**Supplemental Text 3. Iximche’ Paleopathology**

Paleopathological data most relevant to the present study are presented below. See Whittington (2003) for a more complete treatment of paleopathology at Iximche’.

*Pathology and Diet*

Maize is high in carbohydrates, low in protein and iron, deficient in essential amino acids lysine and tryptophan, contains chemicals that inhibit iron absorption, and typically sticks to the teeth when it is eaten. It is logical to expect that skeletal indicators of diet and health would reflect a high proportion of maize in the diet, as do the stable carbon and nitrogen isotopic measurements.

Porotic hyperostosis is a pathological condition mostly caused by iron deficiency anemia in the Prehispanic Americas (Steinbock 1976). It is characterized by cranial lesions in which the cancellous part of the bone expands and the outer table thins so that small holes pierce the cortex (El-Najjar and Robinson 1976; Hooton 1930; Ortner and Putschar 1985; Roberts 1987). Iron deficiency anemia can have a variety of causes in addition to an iron-deficient diet, including poor absorption and heavy iron losses (Wing and Brown 1979), diseases of the digestive system (Layrisse and Roche 1964), hookworm (Shattuck 1938), parasitic infection (Saul 1972), and the synergistic relationship between anemia and infection (Lallo et al. 1977; Scrimshaw and Tejada 1970).

At Iximche’ healed porotic hyperostosis was identified on one or more cranial bones of seven individuals. Standardizing results by considering only bones with 50% or more of the ectocranial surface preserved, 5 of 32 occipitals (15.6%) that could be evaluated had lesions. This frequency of lesions represents a minimum estimate of iron deficiency anemia because bone changes are rare in modern populations and duration is a more important factor than severity (Ortner and Putschar 1985; Perou 1964). The frequency at Iximche’ is low compared to frequencies in most other Maya skeletal series (Whittington 2003:256).

Periosteal reactions are bone lesions produced by periostitis or osteomyeletis. Periostitis is inflammation of the periosteum, a membrane that overlies a bone’s surface, and can be caused by trauma, infection, or as a secondary process of certain specific diseases. It is a valuable indicator of stress (Mensforth et al. 1978). Osteolmyelitis is caused by destructive invasion of the periosteam and bone marrow by pyogenic microorganisms (Luck 1950). Periostitis usually involves pathological changes in which new bone is laid down on the surface of the underlying cortex (Ortner and Putschar 1985).

Active or healed periosteal reactions were present on one or more cranial vault bones of 8 or 9 individuals. The highest frequency of lesions in bones with more than 50% of their surfaces preserved was 13.3% on the ectocranial surface of the right parietal. This is low compared to evidence of cranial infections in other Maya skeletal series (Whittington 2003:262).

Seven maxillas had bony changes related to sinusitis or other sinus or nasal infections. These may have been caused by infections of the upper respiratory tract or dentition (Boocock et al. 1995). The frequency of such lesions cannot be evaluated accurately for Iximche’ because they were generally only visible when sinuses were exposed in broken maxillas. However, the frequency appears to be relatively high and agrees with reports that respiratory infections were common in highland Guatemala in the fifteenth century (Goff 1953).

Low frequencies of porotic hyperostosis and periosteal reactions could reflect relatively good diet and health among those buried at Iximche’. Paradoxically, low frequencies of lesions associated with iron deficiency anemia and infection may mean that people died before lesions formed, not that they were healthy (Wood et al. 1992). However, considering that many of the skeletal remains at Iximche’ came from individuals whose lives were cut short by warfare or sacrifice, this explanation seems unlikely. Therefore, low frequencies may reflect relatively good diet and health among those buried at Iximche’, but influenced by overlapping factors, such as social status, synergism between infection and anemia, parasite load, altitude above sea level, and others.

Chronologic enamel hypoplasia is a condition in which horizontal defects caused by severe metabolic disturbance (Sarnat and Schour 1941, 1942) occur in tooth enamel. Defects were recorded for a subset of 19 individuals whose third molars underwent stable isotopic analysis. The enamel of the mandibular permanent lateral incisors, canines, and second premolars were evaluated for stresses occurring during the first seven years of life, when the enamel is forming. Of the 19 individuals, 17 (89%) had at least one defect formed during early childhood. This frequency and the mean frequency of six-month enamel sections with defects at Iximche’ (0.30) is similar to what has been observed in other ancient Maya skeletal samples (Whittington 2003:274). The age distribution also is similar to what has been reported for other ancient Maya populations, peaking at 4.0 to 4.9 years of age. Saul (1972) attributed a peak in defects around that age to nutritional and infectious disease stresses associated with weaning, but others (e.g., Judkins and Baker 1996; Katzenberg et al. 1996) argued that hypoplastic defects do not reflect age of weaning well. However, studies of stable isotopes in teeth and bones from Maya sites have tended to support late weaning. Children were breast-fed until they were at least 3 or 4 years old and as old as 6 years of age at Kaminaljuyu and Altun Ha (White et al. 2001; Wright and Schwarcz 1998, 1999).

In general, individuals buried at Iximche’ experienced similar amounts of stress during early childhood, no matter what their demographic or social characteristics. Comparisons of mean ranks using the Mann-Whitney *U* test show no evidence that the number of enamel defects is different for decapitation/probable decapitation vs. nondecapitation/probable non-decapitation, female/probable female vs. male/probable male, or adult vs. young adult groups at Iximche’. Levene’s *F* test for homogeneity of variance indicates that the ranges of variation between female/probable female vs. male/probable male and adult vs. young adult groups are not statistically different. Data are too sparse to test this for decapitation/probable decapitation vs. nondecapitation/probable nondecapitation groups.

The correlation between the frequency of defective enamel sections and *δ*13Csc from the teeth is low (Pearson’s *r* = –0.28) in the sample of 19 individuals, which is not statistically significant. This is not unexpected, since the hypoplastic defects are reflecting stresses during the first seven years of life, while *δ*13Csc is reflecting diet between 9 ± 2 and 12 ± 3 years of age, when third molar crowns typically form in American Indians (Ubelaker 1989).

Presence of dental caries at Iximche’ was recorded for all available permanent teeth. The mean frequency of carious teeth at Iximché (0.09) is lower than frequencies reported for many other Maya skeletal series (Whittington 2003:277). In comparison with permanent teeth from southern Ontario skeletal populations (Patterson 1984:313), the majority practicing horticulture based on maize, the frequency for Iximche’ is slightly greater than the highest three frequencies for five groups relying on hunting and gathering (0–0.08). It is lower than any of the frequencies for three groups of maize-based horticulturalists relying somewhat on hunting and gathering or fishing (0.11–0.30) and is much lower than the frequencies for six groups relying more heavily on maize-based horticulture (0.22–0.41).

Individuals buried at Iximche’ had similar frequencies of dental caries, independent of their demographic or social characteristics. Mann-Whitney *U* and Levene’s *F* tests indicate no significant differences in dental caries for decapitation/probable decapitation vs. nondecapitation/probable nondecapitation, female/probable female vs. male/probable male, or adult vs. young adult groups at Iximche’.

Comparison of *δ*13Csc to frequencies of carious teeth per individual for the same 43 individuals whose third molars were studied for stable isotopes would seem to be a valid approach to exposing the relationship between stable isotopes and this skeletal indicator of diet. The correlation is low (Pearson’s *r* = –0.12) and not statistically significant. Frequency of dental caries appears to be statistically unrelated to degree of dependency on maize in the diet and in the skeletons from Iximche’.

One way to interpret the caries data is that people buried at Iximche’ did not rely particularly heavily on maize-based horticulture, but this is at odds with stable isotope data. Low caries frequency can also be related to infrequent consumption of carbohydrates during the course of the day (i.e., few snacks between meals) rather than a low proportion of carbohydrates in the diet (Bibby 1961). This is a more reasonable interpretation.

Polishing of the labial surface or one or more mandibular incisors or canines, reportedly caused by the use of lip plugs in a Rupert Harbour, British Columbia skeletal series (Milner and Larson 1991:370), could be a sign of high status (Miller 2012:239) or foreign origin, or both. No labrets were excavated at Iximche’, but Carmack (1981:262) reported an amber labret from a burial exacavated at Q’umarkaj, the K’iche’ capital. Mann-Whitney *U* and Levene’s *F* tests indicate no significant differences in polishing between adult and young adult groups at Iximche’. The small number in the nondecapitation/probable nondecapitation group that could be evaluated (*n* = 1) makes statistical comparisons with the decapitation/probable decapitation group dangerous. However, there are significant differences in polishing between female/probable female and male/probable male groups (*U* = 34, *p* = 0.04; *F* = 5.33, *p* = 0.03). For individuals that could be evaluated, polishing in the male/probable male group (median = 1.0; mean = 0.83 ± 0.39; *n* = 12) is significantly higher than in the female/probable female group (median = 0.5; mean = 0.40 ± 0.52; *n* = 10). Female/probable female variance for polishing (0.72) is significantly greater than male/probable male variance (0.62). All individuals with labret polishing were in the decapitation/probable decapitation group. Male decapitations may generally have had higher status than female decapitations or may have been more likely to be foreign (but see below).

*Pathology and Migration*

The correlation between frequency of caries and oxygen isotope compositions is low (*δ*18Op: Pearson’s *r* = 0.25; *δ*18Osc: Pearson’s *r* = –0.19). The same is true for the correlation between frequency of six-month enamel sections with hypoplasias and oxygen isotope compositions (*δ*18Op: Pearson’s *r* = 0.18; *δ*18Osc: Pearson’s *r* = 0.02) and the correlation between presence of labret polishing and oxygen isotope compositions (*δ*18Op: Pearson’s *r* = –0.28; *δ*18Osc: Pearson’s *r* = –0.24). There is no evidence that these characteristics of the dentition are related to where individuals originated. Although labret polishing may mark social status, it is not tied to the geographical origin of the individual.

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