Child brides: the age estimation problem in young girls

Roberto Cameriere[1], Luz A. Velandia Palacio[1], Marco Marchetti[2], Francesca Baralla[2], Mario Cingolani[3], Luigi Ferrante[4]

[1] AgEstimation Project, Macerata Italy,
[2] Department of Medicine and Health Sciences, University of Molise, Campobasso, Italy
[3] University of Macerata, Macerata, Italy,
[4] Department of Biomedical Sciences and Public Health, Polytechnic University of Marche, Ancona, Italy.

Corresponding author: luza98@gmail.com

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KEYWORDS

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ABSTRACT

The aim of this work is to study a sample of girls from 15 different countries using Third Molar Maturity Index (I_{3M}), to assess the probability that a girl has reached the legal age of 18 years. The studied sample consisted of 3228 Orthopantomograms of healthy female subjects from 15 different countries. The cut-off value of I_{3M} = 0.08 was tested to discriminate adults (≥18 years) and minors (<18 years). X-ray images were processed by computer-aided drafting program ImageJ. The information on sensitivity and specificity of I_{3M} coming from the 15 countries was pooled together using a bivariate Bayesian modeling approach. Specificity of the I_{3M} test did not change when the country was considered, and its value remains greater than 85% for each studied country. This method is useful to estimate the age of the girls involved in suspected early marriage because of the high probability of correctly identifying a minor with similar results observed among tested populations.

INTRODUCTION

There is an increasing need in estimating age for forensic purposes in recent years due to illegal immigration that not only affects Europe but countries such as the United States and more recently countries in South America such as Argentina and Colombia.[1] In this case subjects without documents can claim to be older or younger than their actual age, proof of being under or over the legally defined age limits is a requirement for several legal decisions including social benefits and protection of rights. When it is not possible to ascertain the given age of an individual, authorities can request a medical age assessment issued by an expert.[2]

According to the United Nations Children's Fund (UNICEF), 230 million children under the age of 5 still have not been registered [3] and 2018 statistics from the World Bank estimated that one billion people around the world struggle to prove who they are due to a lack of legal identification.[4]

The information suggests that this is not always the result of document falsification, but opportunistic fabrication as well. For this reason, the choice of using not only radiographic methods but interviews and social history reconstruction have prevailed to estimate whether adolescents have reached legal age.[5]

To an equal extent, the issue of a lack of documents is linked to a high number of people modifying their age in order to work in competitive sports, practising prostitution or marriage.[6,7] This last phenomenon is more commonplace than would be

expected. Child marriage is defined by UNICEF as any formal marriage or informal union where one or both of the parties are under 18 years of age.[8] According to this organization, 12 million under-age girls are married every year. This is recognized as a global problem that cuts across countries, cultures, religions and ethnicities. It is not uncommon to find child brides in every region of the world.[9]

Figures from UNICEF show that in Bangladesh only 20% of children under the age of 5 are registered and 59% of women aged 20-24 years were married or in union by age 18. In Niger 64% of children under the age of 5 are registered, and 76% of women are married by age 18. In Chad only 12% of children under the age of 5 are registered, while 67% of women are married by age 18.[10,11] Although there is not a direct relationship in every country, it is evident that a lack of coverage on birth registration favours and facilitates the practice of child marriage.

Clearly there is a need to address the cultural choices that lead to these precocious marriages. However, in cases where the country has a clear legislation forbidding this practice, what is mainly required is to have the means of knowing even an approximate age of the girl. Legal age is typically reached at 18 years around the world. [12]

There are several methods that can be used to ascertain adulthood, however of the three most common - those being skeletal, psychological, and dental estimations - the latter has proven to be the most reliable. [13-15]

In 2008 Cameriere et al developed a method named The Third Molar Index (I_{3M}) for age estimation by observing the formation and closure of the apex of the third molar and established a cut-off value of 0.08 that has been tested in several populations.[16]

The aim of this work is to study a sample of girls from 15 different countries using I_{3M} to assess the probability that a girl has reached the legal age of 18 years old or not.

MATERIAL AND METHODS

The studied sample consisted of 3228 healthy female subjects from 15 countries (AL = Albania; AUS= Australia; CHN= China; CO= Colombia; DOM= Dominican Republic, ET= Egypt; F = France; I=Italy ; IND=India ; J= Japan; PL = Polonia; RCH= Chile; SRB= Serbia; TR=Turkey; ZA= South Africa) from whom a panoramic radiograph was collected (Table 1).

The inclusion criteria were as follows: age between 14 and 24 years at the time the panoramic radiographs were obtained, good-quality radiographs, and healthy subjects with known precise age and free of systemic disorders. The exclusion criteria were as follows: unclear radiographs or with radiographic distortion, gross pathology or history of orthodontic treatment, subjects of unknown age or without full dental records, and those with no third molars or third molars with developmental anomalies. Patient data was recorded in an excel file, recording patients' identification number, sex, date of birth, and date of the X- rays. The CA (chronological age) for each subject was calculated by subtracting the date of the X-rays from the date of birth and converted into decimal ages. The study was carried out in accordance with the ethical standards laid down by the Declaration of Helsinki (Finland).[17]

Measurements

As already proposed by Cameriere et al.[16] the dental maturity index (I_{3M}) of the left lower third molar was evaluated.

If the apices of the third molar were completely closed, I_{3M} is equal to = 0; if the apices were not completely closed, the sum of the distance between the inner part of the two apices are divided by the length of the third molar. The cut-off value of I_{3M} = 0.08 was tested to discriminate adults (≥18 years) and minors (<18 years). X-ray images were processed by computer-aided drafting program ImageJ.

Statistical analysis

In this work we combine the information on sensitivity and specificity of the Cameriere's test from the 15 countries pooling them using a bivariate Bayesian modeling approach.[18]

RESULTS

The frequency distribution of the individuals among the countries shows a minimum of 58 females from Australia and a maximum of 499 from South Africa (Table 1).

Table 1. Frequency distribution of individuals among the considered countries

country	AL	AUS	CHN	CO	DOM	ET	F	I	IND	J	PL	RCH	SRB	TR	ZA
frequency	152	58	99	161	285	135	85	315	114	134	435	330	271	155	499

The age distribution in the sample is almost homogeneous in the range 14 – 24 years (Table 2). On the contrary, about 45% of the individuals belong to the first I_{3M} interval [0, 0.08]. This result can be explained by considering that the first class includes all females with closed apices which are about 31% of the sample. Using the Bayesian model, we obtained a pooled estimate for both sensitivity and specificity of the test (Table 3).

Table 2. I_{3M} values and age distributions of the overall sample. The age classes are closed on the left while I_{3M} classes are closed on the right. The first class of I_{3M} is closed both on the left and right.

Age(years)						
I_{3M}	[14,16)	[16,18)	[18,20)	[20,22)	[22,25)	total
[0,0.08]	13	61	401	600	391	1466
(0.08,0.22]	90	250	141	48	16	545
(0.22,0.4]	160	186	52	28	5	431
(0.4,0.7]	188	157	38	5	0	388
(0.7,1]	157	94	19	5	0	275
(1,4.8]	81	32	6	2	2	123
total	689	780	657	688	414	3228

There is a significant difference in the sensitivity distribution among the countries; for example, France and Italy show a significant lower sensitivity**.**

On the contrary, specificity of Cameriere's test does not change when the country is considered, and its value remains greater than 85% for each considered country. Its value is greater than 90% in Albania, China, Dominican Republic, Italy, India, Serbia and Turkey. A pooled analysis of the studies allowed us to summarize sensitivity and specificity of I_{3M} method as reported in Table 3.

Combining the considered studies, we obtained the sensitivity a pooled estimate for the median of 79% ($Q_{2.5\%}$ =71%; $Q_{97.5\%}$ =85%) and for the specificity a pooled median of 96% ($Q_{2.5\%}$ =93%; $Q_{97.5\%}$ =99%).

DISCUSSION

Age estimation is required to confront several social issues in many countries however despite the different situations in which estimating 18 years old is needed, it is illegal immigration which is considered most important.

To address these issues, Cameriere published several articles with samples from different countries studying the third molar through I_{3M}. [16] The results yielded by this research have been positive to the extent of attempts to establish it as regular practice used by professionals.

As in cases of illegal immigration, there are other situations that require the assistance of forensic dentistry in the determination of adult age. One of these is the problem of child brides. It is a cultural issue of great importance that sometimes clashes with national laws. In fact, some countries even allow marriage between minors[10,12,19]

Table 3. Quantile of order 2.5%, 50% (median) and 97.5% of the sensitivity and specificity distribution for each considered country.

	Sensitivity			**Specificity**		
country	$Q_{2.5\%}$	$Q_{50.0\%}$	$Q_{97.5\%}$	$Q_{2.5\%}$	$Q_{50.0\%}$	$Q_{97.5\%}$
AL	66%	76%	85%	92%	96%	98%
AUS	70%	83%	92%	85%	94%	97%
CHN	66%	76%	84%	92%	97%	99%
CO	86%	93%	97%	90%	95%	98%
DOM	85%	90%	94%	95%	98%	99%
ET	72%	81%	87%	90%	96%	98%
F	32%	47%	62%	87%	94%	98%
I	57%	65%	72%	93%	96%	99%
IND	69%	80%	88%	91%	95%	98%
J	70%	78%	85%	87%	94%	98%
PL	78%	82%	86%	90%	94%	97%
RCH	55%	63%	71%	86%	91%	94%
SRB	80%	86%	90%	93%	97%	99%
TR	78%	85%	92%	94%	98%	100%
ZA	76%	82%	86%	93%	96%	97%
pool	71%	79%	85%	93%	95%	97%

In reviewing the many factors that influence early marriage, it stands out how the lack of birth registration facilitates the persistence of the problem. As observed by the Committee on the Elimination of Discrimination against Women (CEDAW), birth registration is an important factor that can support the effective implementation and enforcement of laws on the minimum age of marriage.[7] The lack of reliable documents or birth certificate poses an overwhelming challenge even in countries where the legal age for marriage is 18 years. Without the means to estimate this, these girls cannot be protected by the law.

This study has shown how the use of the I_{3M} method, when third molar is present, can be a

practical and reliable way of estimating adult age. When applying the test in the samples from 15 different countries there were not significant differences in correctly classified minors that could be associated to ethnicity or the country of origin. In fact, the specificity, number of correctly classified minors, displayed a homogeneous result with a minimum value of 91% from the Chilean sample and a maximum of 98% from Dominican Republic without evidencing a trend linked to the place of origin.

There can be different causes for the heterogeneity of specificity among nations. For example, the inter-rater variability in evaluating I_{3M} smaller than 0.08, on the contrary, it is easier to estimate I_{3M} greater than 0.08, in other words, it is easier to obtain false negative than false positive measurement.

The pooled estimate of the specificity, 95%, pointed out the low false positive frequency in using I_{3M} method. Concerning the sensitivity, number of correctly classified adults, the minimum sensitivity value was 47% from the French sample and the maximum was 93% in Colombia which emphasizes the lack of an ethnical trend. It is important to highlight that in our studies of age estimation using the third molar, it is vital to have an optimal specificity which means that I_{3M} can correctly identify a minor.

The results are in line with observations made by Liversidge et al,[20] where they found small differences among world groups when studying the timing of root development in mandibular third molars suggesting that probably it is unnecessary to have population specific reference data to estimate age of an individual using mandibular third molar root formation.

CONCLUSIONS

This method is useful to determine the adult age of girls involved in suspected early marriages because of the high probability of identifying a minor with similar results observed among tested populations.

REFERENCES

1. Waning welcome [Internet]. Mixed Migration Centre. 2019 [cited 2019Oct20]. Available from: http://www.mixedmigration.org/resource/waning-welcome-the-growing-challenges-facing-mixed-migration-flows-from-venezuela
2. Schmeling A, Dettmeyer R, Rudolf E, Vieth V, Geserick G. Forensic Age Estimation. Dtsch Arztebl Int. 2016;113(4):44-50.
3. One in three children under-five does not officially exist – UNICEF [Internet]. [cited 2019Oct3]. Available from: https://www.unicef.org/media/media_71508.html
4. A passport to protection: A Guide to Birth Registration Programming [Internet]. Resource Centre. 2019 [cited 2019Oct27]. Available from: https://resourcecentre.savethechildren.net/library/passport-protection-guide-birth-registration-programming
5. Crawley H. When is a Child not a Child? Asylum, Age Disputes and the Process of Age Assessment. London: Immigration Law Practitioners' Association (ILPA), 2007. 225 p.
6. Timme M, Steinacker JM, Schmeling A. Age estimation in competitive sports. *Int J Legal Med*. 2016;131(1):225–33.
7. Ending child marriage - United Nations Population Fund [Internet]. [cited 2019Oct3]. Available from: https://unfpa.org/sites/default/files/pub-pdf/endchildmarriage.pdf
8. Child Marriage: Latest trends and future prospects [Internet]. UNICEF DATA. 2020 [cited 2019Nov1]. Available from: https://data.unicef.org/resources/child-marriage-latest-trends-and-future-prospects/
9. Child marriage around the world. Girls Not Brides [Internet]. youthpower.org. [cited 2019Nov2]. Available from: https://www.youthpower.org/resources/child-marriage-around-world-girls-not-brides
10. The role of different sectors an overview - Girls Not Brides [Internet]. [cited 2019Nov2]. Available from: https://www.girlsnotbrides.org/wp-content/uploads/2016/03/1.-Overview-Addressing-child-marriage-role-of-diff-sectors.pdf
11. Countries Archive [Internet]. UNICEF DATA. [cited 2019Nov1]. Available from: https://data.unicef.org/country/
12. Marriage Laws around the World - Pew Research Center [Internet]. [cited 2019Oct20]. Available from: http://assets.pewresearch.org/wp-content/uploads/sites/12/2016/09/FT_Marriage_Age_Appendix_2016_09_08.pdf
13. Levelling the playing field [Internet]. [cited 2019Oct25]. Available from: https://miclu.org/assets/uploads/2017/04/25-UNICEF-UK-Levelling-the-playing-field_-A-UNICEF-UK-report-into-provision-of-services-to-unaccompanied-or-separated-migrant-children-in-three-local-authority-areas-in-England-2010.pdf
14. Demirjian A, Goldstein H. New systems for dental maturity based on seven and four teeth. *Ann. Hum. Biol*. 1976;3(5):411–21.
15. Franklin D, Flavel A, Noble J, Swift L, Karkhanis S. Forensic age estimation in living individuals: methodological considerations in the context of medico-legal practice. *Res. Rep. Forensic Med*. 2015;:53-66
16. Cameriere R, Ferrante L, Angelis DD, Scarpino F, Galli F. The comparison between measurement of open apices of third molars and Demirjian stages to test chronological age of over 18 year old in living subjects. *Int. J. Legal Med*. 2008;122(6):493–7.

17. WMA - The World Medical Association-WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects [Internet]. The World Medical Association. [cited 2019 Oct 18]. Available from: https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/
18. Verde PE. Meta-analysis of diagnostic test data: A bivariate Bayesian modeling approach. *Stat Med*. 2010;29(30):3088–102
19. Arthur M, Earle A, Raub A, Vincent I, Atabay E, Latz I, Kranz G, Nandi A, Heymann J, Child Marriage Laws around the World: Minimum Marriage Age, Legal Exceptions, and Gender Disparities. *J Women Polit Policy* 2017;39(1):51–74
20. Liversidge HM, Peariasamy K, Folayan MO, Adeniyi AO, Ngom PI, Mikami Y, Shimada Y, Kuroe K, Tvete IF, Kvaal SI, A radiographic study of the mandibular third molar root development in different ethnic groups, *J Forensic Odontostomatol* 2017; 2(35):97-108