STRESS IMPACT IN CENTRAL ITALY DURING THE IRON AGE: THE EVIDENCE OF LINEAR ENAMEL HYPOPLASIA

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Teeth are important indicators of the interactions between an organism and its cultural and physical environment. Primarily composed of hydroxyapatite crystals, teeth are the strongest structure in the body. Since enamel and dentine do not undergo remodelling once they are formed, they provide immutable records of all types and degrees of environmental stresses that occurred during the time of formation.

Linear enamel hypoplasia is a defect in the enamel that may occur as a result of the disruption in the matrix formation phase of amelogenesis and is thought to be caused by the catabolic processes that occur in the organism as a response to stress (Sarnat and Schour, 1941; Kreshover, 1960; Osborn, 1973; Tanner, 1978, Yaeger, 1980; Goodman and Armelagos, 1985). Enamel defects have been attributed to or associated with as many as 100 different causal factors (Cutress and Suckling, 1982). Chavez and Martinez (1982) consider that the synergetic interaction between disease and malnutrition is most likely to produce hypoplasia. Although it is considered to be a non-specific, but still sensitive, indicator of stress (Kreshover, 1960; Massler et al., 1941; Sarnat and Schour, 1941), linear enamel hypoplasia is the object of the current study. The purpose is to analyze the impact of stress that had to be faced by some Italian populations during the Iron Age.

MATERIALS

The samples discussed in this paper come from some of the most important sites in Central Italy during the Iron Age (first millennium BC). They are the samples from the necropolis of Campovalano (Abruzzo, VII-II century BC), Alfedena (Abruzzo, VI-V century BC), Camerano (Marche, VI-III century BC), and Tarquinia (Lazio, VIII-II century BC). Because of sample size problems, only the data for necropolis of Campovalano could be separated into two chronological periods (period A VII-V century BC; period B IV-II century BC). Tarquinia is located 40 miles north of Rome. Camerano and Campovalano are close to one another at about the same latitude as Tarquinia, but on the eastern side of the peninsula. Alfedena is located south of Rome, in the center of the Peninsula, and slightly closer to Naples than to Rome.

METHODS

Defects have been scored on all teeth available. The total sample consists of 4,434 permanent teeth (2,150 maxillary and 2,284 mandibular) from 511 individuals (Table 1). The actual number of teeth examined is much higher, since only the antimere showing the more marked defect has been considered in the final counts.

The value of stress impact on the mandibular canine is calculated as the number of defects per 100 individuals. The total number of defects for which severity and chronology were sure, and the number of teeth from which data are obtained, are counted. Keeping into consideration the frequency of teeth affected (Table 2) the total number of teeth was calculated. The number of defects was related to the total number of teeth and then was related to 100. This way we have a numeric value per 100 teeth from every sample is available and the values are comparable to one another (Table 3).

The number of individuals over 50 years of age (dx) (Table 4) was calculated from the table of mortality according to the distribution of age of death of the sample. In this case, the lower the number of individuals that were affected by hypoplasia, the higher the chance these of individuals to reach old age (older than 50 years). The frequency was calculated from the table of mortality of the distribution of the age of death of the sample.

For the chronological distribution of dental enamel hypoplasia (Table 5), each number represents the frequency of defects in that age class within its own sample. To calculate the age at onset, all the measurable defects and both upper and lower margins of the defects were measured. Then, from the unworn teeth, the mean crown height for each type of tooth was measured. The standard time of development of every tooth crown was used from Goodman's table (1980-Human Biology). The mean height of the crown was considered as the height of that type of tooth for each sample. (For each sample its own mean crown height was used). Then, with simple mathematical calculations the age of onset and age of end of each defect was calculated to build the chronological distribution.

RESULTS and DISCUSSION

The frequency of individuals affected by at least one defect is shown in Fig. 1. All the samples seem to have undergone a heavy pressure since frequencies range from 95.3% in Campovalano period B to 98.7% in Camerano (Table 1). As a whole, Camerano seems to show the higher frequencies of defects, while the other sites do not show higher or lower prevalence when compared to one another.

The frequency of teeth affected by hypoplastic defects is reported in Table 2. Frequencies are very high in all the groups as regards the anterior teeth. As expected, maxillary central incisors and mandibular canines show higher values than the other teeth.

Since the frequency of defects per tooth does not take into account the number of times the tooth was affected, we tried to quantify the impact of stressful events occurring on each group. In this case, only the mandibular canine has been used. All defects affecting the lower canines have been calculated, no matter how

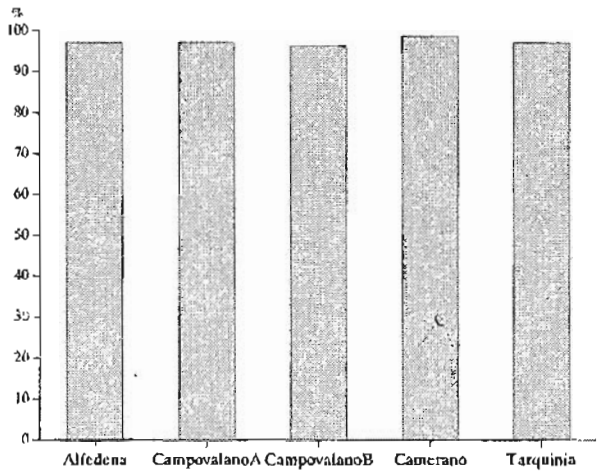

Fig. 1. Frequency of individuals affected by linear enamel hypoplasia in five Italian Iron Age samples. Data are given in Table 1.

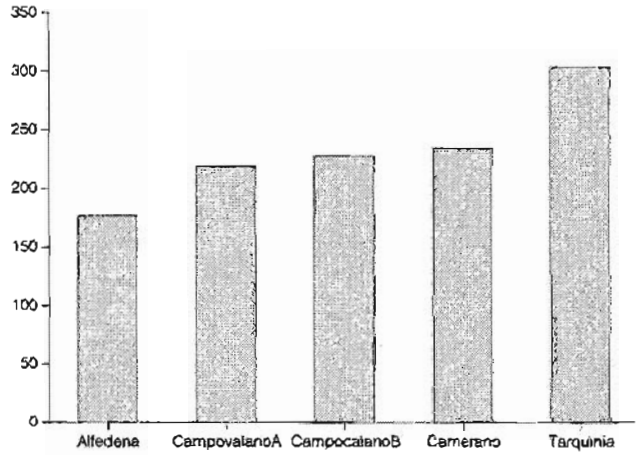

Fig. 2. Stress impact: mandibular canine. The value of stress impact has been calculated as the number of defects per 100 individuals. Complete explanation is given in the section, Methods. Data are given in Table 3.

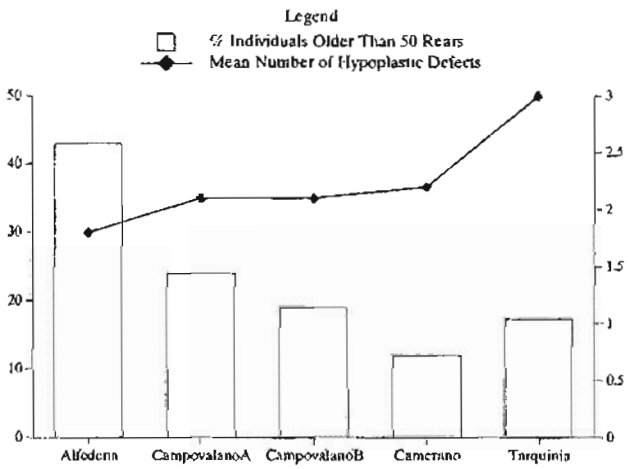

Fig. 3. Comparison between number of individuals older than 50 years of age and mean number of hypoplastic defects. The right and left Y-axes are of different scale. Data are given in Table 4.

severe they were. The total number of defects has been related to the number of teeth affected, and then to the total number of reliable teeth available. This way, as it can be noted in, we can see the real differences in the impact of stress in various human groups.

Camerano shows worst conditions than the other samples (Fig. 2). Tarquinia and both periods of Campovalano are set in the middle, and Alfedena shows the lowest value of stress impact. Alfedena seems to show better life conditions than the other samples. This can actually be confirmed if frequency of deaths after 50 years of age is compared to the mean number of defects affecting the mandibular canine (Fig. 3). Alfedena shows a higher frequency of deaths after 50 years of age and a lower mean number of defects than the other samples.

The chronological distribution of defects is graphically reported in Fig. 4. Alfedena has an earlier time of onset and peaks in the same class as Campovalano A and Campovalano B (2.5-2.9 years). Camerano and Tarquinia have a slightly later onset of defects, Tarquinia then peaks in age range of 3.0 to 3.4 years, while Camerano reaches its peak between 3.5 and 3.9 years of age. Interestingly, Tarquinia's and Camerano's distribution remains higher than Alfedena and both periods of Campovalano in the ages after peaks.

CONCLUSIONS

In conclusion, linear enamel hypoplasia is evident, with frequencies of individuals affected in all the sites considered approaching 100%. Analysis further shows that, although frequencies are high, a differential stress impact can be observed among the populations. This can be confirmed indirectly through comparison of the individuals over 50 years of age with the linear enamel hypoplasias. Slight differences in time of onset and age of peak occurrence can be due to different environmental impact or cultural habits that may have better protected infants either during the early years of life or after weaning occurred.

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TABLE 1. Frequency (%) of individuals (N) with linear enamel hypoplasia in five Italian cemetery samples

	Alfedena		Campovalano A		Campovalano B		Camerano		Tarquinia		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Enamel hypoplasia	143	97.2	36	97.2	27	95.3	76	98.7	129	97.7	511	97.1

TABLE 2. Frequency of linear hypoplasia for each tooth class.

Tooth class	Alfedena	Campovalano A	Campovalano B	Camerano	Tarquinia
Maxillary central incisor	81.8	80.8	70.1	84.8	80.1
Maxillary lateral incisor	73.3	70.4	77.8	90.5	76.6
Maxillary canine	82.8	89.7	89.5	94.3	86.4
Maxillary third premolar	72.6	67.9	70.7	79.1	72.6
Maxillary fourth premolar	42.3	61.5	57.3	65.3	47.9
Maxillary first molar	57.1	48.1	25.3	39.6	43.6
Maxillary second molar	44.3	43.5	20.8	37.8	47.9
Maxillary third molar	5.1	21.1	24.4	39.5	30.8
Mandibular central incisor	71.7	51.9	58.5	84.1	68.8
Mandibular lateral incisor	77.3	54.8	64.9	83.1	78.6
Mandibular canine	80.6	70.9	86.1	95.3	91.5
Mandibular third premolar	74.4	69.1	58.7	78.5	64.9
Mandibular fourth premolar	56.5	55.9	49.4	68.9	61.1
Mandibular first molar	34.7	8.3	20.3	44.8	45.1
Mandibular second molar	34.7	27.3	33.3	49.9	30.9
Mandibular third molar	29.1	6.7	5.1	55.1	35.5

TABLE 3. Stress impact on mandibular canine.

	Alfedena	Campovalano A	Campovalano B	Camerano	Tarquinia
Stress impact mandibular canine	176.9	218.9	228.0	234.1	303.5

TABLE 4. Frequency of individuals older than 50 years and mean number of defects.

	Alfedena	Campovalano A	Campovalano B	Camerano	Tarquinia
% individuals older than 50 yrs	43.0	24.0	19.0	12.0	17.4
Mean number of hypoplastic	1.8	2.1	2.1	2.2	3.0

TABLE 5. Chronological distribution of linear enamel hypoplasia.

	Alfedena	Campovalano A	Campovalano B	Camerano	Tarquinia
Age range in years	%	%	%	%	%
0.0-0.4	0.0	0.3	0.0	0.0	0.0
0.5-0.9	0.9	0.3	1.1	0.6	0.0
1.0-0.4	4.5	1.1	3.4	1.9	1.6
1.5-1.9	7.3	3.3	6.8	4.8	3.8
2.0-2.4	13.8	10.6	14.2	11.8	10.3
2.5-2.9	17.9	13.9	18.2	17.9	11.6
3.0-3.4	14.0	14.4	17.0	17.1	18.8
3.5-3.9	11.0	15.2	13.6	13.0	16.9
4.0-4.4	9.5	13.3	10.2	10.3	12.8
4.5-4.9	10.4	12.8	8.0	11.8	12.5
5.0-5.4	8.4	10.1	6.3	6.5	10.0
5.5-6.0	1.7	4.9	1.1	2.1	1.9
6.0-6.5	0.4	0.0	0.0	0.0	0.0

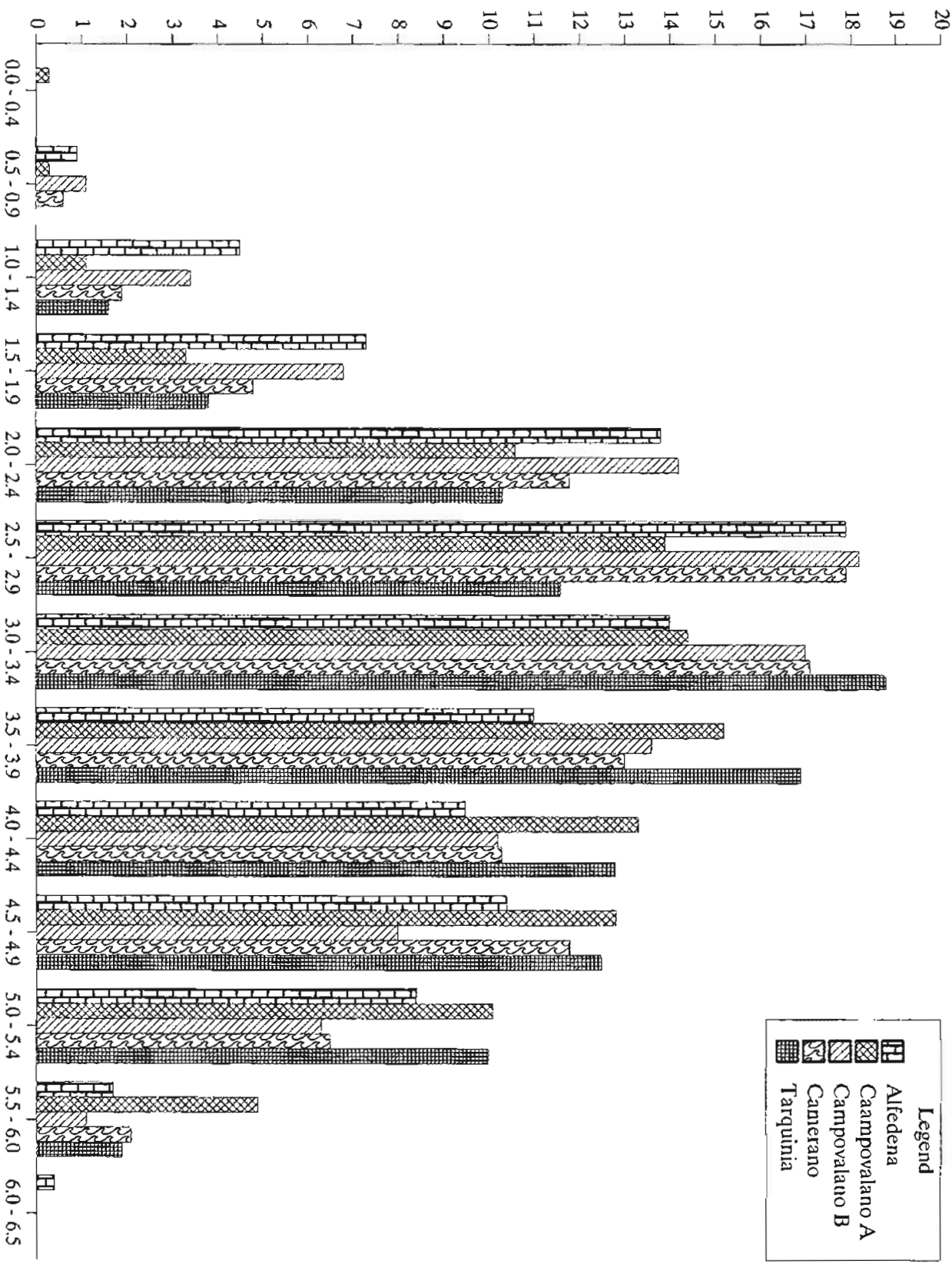

Fig. 4. Chronological distribution of linear enamel hypoplasia. Numbers on the X-axis are years. Explanation of calculations is given in the section, Methods. Data are given in Table 5.