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BIOLOGICAL AGE AND DENTAL AGE – ANTHROPOLOGICAL CORRELATIONS OF THE INDIVIDUAL'S AGE ASSESSMENT IN THE FIRST PERIODS OF LIFE

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Abstract: Tooth eruption is a complex biological phenomenon, which must be understood and taken into consideration by specialists due to its correlation with the development of the entire body.
The issue of tooth eruption was asserted itself not as much due to the anomalies that come during the development of the physiological process of tooth eruption, as evident by interfering with the subjects' general somatic and mental development.
In the present study, the authors have proposed a study of the eruption of permanent teeth correlated with the general somatic development, in a population of children and youth from urban areas (Bucharest).
Given that in the dental apparatus changes occur due to the acceleration of growth and development as a general phenomenon, it is necessary to periodically make such studies in order to highlight the changes in different time periods.
Dental age evaluation is a useful way to assess the maturity and is frequently used in combination with skeletal age not only in anthropology but also in pediatric forensic, etc.

Keywords: dental eruption, anthropology, dental age, biological age.

The physiological phenomenon of teeth migration from the bony jaw area where they were formed towards the occlusal surface is called dental eruption and is a common process in mammals and man.

The migration of teeth from the bony mass of dental arches towards the oral cavity is achieved independently for each group of teeth under the activation of genetic and mesologic factors, marking distinct stages in the ontogenetic development of the individual. The eruption of the teeth exhibits variations in both the phylogenesis and ontogenesis of mammals, even in the Homo genus. The factors which are responsible for these variations are hereditary factors and regional factors, the general health of the dental and maxillary apparatus, socio-economic, cultural factors, etc.

The chronological limits of eruption of temporary and permanent teeth vary according to the categories of teeth, being thereby indicators of the general somatic development for determining the actual age of the subjects, therefore in assessing the limits of growth and development normality in relation to chronological age and gender. At the same time they also allow highlighting genetically or mesologically determined growth acceleration and retardation while being valuable signs in detecting general disorders (endocrine, metabolic, genetic).

The acceleration of growth and development as a phenomenon of microevolution leads, among other things, to an increase in height and weight in different ontogenetic stages and in the final stage to adulthood, in comparison with previous generations, as well as to a precocious physical psychological maturation. The phenomenon is reflected by an acceleration of physiological phenomena such as physical and mental development level, time of dental eruption, sexual maturation, etc. After various studies conducted it can be said that *the timing of tooth eruption is a good marker of the actual age compared to the chronological age*, therefore an indicator of the level of normality, acceleration or delay of the growth and development process in a population at a given time.

The problem of tooth eruption asserted itself not so much by the anomalies that arise during the process of physiological tooth eruption, but mainly due to the obvious interference with subjects' general somatic and psychic development.

The concept of physiological age, introduced by C.W. Crampton as early as 1908, enhances the variability of physiological rhythms that determine in individuals of the same chronological age different biological ages, each person possessing a specific internal movement, one's own pace. (2)

The physiological age or rather the biological age can be assessed based on the morphological correspondences which are the expression of biochemical, physiological modifications, as well as of the relations between them. (3)

Arensburg et al. established as criteria in assessing the age of individuals the age of tooth eruption, namely the type and number of the teeth existing on the dental arch at a given time, a very effective method in evaluating the age in both the current population and the relics that highlight the ontogenetic development of the human species.(1) The authors identify four stages, namely:

- stage I: no deciduous tooth erupted= less than 6 months
- stage II: various stages of deciduous teeth eruption = 6 months -5 years

- stage III: mixed dentition (deciduous + permanent) = 6-12 years
- stage IV: only permanent teeth = over 12 years, adults

Tanner noted that *in order to determine the development for a given biological age, comparable to the chronological age, four criteria can be used*, namely: skeletal age, dental age, morphological age (size, weight, etc.) and the age of the secondary characters (valid only in puberty).(8) He also notes the absence of significant differences between genders in terms of age of the teething on a semi-arch or another (right-left), with differences only between homologue teeth on the antagonist arch (superior-inferior).

Of all the stages of life, adolescence is the period which offers us the most appropriate moment for understanding the complex and variable relationship between the chronological age and the biological one. In childhood, deciduous and secondary tooth eruptions are markers of similar importance in establishing this relation. On the curve of the child's development, the gap between chronological age and biological age is a choice indicator of his / her health.

The relationship between chronological age and biological age manifests itself in the various stages of life in complex and variable ways, depending on genetic and environmental factors, as well as on the stare of health that induces specific rhythms in metabolic processes. In adolescence the physiological and biochemical changes which occur are also reflected in marked morphological equivalences. At this stage we benefit from criteria which allow us to easily define biological age, such as stature and weight, the peculiarities of body proportions, skeletal ossification degrees, the eruption of permanent teeth, the development of secondary sexual characteristics, etc. (6). Consequently, specialised literature uses the terms of bone age, dental age, statural age, physiological age or sexual stage age.

The various studies conducted so far both in our country by teams led by Rusu, I., Maria Cristescu, P. Firu and Cristiana Glavce and worldwide have revealed a wide variability of dental age in the same chronological age both at individuals' and populations' level.

The problem of calendar age estimation in regions where there are no accurate records of data at birth is a notorious problem - and here we are not referring strictly to our country. Comparative clinical evaluations between body weight and height bring a degree of uncertainty through the lack of the population's corresponding standards. Under these circumstances Voors recommended as early as 1957 the use of dental age, taking into account that both the temporary and the permanent

dentition can be used to estimate calendar age with the necessary approximations. (9) Age estimation errors increase with the frequency of eruption delays as a result of trauma, pulp treatments and extractions, especially in the period between 2.5 and about 6 years when deciduous dentition may be affected and permanent dentition has not yet erupted.

Very rarely radiographic investigations are used on developing jaws and teeth (due to the irradiation of tissues and especially to technical difficulties), for accurate assessment of individual development age, most evaluations being based simply on the dental status which reflects the situation of the dental eruption during the respective period. The simplest method of obtaining dental age requires nothing else but the enumeration of the existing deciduous or permanent teeth and the recourse to a table with the dental age of individuals grouped according to gender, age and genetic features.

Variability limits of **temporary teeth eruption** are more limited than in the case of permanent teeth due to a stronger genetic conditioning.

Our studies have confirmed the minimal, in fact insignificant, deviation from the eruptive normal of the deciduous dentition, the mesologic factors having a minor influence on the eruptive moment.

Tooth	**Beginning of calcification**	**Formation of the crown** (months)	**Eruption** (months)	**Maturation of the root** (years)
Central Inc.	4-4.5 months	1.5-2.5 months	6-8 months	1.5 years
Lateral Incisor	4.5 months	2.5-3.0 months	8-10 months	1.5-2 years
Canine	5 months	9 months	10-20 months	3.5 years
Molar 1	5 months	5.5-6.0 months	12-16 months	2.5 years
Molar 2	6 months	10-11 months	20-24 months	3 years

Table 1. Beginning of calcification, formation of the crown, age of eruption and maturation of the root in temporary dentition (Molnar) (i.u. = intrauterine)

The chronology of deciduous dentition eruption is: central incisor, lateral incisor, molar l, canine and molar 2.

Deciduous teeth erupt between about 6 months and maximum 30 months (two and ½ years). At 6 months the first group of teeth erupts: the lower central incisors; first on the low jaw then on the upper jaw, with the exception of the upper lateral incisors that erupt before the lower lateral incisors.

The chronology of deciduous dental eruption is influenced mainly by genetic factors and less by environmental factors and this because for a long period of time (approximately 9 months) they are protected by the maternal body.

It seems that there are no significant differences between genders in terms of deciduous teeth eruption, the factors that influence skeletal maturation and tooth eruption being similar to those which control growth.

The difficulties of comparative assessment arise from the simple fact that certain researchers viewed "eruption" as the moment of the first appearance of any part of the crown out of the gum, while others waited for the eruption of the whole crown, leading thus to a considerable interval between the two eruptive stages. (8)

We took into account the emergence of the first cusp in the gingival mucosa, considering that tooth eruption begins once the tooth crown is mineralised and appears on the gingival mucosa and ends when the tooth migrated until it touched the proximal neighbour and reached the occlusion plan.

In the case of **permanent dentition eruption**, which covers a much longer ontogenetic period (from the age of 5-6 years until over 18 years), there are groups of teeth with a stronger genetic conditioning (incisors and molar 1) and groups of teeth with stronger mesologic conditionings (canines, the second molar, the premolars 1 and 2).

The highly genetically conditioned teeth: incisors and molars 1 (of 6 years) appear in easily predictable periods and suffer only minor variations due to environmental conditions. Environmental factors exert their influence only on the quality of dental structures and consequently on dental morbidity due to individuals' dental hygiene, nutrition.

Central incisors appear around the age of 7 in a brief period of time of only several months, in both sexes, when there is already a posterior support for the molar of 6 years which has already concluded its eruption.

The first permanent molar erupts in a narrow range of ± 6 months around the age of 6 years and is a marker of this age. The eruption of this tooth indicates that the individual is ready to start his / her elementary education.

The second permanent molar erupts around the age of 12 years. Because of this regularity, the eruption of the second permanent molar was once used as an indicator of the age at which a child could or could not work in a factory, therefore it was called factory tooth. In an era in which documentation on chronological age was far from being exhaustive, such a test had a considerable intrinsic value.

The third permanent molar, erupting in a variable age range (between 17 and 80 years) and having no marker value, was called "wisdom tooth" according to the assumption that it appears around the age of discernment.

The greatest difference in terms of living conditions appears during the eruption of the canines and premolars, precarious conditions leading to a delay in the emergence of these teeth.

We can notice in secondary dentition sexual dimorphism manifested by tooth eruption precocity in girls as compared to boys, comparable with differences in skeletal maturation. The factors that influence skeletal maturation and tooth eruption are similar to those which control growth.

In general the eruption of permanent teeth is done chronologically according to the data in Table 2.

	CI years	LI years	C years	P1 years	P2 years	M1 years	M2 years	M3 years
sup.	7-8	8-9	11-12	10-11	10-12	6-7	12-13	17-21
inf.	6-7	7-8	9-10	10-12	11-12	6-7	11-13	17-21

Table 2. Dental age as an indicator of biological age
(according to Stewart and Barker) (7)

Based on the study of some of our study subjects' dental radiographs and according to the literature data that dental crowns are formed and tooth eruption is completed, however, the roots of the erupted teeth are still not fully developed. (Table 3.)

	IC years	IL years	C years	P1 years	P2 years	M1 years	M2 years	M3 years
calcifi-cation	3-4 months	10-12 months	4-5 months	1.5-2 years	2-2.5 years	birth	2.5-3 years	7-10 years
crown term./ani	4-5 years	4-5 years	6-7 years	5-6 years	6-7 years	2.5-3 years	7-8 years	12-16 years
eruption	7 years	8 years	11 years	10 years	11 years	6 years	12 years	16-22 years
root	9-10 years	10-11 years	12-15 years	12-13 years	12-14 years	9-10 years	12-14 years	18-23 years

Table 3. Chronology of the development of human permanent teeth
(Logan. Kronfield according to Schour and Massler)

As we have already mentioned, the acceleration of growth and development as a phenomenon manifests itself, among others, through an increase in height and weight compared to previous generations, and through a precocious physical, psychological maturation. The acceleration phenomenon reveals itself through a precession of physiological phenomena such as the mental development level, time of tooth eruption, sexual maturation. Following the various studies conducted, it can be said that *the moment of tooth eruption is a good marker of the actual age compared to the chronological one*, therefore an indicator of the level of the acceleration in a population at a given time.

In the present paper we have intended to study the definitive teeth eruption in a population of children and youths from our country. Given that also at the level of the dental maxillary apparatus changes of growth and development occur due to acceleration as a general phenomenon, it is necessary to periodically make such studies in order to highlight the changes occurred in different time periods.

Besides the strictly theoretical interest of variability of tooth eruption depending on the genetic load in a population, through the researches conducted the study of tooth eruption can bring a significant practical contribution, the scope and the applicability extending to several areas.

The knowledge of deviations from processes of growth and development is the main element of the preventive and curative treatment of the young population concerned.

To determine whether a child falls within the normal range from the medical viewpoint dental investigations deserve a particular attention, which like other growth parameters have the advantage of being achieved by mere inspection.

The chronological limits of eruption should be indicators of the general somatic development, valuable signs in detecting metabolic, genetic or general endocrine disorders. (4)

The study we have conducted analyses dental eruption - indicator of ontogenetic development stages, well defined and very important in determining a child's general health condition.

The material which makes the object of the paper consists of the school population of different ages from both rural and urban areas of our country, and the sample can be considered "relatively" representative of the country's child population, given the amalgamated composition (from all the regions of the country) of the capital's residents. (5)

A total number of 3767 subjects were investigated, of whom 1921 were male and 1846 female subjects, aged between 5 and 19, whose numerical distribution within each age group is exhibited in Table 4.

The samples were made according to the chronological age and sex. The basic core, longitudinally watched for four years, was initially made up of subjects grouped according to the educational system in our country, namely: kindergarten: 4-6 years, elementary school: 7-14 years, and high school: 15-19.

YEARS	BOYS	GIRLS	TOTAL
5	98	96	194
6	112	102	214
7	100	174	274
8	108	101	209
9	101	106	207
10	100	102	202
11	124	101	225
12	191	180	371
13	154	154	308
14	116	100	216
15	129	103	232
16	108	157	355
17	111	101	212
18	154	154	308
19	115	105	220
Total	1921	1846	3767

Table 4. Study samples

In this paper we focused mainly on aspects pertaining to dental eruption chronology as an anthropological marker of biological age.

For the study we have conducted, Table 5 presents the age ranges of eruption of permanent dentition in both boys and girls, as well as how differentiated it is on dental arches in both sexes.

	IC years	I.L years	C years	P1 years	P2 years ni	M1 years	M2 years	M3 years
maxillary arch								
B.	6.7-8.4	7.4-9.3	9.8-12.8	8.2-12.1	9.6-13.1	6.1-6.9	11.6-13.7	18.3-
G.	6.6-7.7	7.3-9.2	9.9-12.6	9.4-11.0	9.7-12.7	5.7-6.4	10.8-13.2	19-
mandibular arch								
B.	6.3-7.2	6.8-8.6	9.5-12.1	9.4-12.8	10.1-13.2	5.3-6.4	11.4-13.3	18.2-
G.	6.5-6.8	6.7-7.9	9.4-11.1	9.4-11.4	9.8-13.2	5.6-6.5	10.8-12.7	18.8-

B=boys G=girls

Table 5. Table summarising dental eruption depending on arcade and sex. (Years, months)

In order to view the micro-evolutionary differences in permanent dentition eruption in populations of children and teenagers in our country, we have compared the results obtained with dental ages indicated by Stewart and Baker.

The variability noticed is given by a genetic and mesologic conditioning specific to our group, which however observes a slight bent towards acceleration.

The eruption variations within the group of strongly conditioned genetically teeth (central and lateral incisors, and the molar of 6 years) in the samples taken into consideration can be noticed within the range of ± 6 months, neither acceleration nor the retardation being observed. Special attention should be paid to the mesologically conditioned dental groups (canine and premolars). In these groups the allowed variability is comprised between 10 and 12 months.

For the groups of teeth whose eruption is more influenced by living conditions, the retardation in the evolution of the periods of dental eruption is detected especially in boys, who are always more sensitive and are the first to respond to environmental changes.

Following our study we can say that dental eruption is a useful and handy indicator in determining the level of growth and development, thus enabling the detection of subjects who deviate from normality by accelerated or delayed evolution of this process.

We can say in our turn that the eruption of permanent teeth namely of each and every dental group cannot be linked to a limited time, characteristic of life, but rather to a period, due to the extension of the eruption on a minimum and maximum variable number of years. These periods have not undergone significant

changes due to the poor conditions of nutrition during the studied period, as we could have expected.

As to the poor mesologic conditions the quality of teeth suffered greatly during the investigated period and we can state the following things:

- A serious process of degradation of periodontal dental health stands out in the studied teenagers and youths, which increases with age. The health of teeth depends largely on genetic determinism, but the influence of environmental factors can lead to a stagnation or acceleration of the degradation process.
- There is a strong inter-conditionality of human (biological, physiological) and socio-cultural factors and the individual's periodontal dental health.
- There is a positive relationship between the degree of sexual maturation and the concern for the maintenance of oral hygiene, which explains the sexual dimorphism encountered after 15 years of the health of teeth and periodontium, which is better in girls than in boys. This may have as psycho-biological support the slower maturation of boys compared to girls.

The study of the changes that have occurred in the eruption data compared to the data considered as classics and which are regarded as a result of the acceleration phenomenon, which is obvious and proven in terms of somatic development, presents both a scientific and practical importance:

- scientifically speaking, by offering new data in the field of biological investigations and the interdependence between phenomena,

- practically speaking, by updating the changed data on the order of dental eruption, which will thus modify the therapeutic approach currently linked to intervals and orders of eruption that in modern man no longer correspond to the old patterns, acceleration and mesologic conditions inducing new aspects of sequence and order of dental eruption.

By applying the above mentioned considerations, we believe that physicians will have another approach in establishing dental age with applications in paediatrics, auxological anthropology, historical, legal anthropology, etc.

We can finally conclude that:

- Genetically conditioned teeth (central and lateral incisors and the first molars) present no changes as compared to the series studied by other authors.

- Mesologically conditioned teeth (canines, first and second premolar, second molar) exhibit retardation as compared to samples referred to in that eruption

ages instead of being lower remain at the same values or increase compared to previous studies.

- It seems that the strongest indicator of the extent of suffering in eruption is the elongation of the eruption span of the second molar.

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