Sex-Related Dental Wear Patterns in an Alaskan Population

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Background

Patterns in the rate and distribution of occlusal dental wear differ among populations, based on both diet (what is eaten and how the food is processed), and how the teeth are used for non-masticatory functions, such as using the mouth as a tool for processing or holding objects. Differences may also occur between males and females in a group if they have gender-based divisions of labor. This study will assess differences in wear patterns in males and females in a population of individuals from southwest Alaska.

The individuals examined in this study (Accession 115748, Catalog numbers P363547-566 and P363566-600) were excavated in 1931 by Ales Hrdlička, NMNH, from the Kaskanak Village area on the Kvichak River, Bristol Bay, Alaska, just west of Lake Iliamna (Fig. 1). They primarily represent Yup'ik Eskimo of the 19th century, although this region bordered Athabascan and Aleut (Alutiiq) territories and admixture with these groups and their cultural traditions was likely. Their primary food source was salmon, but they also relied on other foodstuffs including Beluga whales, birds, caribou, bear, and other large game, and wild plants, including celery and berries, to a lesser extent. Meat was preserved through smoking, drying, and freezing. Labor was usually divided by gender, with men making tools, hunting, participating in warfare and women involved in salmon processing, gathering, and domestic tasks such as clothing and basketry production (Salmon, 2008). Grave markers of the area also suggest gender-specific activities, with those of men displaying paddles and bows, and those of women kettles and ladles (Powell and Dudar, 2017). Work also was age-graded, with children not expected to participate in chores until the age of ten (Salmon, 2008).

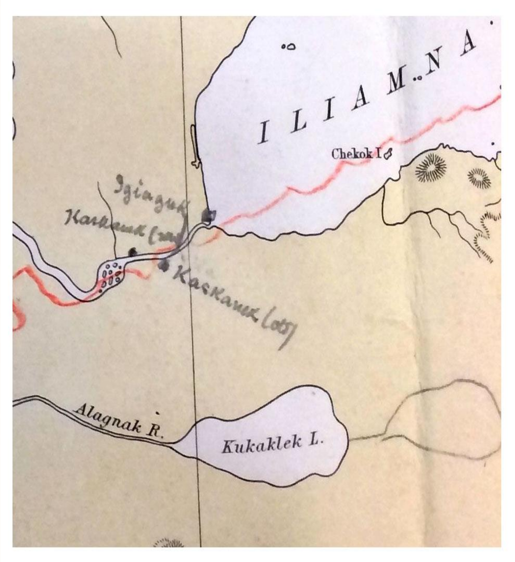

Fig. 1. Location of Kaskanak, Kvichak River (Aleš Hrdlička papers, National Anthropological Archives)

Methods

Dental occlusal wear occurs from the action of materials wearing down enamel to expose the underlying dentin. Wear scoring methods currently used by most researchers assign a qualitative ordinal score to each tooth, comparing it to images and a written description (Smith, 1984) (Fig. 2). These methods are subjective, and data may not be comparable among researchers.

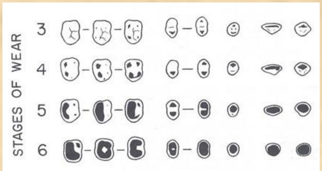

Fig. 2. Dental wear scoring method of Smith (1984)

Instead, we hope to obtain more precision by quantifying wear, taking direct measurements from digital photographs of the occlusal surface of the mandible taken during the repatriation documentation process. (Note that the maxillary teeth were not used due to a high incidence of postmortem loss of the incisors.) Using the free-form selection option in Photoshop (v.22.4.3), the area of dentin exposure of the left teeth (right substituted when necessary) was traced as well as the total occlusal surface area. An XP-Pen tablet and stylus were used to optimize precision (Fig. 3). The number of pixels within each area was determined, and the **dentin proportion** calculated using Behrend's (1977) ratio: the dentin area divided by the total dentin surface, multiplied by 100. All M1 measurements were repeated by the first author two weeks after completion of the initial data collection. A paired samples t-test demonstrated no significant differences between the means ($t(18) = 1.673, p = .112$).

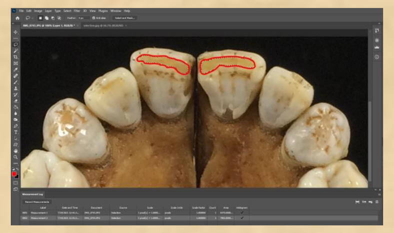

Fig. 3. Tracing of exposed dentin on the maxillary central incisors of a 38-year-old white male (HTH 581) from the Hamann-Todd Collection (Photo by R. Coolidge)

As wear tends to increase with age and this population represents a range of ages, its effect was controlled for by relating the dentin proportion for each tooth to that of the first molar, the first permanent tooth to erupt (Fig 4). This **wear ratio** divides the dentin proportion for each tooth by that of the first molar. Teeth with a wear ratio close to 1 show the same amount of wear as the first molar, while those with a higher wear ratio wore faster than the first molar, and those with a score less than 1, slower (Clement and Hillson, 2012).

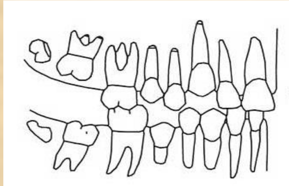

Fig. 4. Dental eruption stage at 11 years (Ubelaker, 1989)

Results

Individuals by Age and Sex	All	<35 Years	>35 Years
Male	9	6	3
Female	10	5	5
Total	19	11	8

Fig. 5. Ages and sexes of individuals in study

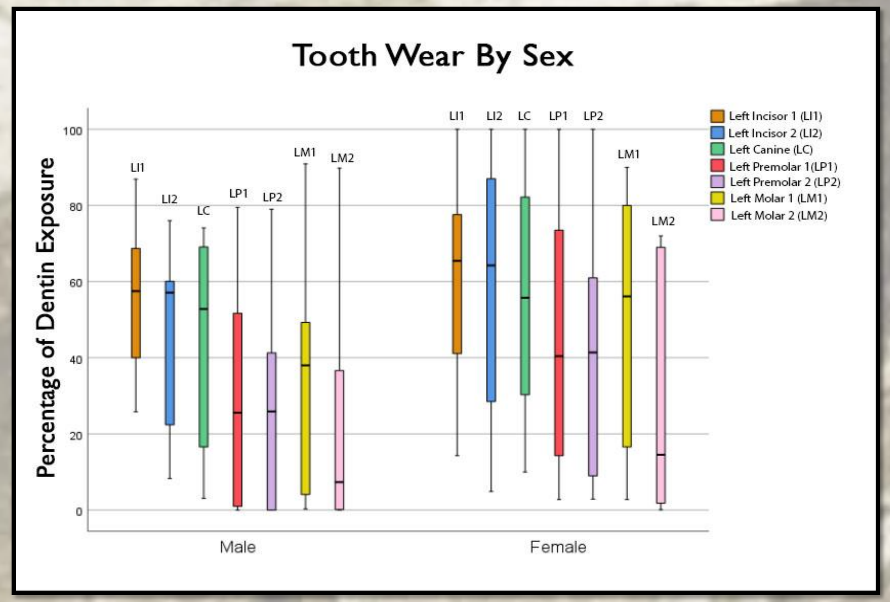

Fig. 6. Percentage of dentin exposure on tooth categories by sex

Tooth Frequencies and Median Wear Ratios by Sex

		I1	I2	C	P1	P2	M2
Male	N	9	9	9	9	9	8
	Median Wear Ratio	2.3	2.0	1.9	.8	.6	.2
Female	N	8	10	10	10	9	10
	Median Wear Ratio	1.2	1.2	1.0	.9	.9	.3
Total	N	17	19	19	19	18	18
	Median Wear Ratio	1.4	1.3	1.2	.9	.8	.3

Fig. 7. Tooth frequencies and median wear ratios by sex

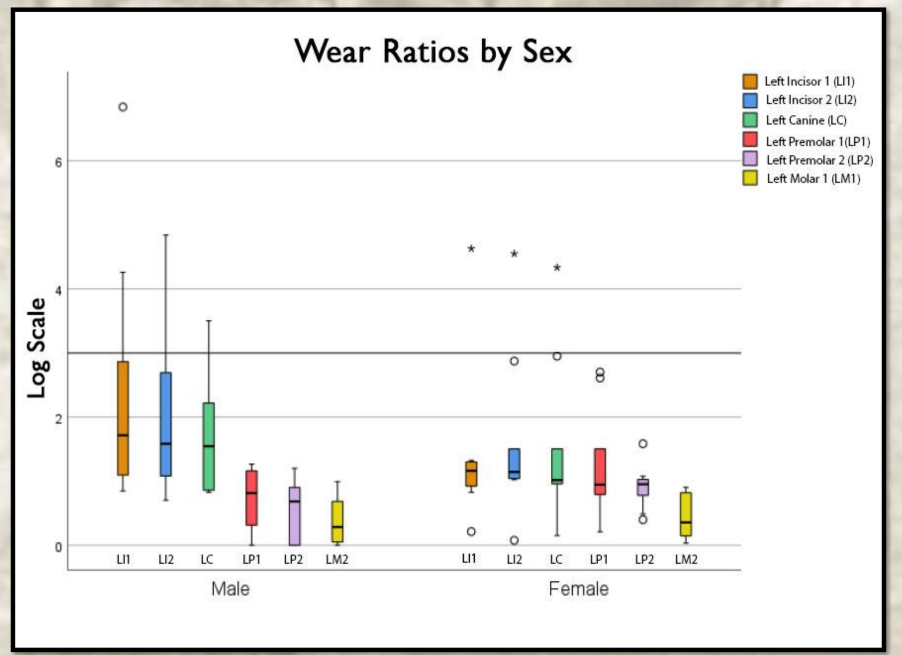

Fig. 8. Wear ratios by tooth and sex
Mandibular tooth wear by sex with combined age groups plotted on a logarithmic scale. Refer to Figure 7 for sample sizes and median values. "O" represents outliers greater than 1.5 times the interquartile range. "*" represents outliers at greater than 3 times the interquartile range.

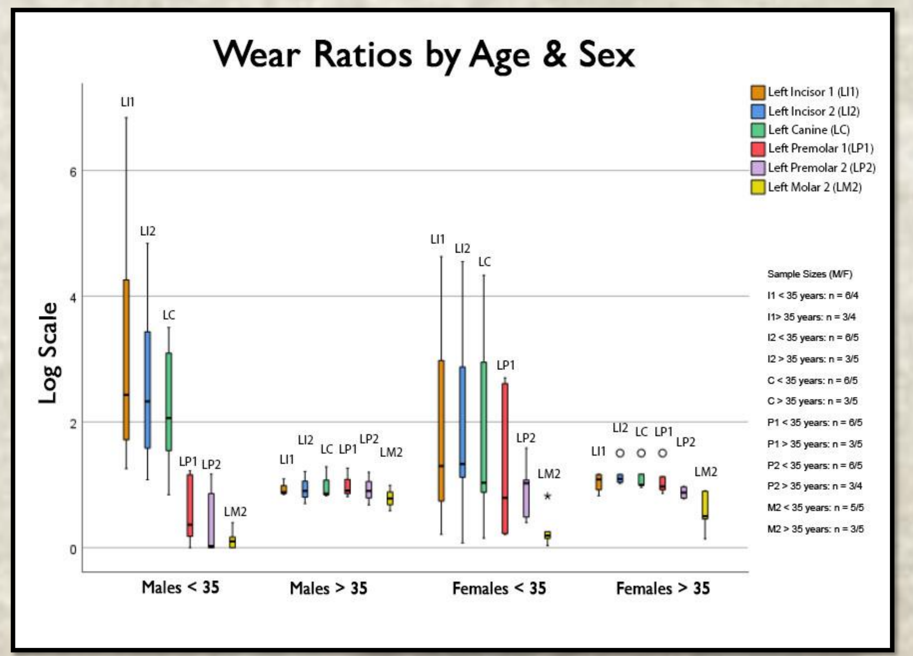

Fig. 9. Wear ratios by tooth, sex, and age category
Mandibular wear ratios comparing males to females, plotted by age groups on a logarithmic scale. See in-graph key for sample sizes. For explanation of plot symbols, see Figure 8.

The dentition of only 19 adult individuals was available for this study, 9 males and 10 females (Fig. 4). Due to the small sample size, several missing values, and violation of various assumptions, parametric and nonparametric hypothesis testing could not be conducted. Instead, we discuss the trends observed in the plotted data. Results are discussed in terms of median wear values, rather than means, due to the presence of outliers.

The box plots in Figure 6 show the dentin proportion data by sex, showing the entire range for each tooth without control for age. The medians are not markedly dissimilar between the sexes in the anterior teeth; however, females exhibit more wear on the premolars and first molar.

Given that the incisors and first molar erupt at roughly the same age and the remaining teeth later (Fig. 3), we would expect the incisor wear ratios to be close to 1, and the others less than 1. For females, that expectation is not met for the incisors or canines, but is for the posterior teeth, although all teeth (except the second molar) show slightly higher-than-expected wear. Males, however, have much higher wear ratios for incisors and canines than females (almost double, at 2.3 for the first incisor, 2.0 for the second, and 1.9 for the canine) (Figs. 6 &7). The sequence of eruption suggests the scores for premolars and the second molar should be less than 1, and that expectation has been met.

As variation in tooth wear evens out over time, examining the data by age category provides a more nuanced view of wear differences (Fig. 8). This data reinforces the differences discussed above, showing wear concentrated on the incisors and canines of the younger males, a pattern obscured in the older individuals. Younger females show a pattern of wear more widely spread throughout the dentition, including the premolars.

Discussion

Previous studies have suggested that groups primarily relying on hunting and gathering generally show low rates of posterior and high rates of anterior wear as opposed to agriculturalists, due to less consumption of abrasive plant material (Deter, 2009). As noted, individuals from Kaskanak consumed relatively little vegetation, instead eating substantial amounts of dehydrated meat for much of the year. While it seems logical that this tough material would have led to significant wear on the posterior teeth, Merbs (1983) notes that, in the Arctic, a small amount of dried meat was sliced off, then swallowed without chewing. This supports the pattern seen here of lower wear on the second molars relative to more anterior teeth.

Merbs (1968) notes that males used their anterior teeth on objects of small diameter, concentrating wear on a small number of teeth, while females used their teeth to process larger objects, leading to wear spread more evenly around the mouth. Ethnographic accounts of the Arctic groups suggest that teeth were often used as tools or "third hands". Among men, they were used for activities such as grasping bow drills and bending kayak ribs. Bow drills, for example, were extensively used throughout the region for drilling holes in hard materials and starting fires (Figure 10; Hough, 1929). The mouthpiece of the drill was clenched in the anterior teeth (incisors and canines) with such force that tooth marks can be seen on extant drills in museum collections. The resulting motion and force used during activities such as during drilling likely contributed to increased tooth wear. Women used their teeth for tasks such as hide processing and basketry production, which concentrated on the anterior teeth and premolars. Molnar (1971) also notes that women also consumed more abrasive plant foods while gathering, which would have been processed by posterior teeth.

Our data support the ethnographic evidence of gender-specific labor in the Arctic, echoing the findings of researchers such as Clement and Hillson (2012) among the Igoolik Inuit of Canada, with males exhibiting marked anterior tooth wear and females showing both higher-than-expected, but relatively uniform, wear throughout the mouth.

Further studies on groups from other areas with different subsistence methods or cultural practices might help to elucidate wear patterns associated with those diets and lifeways. This methodology could help to support or assign cultural affiliation to unknown individuals or groups in repatriation assessments. This study also demonstrates the utility of images taken during the NMNH's repatriation documentation process for assisting in such assessments after remains have been returned.

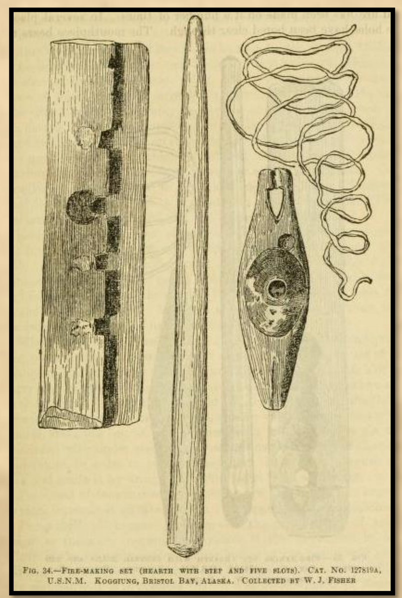

Fig. 10. Image of a bow drill from Kvichak River, Alaska (E127819, from the collections of the Department of Anthropology, NMNH). Note the mouthpiece of the right, which would have been clenched between the teeth.

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