Age and Sex-Related Topography of Carious Lesions and Oral Conditions among Prehispanic Coastal Mayas

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Keywords: Oral health, caries topography, antemortem tooth loss, Maya, Prehispanic, Mexico

ABSTRACT **Objectives**: The objective is to assess topographic distribution of carious lesions on the crown and cement-enamel junction (CEJ) by sex and age class and relate it to food intake.
Materials and methods: Sixty-eight males and 45 females aged 15 years and older from the Prehispanic Classic period Maya site of Xcambó (AD 250-700) were selected and organized into 15-30 years, 31-45 years and 46+years age classes. Caries were scored on all permanent teeth based on their location on the crown, interstitial CEJ as well as buccal and lingual CEJ. Antemortem tooth loss (AMTL) was considered as present when the tooth socket was remodeled and the bone reabsorbed to such an extent that it no longer provided support for the tooth.
Results: Caries affected 14.6% of the permanent teeth in males and 27.7% in females. About half of all the lesions were located at the mesial and distal CEJ edge of the teeth (50% in males and 46.6% in females), while 12.9% and 17.1% (respectively for males and females) affected the buccal and lingual CEJ edge. Multiple carious lesions were found on 19.7% of teeth in males and 24.9% in females. Lastly, AMTL was recorded in 16.4% of sockets in males and in 27.4% in females. The overall frequencies of dental caries and AMTL increase with age at death, and differences by sex are statistically significant; on the contrary, interstitial CEJ, buccal and lingual CEJ and multiple carious lesions do not follow an age-related pattern of distribution, and do not show statistically significant differences between males and females when differences are analyzed using Chi-Squared test.
Discussion and conclusions: The coastal site of Xcambó shows one of the highest frequencies of dental caries in the region. The high socioeconomic status of the site suggests that carious lesions were not due to a diet based on maize, but that also sugary (honey and various fruits) and starchy foods were ingested on a daily basis. Cariogenic sticky foodstuff, which likely triggered dental caries progression at the buccal and lingual CEJ edges of the teeth, were ingested by all the members of the society regardless of sex and age.

Studies of carious lesions in Prehispanic Maya societies from the northern lowlands (i.e. the Peninsula of Yucatan, Mexico) have highlighted a marked heterogeneity in the frequency of such lesions (Cucina et al., 2011), regardless of the sites' geographical location. Significant access to non-cariogenic proteins of marine origins (fish and seafood), which characterize coastal sites, is not found to buffer the sites' settlers from the insurgence of carious lesions (Cucina et al., 2003, 2011; Seidemann & McKillop, 2008). Likewise, dental caries is not always an indicator of poor nutrition affecting mainly the fringes or commoner segments of the society (Cucina & Tiesler, 2003, 2007).

The present study focuses on the Maya site of Xcambó, which is dated to the Classic period (AD 250-700) and is located along the northern shores of the Yucatan peninsula (Mexico) (Figure 1). The site was an autonomous port of trade dedicated to the production and administration of marine salt, and its population was characterized by a relatively homogeneous and high socioeconomic level, though no true political elite lived there (Sierra Sosa et al., 2014).

Previous papers (Cucina et al., 2003, 2011) revealed that the human skeletal collection from Xcambó manifested among the highest frequencies of carious lesions in comparison with other inland and coastal sites from the region. Cucina et al. (2003, 2011) have already discussed the generic causes of Xcambó' s high frequency of dental caries, with the 2003 paper investigating the oral conditions in the site's different compounds. Given the site's economic wealth, and the large amount of fish and animal remains recovered, which suggests a diet

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with heavy animal protein consumption, the authors pointed to both lifestyle and daily habits, and to the access to cariogenic food like honey, as causative factors for carious lesions. According to their findings, and to the evidence that both males and females equally increased in carious lesion frequencies from an earlier time, access to such "exotic" types of food was granted to both sexes and was not gender related.

However, all these studies (see Cucina et al., 2011 for a list of comparative studies and related publications) focused on the overall frequency of carious lesions regardless of their topographic location on the crown or around the teeth cervical edges.

Figure 1. Geographical location of the site of Xcambó within the context of the northern Maya lowlands, Yucatan.

Topographic distribution of carious lesions is meant to be informative of the kind of food ingested, in particular for cervical caries that are considered indicative of a starchy diet and are found to affect mainly older individuals (Lanfranco & Eggers, 2010; Lingström et al., 2000). Based on these premises, the present study aims at investigating the topographic distribution of carious lesions by age and sex in the permanent dentitions of a selected sample from the Classic period Maya skeletal collection of Xcambó. The purpose of this study is to assess, and interpret it from a biocultural perspective, whether age and sex play a role in the onset of different kinds of carious lesions (i.e., crown vs cervical), or whether the qualitative (topographic) distribution of carious lesions is independent from the individuals' biovital parameters.

Materials and Methods

The skeletal sample was excavated between 1996 and 2000 by one of the authors (TSS, - National Institute of Anthropology and History, Yucatan Center) (Sierra Sosa, 1999; Sierra Sosa et al., 2014). The skeletal collection is currently housed at the Bioarchaeology and Histomorphology Laboratory, School of Anthropological Sciences, Autonomous University of Yucatan (UADY). For the present study, 113 individuals were selected. In order to avoid interobserver error, only individuals scored by the senior author were chosen. The final sample comprises 68 males and 45 females, and is composed of individuals for whom sex and an age at death of 15 years and older could be estimated. Individuals not scored by the senior author, without a clear sex determination, and whose age at death did not fit into the 15-30 years, 31-45 years and 46+ years age categories, were excluded from the present study. Every individual was assigned to one of three age categories by sex: 23, 30 and 15 individuals comprise the male sample by age classes, and 9, 12 and 24 individuals the female one. Biovital data were extrapolated from the skeletal collections' database of the Bioarchaeology and Histomorphology Laboratory (UADY). A total number of 1,915 permanent teeth and 2,437 sockets were studied.

All the available permanent teeth were scored for the presence of carious lesions, while tooth sockets were evaluated for antemortem tooth loss (AMTL). It must be stressed that the skeletal collection of Xcambó is characterized by a relatively low degree of occlusal wear. Therefore, attrition was not a limiting factor for scoring dental caries and its subsequent analysis.

Carious lesions were scored following a 0-4 scale, with grade zero indicating no lesions; grade 1 indicates that the lesion had affected only the enamel; grade 2 corresponds to the lesion that had penetrated into the dentine. Caries were scored as grade 3 when the lesion had penetrated into the pulpal chamber, and grade 4 indicated a cavity that had destroyed more than half of the crown (Cucina et al., 2003, 2011). Lesions were considered as present when they had penetrated into the dentine; therefore, caries affecting only the enamel were considered as absent (Hillson, 2001; Cucina et al., 2011). Carious lesions were scored according to their location on the crown and long the CEJ. When carious lesions had affected the exposed root, they were recorded as such, and included with CEJ or cervical lesions (Watt et al., 1997). For the purpose of this study, carious lesions affecting any side of the crown were considered all together; mesial and distal CEJ carious lesions, instead, were analyzed separately from those of the buccal and lingual CEJ. Multiple carious lesions have been counted regardless of their location on the crown or the CEJ. The frequencies of teeth presenting mesio-distal CEJ, bucco-lingual CEJ, as well as multiple carious lesions were calculated based on the number of carious teeth. In this case, mesio-distal CEJ and bucco-lingual CEJ are not mutually exclusive because some teeth did present both kinds of lesions at the same time.

The presence of AMTL was considered when the maxillary and mandibular bones were available for

study, the tooth socket was remodeled, and the bone had reabsorbed to such an extent that it could not provide support to the tooth. The overall rate of AMTL was calculated on the exclusive basis of the total number of sockets available.

Comparative analyses were run using Chi-Squared statistical test. Sample size was large enough that it did not need Yate's correction or the use of Fisher's exact test.

Results

Table 1 lists the frequency of carious lesions for the anterior, posterior, and total dentition by sex and classes of age (see also Figure 2 for the graphical distribution by sex and age). Carious lesions are more frequent in the posterior dentition in comparison with the anterior teeth. In male individuals, lesions range from 13.2% in the 15-30 years age class, to 20.5% in the 46+ class, with a total value of 14.6%. Females, on the other hand, range from 17.3% in the younger class to 37.5% in the older, with a total frequency of 27.7%. Differences between sexes are statistically significant (Chi-Squared=48.17, 1 d.f., p=.000), as previously noted also by Cucina et al. (2011) in a Late Classic-only sample. As expected, frequencies of lesions increase with age for all the categories with the exception of the anterior teeth in the male sample, for which the highest frequency (7.7%) can be found in the younger age class.

The topographic distribution of carious lesions, whose frequency has been calculated out of the total number of teeth with carious lesions, is described in Table 2 and graphically represented in Figures 3 and 4. Mesio-distal cavities at the CEJ (Table 2 upper part, and Figure 3) tend to increase with age in both sexes, with the exception of the anterior teeth in the male segment of the collection. Overall, about half of all the carious lesions scored in the collection are located in between teeth long the CEJ edge of the crown. Differences by sex are not significant (Chi-Squared=0.4206, 1 d.f., p=.5166).

Location at the buccolingual edges of the CEJ (Table 2 lower half, and Figure 4) is less frequent that at the mesiodistal one. Their distribution by sexes and age classes ranges between 0% and 100%; the latter (100.0%) however, is the result of only four carious lesions. Overall frequencies total 12.9% in males and 17.1% in females; similar to the mesio-distal CEJ le-

Table 1. Absolute values and percent frequencies of carious lesions in the anterior, posterior and total dentition by sex and age classes

	Anterior			Posterior			Total		
Males	Caries	Caries-free	%	Caries	Caries-free	%	Caries	Caries-free	%
15-30	12	144	7.7%	46	239	16.1%	58	383	13.2%
31-45	10	213	4.5%	68	280	19.5%	78	493	13.7%
46+	4	63	6.0%	38	100	27.5%	42	163	20.5%
Total	**26**	**420**	**5.8%**	**152**	**619**	**19.7%**	**178**	**1039**	**14.6%**
Females									
15-30	7	67	9.5%	29	105	21.6%	36	172	17.3%
31-45	9	59	13.2%	33	82	28.7%	42	141	22.9%
46+	42	101	29.4%	73	91	44.5%	115	192	37.5%
Total	**58**	**227**	**20.4%**	**135**	**278**	**32.7%**	**193**	**505**	**27.7%**

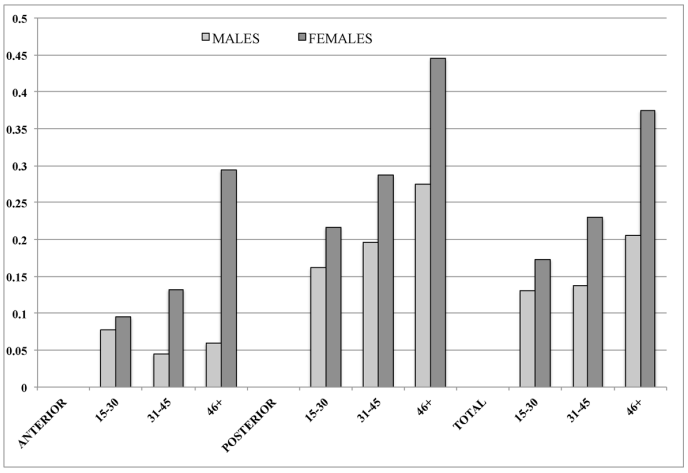

Figure 2. Frequency of carious lesions by sex and age-at-death for anterior, posterior, and total dentition.

Table 2. Frequency of caries location at the mesio-distal and bucco-lingual CEJ edge for anterior, posterior and total number of teeth by sex and age classes

	Anterior			Posterior			Total		
Male	Carious teeth	M-D	%	Carious teeth	M-D	%	Carious teeth	M-D	%
15-30	12	8	66.7%	46	16	34.8%	58	24	41.4%
31-45	10	5	50.0%	68	32	47.1%	78	37	47.4%
46+	4	1	25.0%	38	27	71.1%	42	28	66.7%
TOT	**26**	**14**	**53.8%**	**152**	**75**	**49.3%**	**178**	**89**	**50.0%**
Female									
15-30	7	2	28.6%	29	7	24.1%	36	9	25.0%
31-45	9	3	33.3%	33	14	42.4%	42	17	40.5%
46+	42	27	64.3%	73	37	50.7%	115	64	55.7%
TOT	**58**	**32**	**55.2%**	**135**	**58**	**43.0%**	**193**	**90**	**46.6%**
Male	Carious teeth	B-L	%	Carious teeth	B-L	%	Carious teeth	B-L	%
15-30	12	0	0.0%	46	3	6.5%	58	3	5.2%
31-45	10	3	30.0%	68	6	8.8%	78	9	11.5%
46+	4	4	100.0%	38	7	18.4%	42	11	26.2%
TOT	**26**	**7**	**26.9%**	**152**	**16**	**10.5%**	**178**	**23**	**12.9%**
Female									
15-30	7	1	14.3%	29	7	24.1%	36	8	22.2%
31-45	9	1	11.1%	33	4	12.1%	42	5	11.9%
46+	42	7	16.7%	73	13	17.8%	115	20	17.4%
TOT	**58**	**9**	**15.5%**	**135**	**24**	**17.8%**	**193**	**33**	**17.1%**

sions, difference by sex is not statistically significant (Chi-Squared=1.2607, 1 d.f., p=.2615). In general, buccolingual CEJ carious lesions tend to increase with age, with the exception of the female younger age class, which shows higher frequencies in comparison with the two other age classes.

Table 3 and Figure 5 present the absolute values and percent frequencies of multiple caries within the total number of carious lesions, by sex and age classes. Similarl to the overall frequency of lesions, also for multiple caries females present higher frequencies (ranging between 24.4% and 25.9%) than their male counterpart (ranging between 19.2% and 19.7%). In this case, however, differences between sexes are not statistically significant (Chi-Squared=1.4459, 1 d.f., p=.229).

Multiple lesions do not follow the same patterns by age and location as the overall rate of dental caries. In fact, the age class that appears to be most often affected by more than one lesion in a single tooth is the 31-45 years, both for males and females. Also, the category of posterior teeth, which is the one that is more often affected by dental caries, does not always present higher frequencies of multiple lesions. To the same extent as the pattern by age class, also in this case the lack of a clear pattern applies for males and females, and the difference between sexes is not significant (Chi-Squared=1.4459, 1 d.f., p=.229).

Last, AMTL is presented in Table 4 and Figure 6. Similar to dental caries frequency, AMTL also increases with age in both sexes, and the difference between males and females is statistically significant (Chi-Squared=42.1579, 1 d.f., p=.000). The most noticeable increase occurs in the female oldest group, which shows a total frequency of 42.1% in comparison with the 16.1% calculated among females 31-45 years of age. An increase in males, instead, is not as noticeable as in their female counterpart.

Discussion

The sample used in this study is slightly different from the ones previously published by Cucina and colleagues (2003, 2011), for it includes a younger age cohort of individuals between 15 and 20 years of age (Cucina et al., 2003, 2011 started from age 20 and older), and only used sexed individuals whose age could be assigned to one of the three age classes. Nonetheless, overall frequencies are very similar between the studies. As expected, the overall frequency of carious

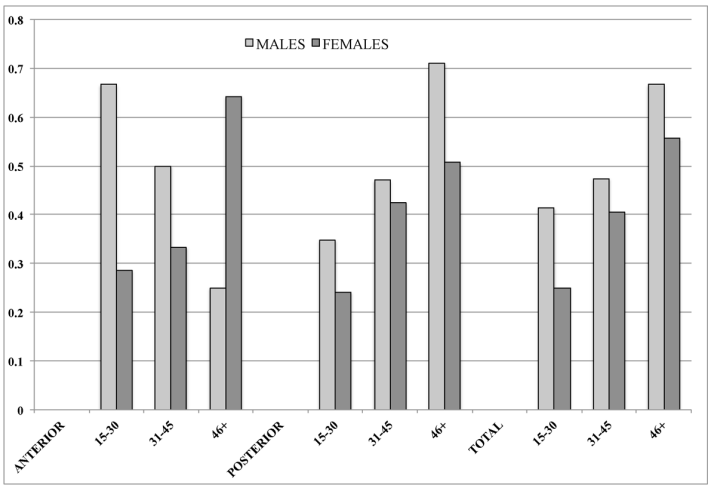

Figure 3. Frequency of mesial and distal CEJ carious lesions by sex and age-at-death for anterior, posterior and total dentition.

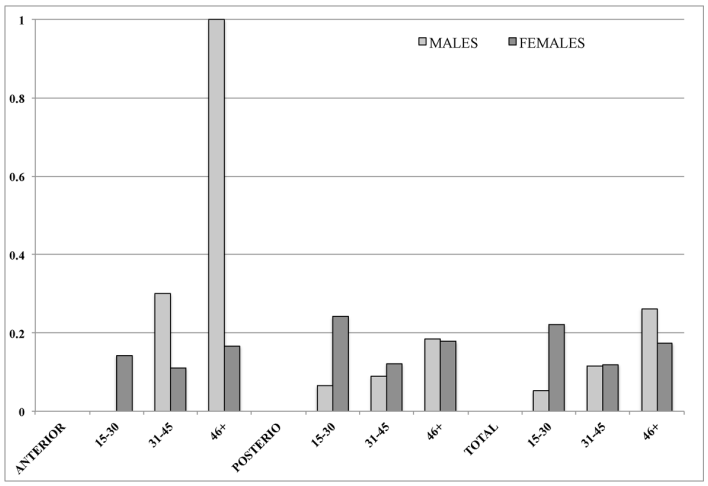

Figure 4. Frequency of buccal and lingual CEJ carious lesions by sex and age-at-death for anterior, posterior and total dentition.

Table 3. Frequency of multiple caries in the anterior, posterior and total dentition by sex and age classes

	Anterior			Posterior			Total		
Male	Carious teeth	Multiple	%	Carious teeth	Multiple	%	Carious teeth	Multiple	%
15-30	12	3	25.0%	46	8	17.4%	58	11	19.0%
31-45	10	1	10.0%	68	15	22.1%	78	16	20.5%
46+	4	1	25.0%	38	7	18.4%	42	8	19.0%
Total	**26**	**5**	**19.2%**	**152**	**30**	**19.7%**	**178**	**35**	**19.7%**
Female									
15-30	7	0	0.0%	29	4	13.8%	36	4	11.1%
31-45	9	2	22.2%	33	12	36.4%	42	14	33.3%
46+	42	13	31.0%	73	17	23.3%	115	30	26.1%
Total	**58**	**15**	**25.9%**	**135**	**33**	**24.4%**	**193**	**48**	**24.9%**

Table 4. Frequency of AMTL for anterior, posterior and total number of open and remodeled sockets by sex and age classes

	Anterior			Posterior			Total		
Male	AMTL	TOTAL	%	AMTL	TOTAL	%	AMTL	TOTAL	%
15-30	9	208	4.3%	39	336	11.6%	48	544	8.8%
31-45	34	190	17.9%	70	429	16.3%	104	619	16.8%
46+	34	151	22.5%	66	219	30.1%	100	370	27.0%
TOT	**77**	**549**	**14.0%**	**175**	**984**	**17.8%**	**252**	**1533**	**16.4%**
Female									
15-30	4	68	5.9%	12	128	9.4%	16	196	8.2%
31-45	12	101	11.9%	29	153	19.0%	41	254	16.1%
46+	36	123	29.3%	155	331	46.8%	191	454	42.1%
TOT	**52**	**292**	**17.8%**	**196**	**612**	**32.0%**	**248**	**904**	**27.4%**

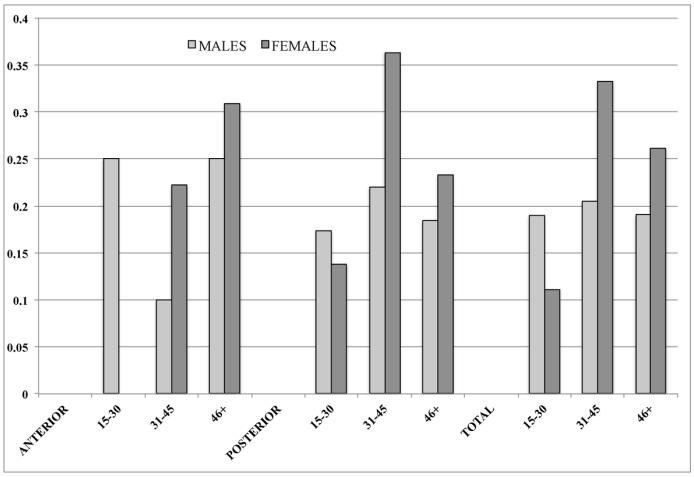

Figure 5. Frequency of multiple caries by sex and age-at-death for anterior, posterior and total dentition.

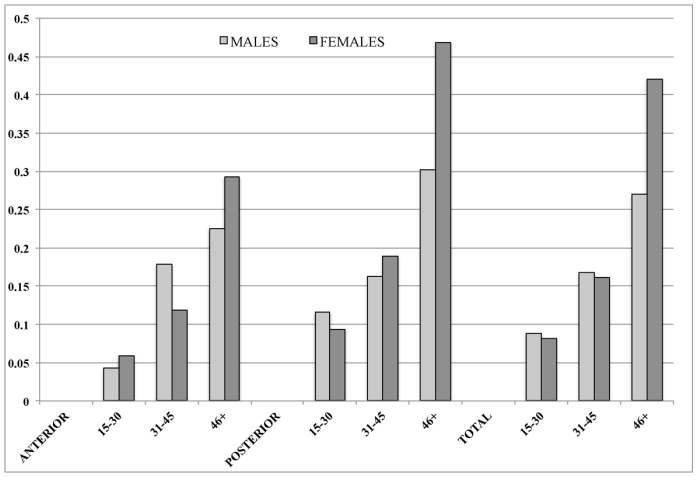

Figure 6. Frequency of antemortem tooth loss (AMTL) by sex and age-at-death for anterior, posterior and total dentition.

lesions, regardless of the location on the crown or CEJ, increases with age (Hillson, 1996). Within sexes, the most noticeable and statistically significant increase occurs between the 31-45 and 46+ age classes, both for males and females; such increase, however, is much more extreme in the female group (respectively, Chi-Squared=11.083, 1 d.f., p=.000871 for females , and Chi-Squared=5.379, 1 d.f., p=.020 for males).

Differences between sexes, instead, reach significant levels in the 31-45 years age class (Chi-Squared=8.9387, 1 d.f., p=.002792), and highly significant levels in the 46+ years age class (Chi-Squared=16.6523, 1 d.f., p=.0000450) (the Chi-Squared difference between males and females in the younger age group is 1.9707, p=.1603). The fact that females manifest higher frequencies than males in each age class is a phenomenon that has been thoroughly discussed in the literature, and that rests on physiological/hormonal differences between sexes as well as differential access to resources and daily habits (see Larsen et al., 1991; Lukacs, 1996, 2008; Lukacs &Largaespada, 2006). In a recent study on carious lesions in two modern samples from northern Yucatan (Vega & Cucina, 2014), females manifested statistically significant higher rates of caries already in the 15-19 year age class. Similarly Cucina and colleagues (2011) stated that differences between sexes were more marked in the younger age groups (starting at age 20 years), though no values of statistical significance were reported. In the present study, instead, differences between the younger age group by sex does not reach the significance thresholds (though females still manifest more carious lesions than males). It is possible that adding to the present study the individuals aged 15 to 20 years, whose amount of carious lesions tend to be lower because of the younger age, might have contributed to more balanced values between sexes dropping the difference below significance.

Differently from the quantitative amount of dental caries, results indicate no differences between sexes for multiple caries, for interstitial caries at the CEJ, and for lingual and buccal caries at the CEJ. Moreover, it is important to stress that none of the above variables presents differences between anterior and posterior teeth, clearly indicating the way teeth are affected in terms of topography and multiple carious lesions does not follow the same anterior vs posterior pattern that characterizes the overall frequency of carious lesions.

Interstitial dental caries at the CEJ (mesial and distal CEJ) is commonly generated by plaque that forms in between teeth, and proliferates in the presence of a diet rich in gelatinized maize and starches (Lanfranco & Eggers, 2010). Experimental animal models suggest that sucrose, maltose, fructose, simple starches or starches in combination with sucrose stimulate the production of cervical lesions, smooth surface lesions or both (Frostell et al., 1967; Lingström et al., 2000). They are also associated with regular consumption of alcohol, low salivary secretion (xerostomy) and high concentration of salivary lactobacilli (Badet & Thebaud, 2008; Beck, 1990; Brown et al., 1986). Age and mechanical factors like cervical calculus and periodontal bone reabsorption represent additional elements favoring the insurgence of cervical lesions (Banting, 2001; Otani et al., 2009). Liebe-Harkort (2012) found exceptionally high rates of dental caries in an Iron Age population from Sweden. Lesions were most common in the cervical region, which the author interpreted as probably related to a dietary pattern where starchy and sticky food tended to accumulate around the neck of the teeth.

At Xcambó, such lesions are very frequent and affect

about half of the carious teeth recorded in both sexes, following a pattern that increases with age. On the contrary, these lesions do not differentiate between anterior and posterior dentition, which can be explained with the fact that, by accumulating in between teeth, plaque finds a hospitable environment regardless of the morphology of the crown above the cervical part of the tooth.

Buccal and lingual caries at the CEJ edge, and root caries, instead, were detected in 12.9% and 17.1% of the males' and females' carious teeth respectively. In males, anterior teeth present higher frequencies than the posterior teeth, while frequency distribution is more evenly balanced in females. As expected, such figures are much lower than mesial and cervical caries at the CEJ, because the buccal and lingual sides are less suitable for plaque to deposit and can be more easily cleaned by tongue and salivary autolysis. Nonetheless, their presence stresses the hypothesis of intake of sticky and cariogenic food.

Last, multiple carious lesions affect slightly less than one out of five teeth in males (19.2%) and one out of four teeth in females (24.9%), which indicates that, despite the considerable amount of lesions recorded, the majority of teeth were attacked only by one cariogenic event. Little information is available in the literature with regard to the pattern and meaning of multiple carious lesions in human populations. Watt et al. (1997) only reported an "average number of surfaces affected by caries per carious tooth" (1997: 617), without specifying the frequency of multiple caries, as well as the possible reasons behind such evidence.

Frequency of carious lesions at Xcambó is one of the highest found among the Prehispanic skeletal collections from the Yucatan peninsula (Cucina et al., 2011). Only the coastal site of Wild Cane Cay, Belize (Seidemann & McKillop, 2008) shows higher frequencies than those recorded at Xcambó. According to the authors, the heavy reliance of the Wild Cane Cay inhabitants on tree crops like *Orbignya cohune*, *Acrocomia mexicana* and *Bactris major*, which are soft foods that presumably adhere to the teeth, could account for the high caries rate; this would be exacerbated by the low amount of dental wear. The authors, however, do not report the sample composition by age and sex, so it is difficult to make detailed comparisons, even though the impressive 36.2% of teeth affected by carious lesions remains the highest among the Prehispanic Maya sites reported in the literature (Saul & Saul, 1997; Glassman & Garber, 1999; Magennis, 1999; Whittington, 1999; Cucina & Tiesler, 2003; Cucina et al., 2003, 2011; Marquez & Hernández, 2007).

In the case of Xcambó, the high frequency of dental caries encountered in the female subgroup might also be due to the elevated number of women aged 46+ years in the sample; with 24 individuals, it represents more than 50% of the whole female sample (N=45). Nonetheless, if the three age classes were represented by the same number of individuals, the overall frequency would drop to about 24.5% (instead of the 27.7%), a figure that still remains one of the highest frequencies in the Maya realm. Antemortem tooth loss does not seem to account for differences between sexes, since the frequencies of teeth lost in life (16.4% in males and 27.4% in females) match very close the rates of carious lesions.

The topographic distribution of carious lesions opens a new window on the biocultural and dietary habits of these people. In particular, it is worthy to note the similarity in distribution of lesion by sex and location (anterior and posterior teeth), and in some cases, also by age. Cervical lesions at Xcambó are observed in the youngest age cohort analyzed here, and bucco-lingual CEJ carious lesions are even more frequent in younger females than in older females. Cervical caries have been associated with older ages, mainly as the result of periodontal bone reabsorption (Faine et al., 1992; Lanfranco & Eggers, 2010). Although age is definitely a conditioning factor, the presence of cervical caries (both M-D and B-L) in the younger age class indicates that it was not a problem limited mostly to older people, but that affected every segment of the society, as also noted by O'Sullivan et al. (1993) in prehistoric British children.

As mentioned above, CEJ carious lesions in general and bucco-lingual CEJ lesions in particular, are associated with the ingestion of cariogenic starchy and, more so, sticky food (Frostell et al., 1967; Lanfranco & Eggers, 2010; Lingström et al., 2000). No data on tartar phytoliths, which could help shed light on the kind of plants ingested, exist yet for the skeletal collection of Xcambó. However, iconographic, epigraphic and historical information report the extensive use of maize-based *atole* beverages to which cocoa, honey and different varieties of fruits were added (Fernandez Souza, 2019). *Yutal kakaw* (fruity cacao), cacao with honey, sweet cacao were often ingested (Beliaev et al., 2009). *Capulin* (a cherry-like small fruit) is reported in several Classic period Maya sites (Lentz, 1999). Fernandez Souza (2019) reports of tamales (see also Taube, 1989) dressed with many different ingredients, many of which were sugar-based like fruits and *camote* (sweet potato), and an extended use of honey to sweeten different recipes and to make a marmalade of sorts. Natural plants also exist that might have entered the local peoples' diet, as for example the *Batis maritima* (Saltwort/Beachwort) (Marcone, 2003), which is typical of marshy coastland in the Yucatan peninsula (Lonard et al., 2011); its succulent leaves and seeds are nutritious, starchy, and relatively (but not highly) rich in

sugars.

Although the basic nutritional intake consisted of marine and terrestrial animal proteins, as well as maize, beans and squash (Fernandez Souza, 2019), all the other kinds of foodstuff mentioned above represented important contributions to the daily intake. We must remember, however, that while the whole population commonly ingested fruits, honey and tamales, other ingredients (like cacao) were oftentimes limited to the society's wealthier class (Cucina et al., 2011). In this perspective, the elevated socio-economic status of the population of Xcambó (Sierra Sosa et al., 2014), in particular during the Late Classic, permitted them to access also this kind of foodstuff. The picture that emerges based on the kind of foodstuff and food recipes is that the bucco-lingual CEJ lesions might have been triggered also by the ingestion of sugary sticky fruits and not just by starchy ones. Sucrose and fructose, in fact, are more cariogenic than starches, because they enhance the streptococci's acidic (and cariogenic) activity (Lingström et al., 2000).

Nonetheless, dental caries is the result of a very complex interaction of different intrinsic (pH, salivation, dental plaque) and extrinsic (type of food, timing of food consumption and food preparation) parameters, so a simplistic association between starches and caries must be taken with caution (Lingström et al., 2000). In particular, timing of food consumption is a parameter that likely played a role in the insurgence of carious lesions in this population. Frequent intake of cariogenic food exposes the individuals to a more intense activity by the oral bacteria (Larsen et al., 1991; Vega & Cucina, 2014); the site's administrative tasks undertaken by the local people, in particular the male segment, likely exposed them to more frequent ingestion of cariogenic alcoholic and non-alcoholic beverages and food, increasing risks of insurgence of carious lesions, as already proposed by Cucina et al. (2011).

Conclusions

In conclusion, dental caries rates at the Classic period site of Xcambó were among the highest in the Yucatan peninsula, regardless of the geographical (coastal or inland) location. The frequency increases with age and is more common in females than males. However, a more detailed distribution of lesions on the crown and cervical edges of the teeth shows patterns not always related to age and sex. The presence of lesions long the buccal and lingual CEJ edges suggests frequent intake of sticky cariogenic food in this population. The way food was prepared, with honey and fruits oftentimes added to different recipes, and the timing of ingestion seemingly exposed this population to increased risks of developing carious lesions already by a young age. A more detailed topographic analysis of carious lesions in other coastal and inland human archaeological settings from the region, each one within its own biocultural context, will allow a clearer picture of the effects of diet and daily habits on the oral conditions of the inhabitants of the peninsula in Prehispanic times.

Acknowledgments

The authors are grateful to Lilia Fernandez Souza, from the Autonomous University of Yucatan, for the interesting discussion on, and for providing the information about food and modes of preparing it in Prehispanic times. A special thanks goes to Marin Pilloud for organizing this special issue of Dental Anthropology.

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