	6.65	7.29	7.87	5.95	-8.70	154	0.00*
	LBHTNZ	154	2.31	7.77	6.27	5.11	-3.05	154	0.00*
	PU	154	1.29	7.74	6.17	4.82	-1.53	154	0.12
Ecuador	FIDB	80	5.67	4.87	6.36	3.93	-7.00	80	0.00*
	LBHTNZ	80	1.87	4.02	3.74	2.34	-3.59	80	0.00*
	PU	80	1.89	4.24	3.90	2.49	-3.69	80	0.00*
Guatemala	FIDB	20	-0.16	9.80	7.83	5.56	0.41	20	0.68
	LBHTNZ	20	-2.22	10.86	9.67	4.96	0.89	20	0.37
	PU	20	-3.00	10.27	9.47	4.55	1.23	20	0.21
México	FIDB	50	-10.51	8.98	10.59	8.88	6.08	50	0.00*
	LBHTNZ	50	-9.43	7.62	11.50	3.71	5.08	50	0.00*
	PU	50	-10.12	6.70	11.41	4.08	5.81	50	0.00*

DISCUSSION & CONCLUSION

- Although significant differences were observed between the estimated and documented ages, the errors reported in the estimates support the use of these methods in individuals aged 30-59.
- This work reaffirms that the conditions of the sex and the lingual/labial surface of the teeth have no statistically significant influence on the estimation of age using FIDB.
- Due to the "trajectory effect", in this research the overestimation of age is slight in individuals under 29 and the underestimation of age in adults over 60 persists, which is reduced by FIDB in comparison with the other procedures. FIDB shows favorable results for application in Latin America.

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REFERENCES AVAILABLE UPON REQUEST

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