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Tooth Wear of a Medieval Japanese Population From the Yoshimohama Site

Yousuke Kaifu

Department of Anthropology, National Science Museum,
3–23–1 Hyakunincho, Shinjuku-ku, Tokyo, 169–0073 Japan

Abstract Occlusal tooth wear of the human skeletal remains from the Yoshimohama site was compared with those from the Zaimokuza site in order to examine local variation of temporal characteristics in tooth wear of the medieval Japanese populations. The two samples showed broad similarity in both degree and pattern of wear with some minor differences. Wear severity of these populations was, compared with the premodern Edo population from the Tokyo area, distinctly heavier on the posterior teeth while equally light on the maxillary anterior teeth.
Key words: Attrition, Tooth wear, Japanese

In the author's previous study (Kaifu, 1999), temporal changes in the pattern of tooth wear was investigated in the Japanese populations from the Jomon to Recent periods. It was revealed that the pattern of reduction of occlusal wear severity was not similar between the anterior and posterior portions of the dentition. Occlusal wear on the anterior teeth was noticeably lighter in prehistoric agriculturists (Yayoi people) and later populations than in the prehistoric hunter-gatherers (Jomon people), while clear reduction of occlusal wear on the posterior teeth occurred after the medieval times. However, the medieval and premodern (Edo period) materials used in that study were restricted to specimens from the Kanto District, eastern Japan. In a more detailed investigation, we should investigate the materials from various regions in Japan. In the present study, the condition of occlusal tooth wear is examined in a medieval population from Yamaguchi Prefecture, western Japan.

Materials and Methods

The materials used in this study and other relevant information are presented in Table 1. Hereafter, the term Yoshimohama is used to refer to the sample from the Yoshimohama site. Terms Yayoi, Zaimokuza Kamakura, and Edo are used to refer to the same samples as in the previous study (Kaifu, 1999).

Subsistence pattern and other relevant information about the later three populations are available in Kaifu (1999). The medieval human skeletal remains of 107 individuals from the Yoshimohama site were unearthed during 1962–1982. The detailed description, measurements, and results of morphological comparisons with other

Table 1. Materials used in this study.

Sample name	Period	Estimated age of the samples	Regions	N[1]				Collection[2]
				M	F	juv.	Total	
Yoshimohama	Muromachi (Medieval)	AD 1300 – AD 1600	Yamaguchi	10	12	6	28	Kyushu Univ.
Yayoi	Yayoi (Prehistoric)	300 BC – AD 300	Northern Kyushu and Yamaguchi	20	15	7	42	Kyushu Univ.
Zaimokuza Kamakura	Kamakura (Medieval)	AD 1333	Kanto	55	35	8	98	TUM, NSM
Edo	Edo (Premodern)	AD 1600 – AD 1868	Tokyo	46	29	6	81	NSM

[1] The number of sexed individuals (dental age≥14) (columns M and F) and unsexed individuals (dental age<14) (in "juv." Column; Juv., juveniles).

[2] TUM, University Museum, Univ. of Tokyo; NSM, National Science Museum, Tokyo.

Japanese ancient skeletal remains were published by Nakahashi and Nagai (1985). In that report, they briefly described about the condition of tooth wear of the Yoshimohama specimens as "generally heavier than considered from inferred age of each specimen" (English translation by the present author).

The material selection criteria of this study is the same as in the previous paper (Kaifu, 1999) and described in detail therein. Only basic points are outlined below. Among skulls with their first molars fully erupted, those with antemortem loss of no more than two teeth in the ante-third molar dentition were selected if they were judged as maintaining original normal wear pattern. Dental age was judged for subadult specimens with reference to Ubelaker (1989, Figure 71), from 7 to 20.5 years with an interval of 0.5 years. Sex was determined by the present author for the specimens with dental age of 14 or more mainly on the basis of pelvic and cranial morphology.

The first and second molars were used as representing wear on the posterior teeth, and the canine and central incisor were used as representing wear on the anterior teeth. These teeth were chosen in view of their relative positions in the dentition and convenience in wear quantification.

The scoring method proposed by Scott (1979) was used to quantify wear severity on the molars (*M2* and *M1 wear score*). In this method, the occlusal surface is visually divided into four quadrants and each is graded 1–10. The score for the whole tooth is the sum of these four numbers and ranges from 4–40. For the occlusal wear parameter on the anterior teeth, buccal crown height was used (*C* and *I1 crown height*). The mean of right and left sides was used for the analyses but one side was used when the data of the other side was not available.

Table 2. Rotated factor loadings.

	Males						Females					
	Maxillae			Mandibles			Maxillae			Mandibles		
Variables	F I	F II	F III	F I	F II	F III	F I	F II	F III	F I	F II	F III
M2 wear score	0.91	−0.26	−0.28	0.78	−0.34	0.28	0.93	−0.21	0.17	0.58	−0.20	0.28
M1 wear score	0.88	−0.30	−0.28	0.92	−0.26	0.31	0.93	−0.17	0.22	0.90	−0.22	0.22
C crown height	−0.31	0.87	0.38	−0.35	0.41	−0.84	−0.24	0.41	−0.88	−0.28	0.50	−0.78
I1 crown height	−0.36	0.45	0.82	−0.33	0.85	−0.40	−0.23	0.89	−0.39	−0.20	0.92	−0.31
Total contribution (%)	45.7	28.0	24.0	41.7	26.9	25.8	46.1	25.9	25.1	31.7	29.5	20.6
Cumulative prop. (%)	45.7	73.7	97.7	41.7	68.6	94.4	46.1	72.0	97.1	31.7	61.2	81.8

Table 3. Mean factor scores.

	Males						Females					
	Maxillae			Mandibles			Maxillae			Mandibles		
	N	F I	F II	N	F I	F II	N	F I	F II	N	F I	F II
Yoshimohama	10	1.41	−0.36	10	1.11	−1.05	10	1.25	0.03	10	0.94	0.00
Yayoi	17	0.76	0.23	14	0.86	−0.17	14	−0.05	−0.80	11	−0.11	−0.71
Z. Kamakura	47	−0.14	−0.16	21	0.19	0.48	27	0.10	0.24	16	0.43	0.16
Edo	40	−0.44	0.23	35	−0.51	0.26	20	−0.61	0.53	24	−0.51	0.31

Principal component analyses (PCAs) were applied to the combined adolescent and adult subsamples using the four occlusal wear parameters as the variables. By this method, between-sample comparisons can be made for the distribution of wear severity and antero-posterior wear gradient. The rate of wear was also assessed by bivariate analyses between wear severity and dental age for subadult subsamples. All the statistical procedures were performed using SYSTAT Macintosh 5.2.1 (SYSTAT, Inc, 1992).

Results

Principal component analysis

The principal component analysis (PCA) was performed using *M2* and *M1 wear score*, and *C* and *I1 crown height* as variables. Materials analyzed were those specimens whose sex was determinable (dental age≥14). The matrix used was the correlation matrix (computed by the pairwise deletion method) of the pooled sample. The principal components were rotated using the Varimax method to achieve more meaningful factor loadings and the results are shown in Table 2. In both jaws and sexes, the first factor (Factor I) gives greater scores if wear on the posterior teeth is heavy,

and the second factor (Factor II) gives greater scores if wear on the anterior teeth is light. Two factors explain about 60–70% of the total variance in every case. The factor scores for each individual are shown in Figure 1 and the average scores for each sample are tabulated in Table 3. Table 4 shows the result of Mann-Whitney *U* test for these scores between the Yoshimohama and other samples.

Degree of wear in both the maxillary and mandibular molars of Yoshimohama is close to Yayoi in males but heavier than the other comparative samples in both sexes. Degree of wear in both the maxillary and mandibular anterior teeth of Yoshimohama is generally not significantly different from that of the other comparative samples, except that wear on the mandibular anterior teeth of males is greater in the Yoshimohama than the Zaimokuza Kamakura and Edo.

Regression analysis

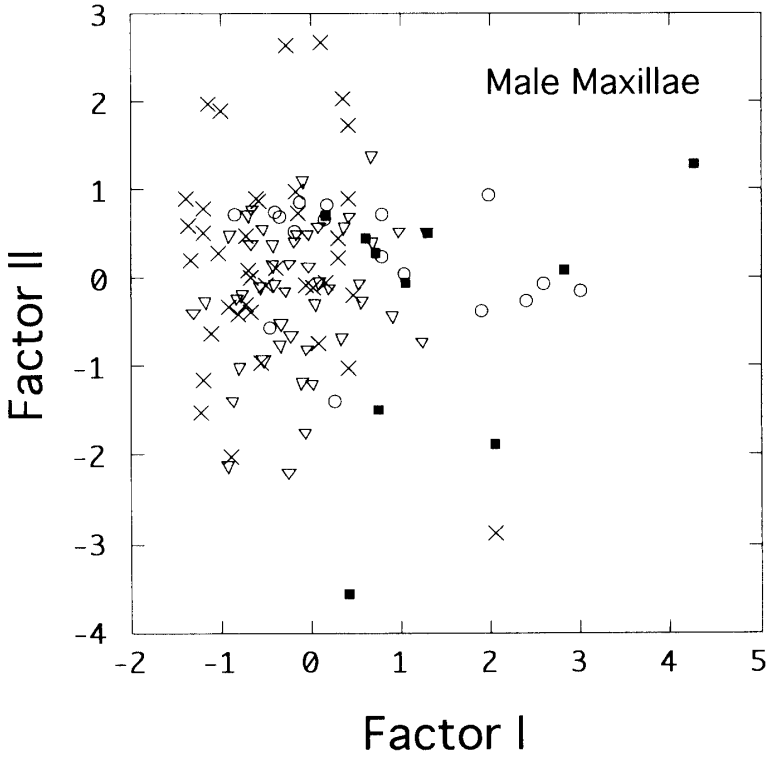
Table 5 shows the regression coefficients of the wear scores on dental ages for subadult subsamples for which dental age can be assessed. Both sexes were mixed here because sex determination is difficult for an individual before adolescence. The wear score for a molar immediately after eruption is 4 in Scott's system (Scott, 1979). In the standard adopted in this study (Ubelaker, 1989), dental age for an individual with just completed eruption of the second molar is about 13, and that for the first molar is 7. Thus, the regression equations in Table 5 are controlled to path (13, 4) for the second molar, and (7, 4) for the first molar. The equations for the anterior teeth are ordinal ones because average initial crown height for the parent populations can not be accurately inferred for the anterior teeth owing to the small sample sizes.

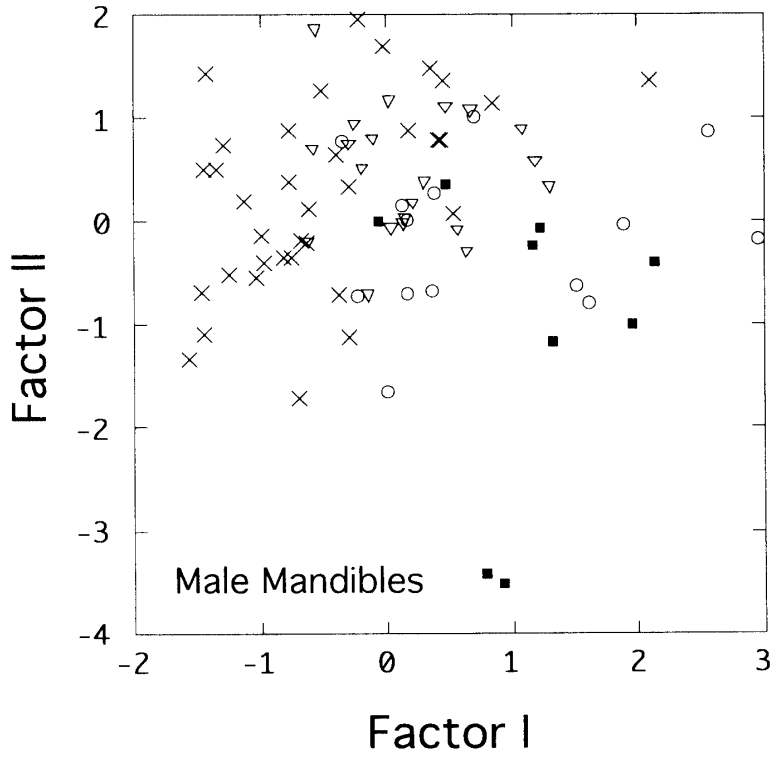
In the molars, the Yayoi shows the greatest slope and the Edo shows the least slope in every case, as indicated in the previous study (Kaifu, 1999). The slopes of Yoshimohama and Zaimokuza Kamakura are in between these two samples and are generally close to each other. The slopes for the anterior teeth are negative in most cases because the crown heights are used as wear parameters. In the anterior teeth, the Yayoi generally shows the least slope in every case. The slopes of Yoshimohama are generally close to zero and similar in this trend to the Zaimokuza Kamakura and Edo. One exception to this later tendency is the mandibular central incisor in which Yoshimohama is close to the condition seen in Yayoi.

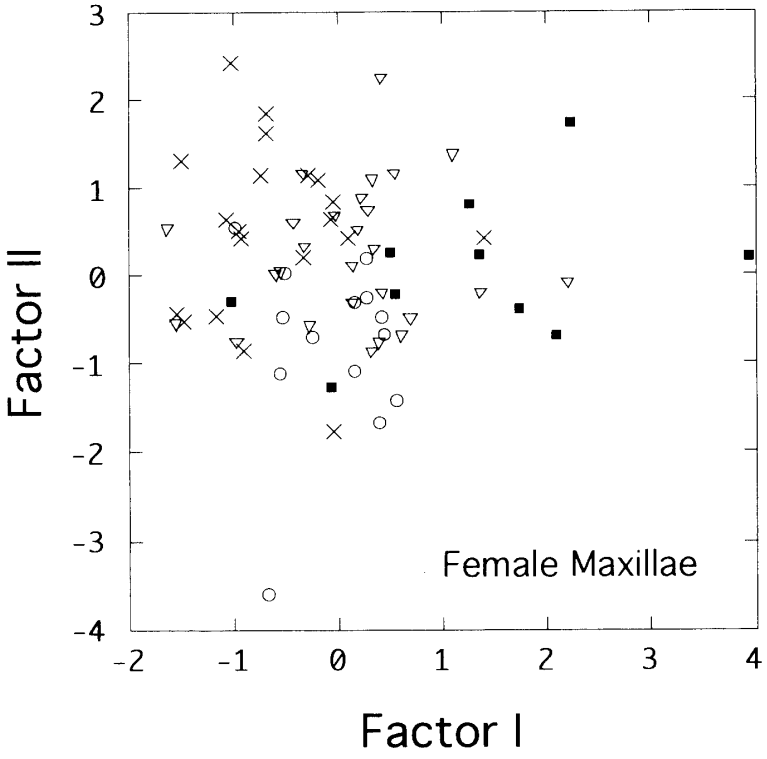
Discussion and Conclusions

The results of PCA presented above are complicated by possible difference in age distribution among the samples. The shortcoming of this analysis is partly complemented by integrating the results of regression analyses.

Fig. 1. Scatterplots of the first and second factor scores. Solid squares, Yoshimohama; open circles, Yayoi; open triangles, Zaimokuza Kamakura; x, Edo.







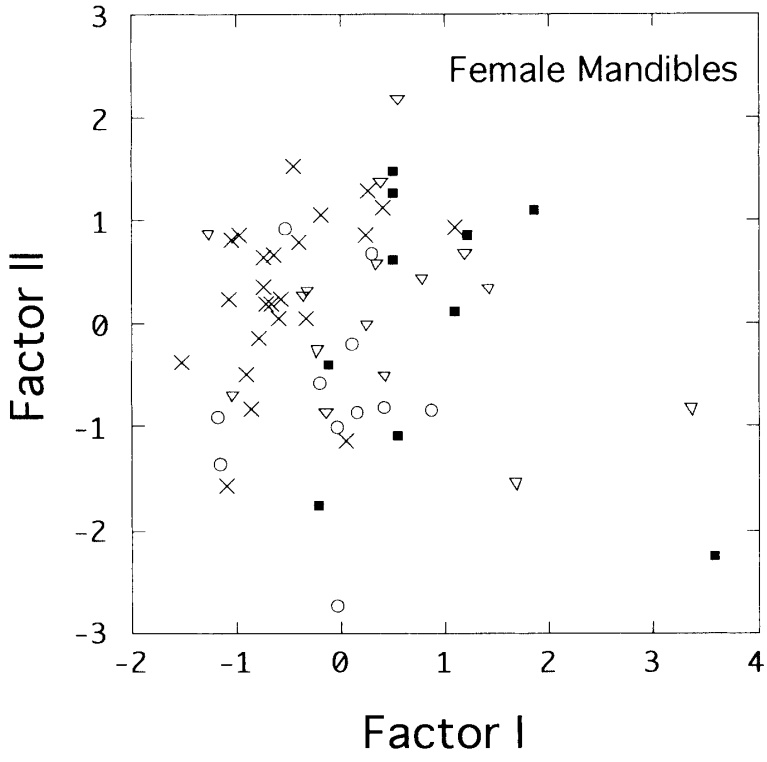


Fig. 1. (continued)

Table 4. Results of Mann-Whitney *U* test for the factor scores between the Yoshimohama and other samples.[1)]

	Yayoi			Kamakura			Edo		
	N	*U*	Prob.	N	*U*	Prob.	N	*U*	Prob.
Male maxillae (10)									
Factor I	17	57	0.16	47	37	0.00	40	382	0.00
Factor II	17	103	0.37	47	222	0.79	40	174	0.53
Male mandibles (9)									
Factor I	14	47	0.31	21	29	0.00	35	296	0.00
Factor II	14	85	0.17	21	168	0.00	35	71	0.01
Female maxillae (10)									
Factor I	14	24	0.01	27	60	0.01	20	178	0.00
Factor II	14	34	0.04	27	155	0.49	20	65	0.12
Female mandibles (10)									
Factor I	11	19	0.01	16	52	0.14	24	225	0.00
Factor II	11	37	0.20	16	79	0.96	24	112	0.76

[1)] Sample size of Yoshimohama in parentheses.

Table 5. Regression coefficients for the subadult subsamples (mixed sex).[1)]

	M2 wear score			M1 wear score			C crown height					I1 crown height				
	N	b	SE of b	N	b	SE of b	N	r^2	b	a	SE of b	N	r^2	b	a	SE of b
Maxillae																
Yoshimohama	3	0.87	0.52	8	0.80	0.08	6	0.02	−0.02	10.39	0.09	9	0.43	−0.07	12.24	0.03
Yayoi	3	1.35	0.25	9	0.84	0.13	6	0.81	−0.23	13.21	0.06	10	0.66	−0.19	13.89	0.05
Z. Kamakura	17	0.99	0.15	27	0.82	0.05	24	0.06	−0.06	11.40	0.05	23	0.01	0.01	11.12	0.04
Edo	16	0.64	0.10	19	0.49	0.05	15	0.01	0.04	10.66	0.10	16	0.01	0.03	11.88	0.07
Mandible																
Yoshimohama	4	0.75	0.33	7	0.79	0.07	6	0.39	−0.04	10.87	0.03	9	0.58	−0.13	10.53	0.04
Yayoi	4	1.57	0.22	9	0.82	0.11	6	0.78	−0.26	14.10	0.07	9	0.33	−0.11	10.40	0.06
Z.Kamakura	10	1.19	0.09	13	0.78	0.06	11	0.13	−0.11	11.71	0.09	13	0.01	−0.01	8.96	0.05
Edo	16	0.51	0.09	19	0.47	0.06	18	0.00	0.02	11.41	0.09	11	0.08	−0.05	10.17	0.06

[1)] The regression equation is: (wear parameter)=b*(age)+a.

One of the important findings in the previous study (Kaifu, 1999) was the remarkable reduction of occlusal wear on the molars after the medieval period. The present study confirmed that a medieval population from western Japan also showed heavier occlusal wear on the molars compared with the later Japanese populations. On the other hand, this study did not give clear-cut conclusions whether there was significant difference in the degree of molar wear between the Zaimokuza Kamakura

and Yoshimohama populations. In the PCAs, the Yoshimohama showed significantly heavier wear on the molars than in the Zaimokuza Kamakura. However, the results of the regression analyses suggested that they were almost equal in wear rate of the molars. Because there is evidence that the present Zaimokuza Kamakura sample includes younger individuals more than in the Yayoi and Edo (Kaifu, 1999), it may be more reasonable to regard that the degree of molar wear was generally similar between the two populations. Wear severity on the molars of the Yoshimohama was not significantly different from the Yayoi.

The results for wear severity of the anterior teeth were generally consistent between the two analyses. The Yoshimohama was similar to the Zaimokuza Kamakura and Edo in showing lighter wear than the Yayoi condition, except that the mandibular central incisor of the Yoshimohama seemed to have worn to the similar extent to the Yayoi at least in males.

Kaifu (1999) inferred that the adoption and diffusion of chopsticks had influenced upon the reduction of wear severity on the anterior teeth after the Yayoi period. Although the Yoshimohama sample showed relatively heavy wear on the mandibular incisors than the Zaimokuza Kamakura, this is not negative evidence for the proposed interpretation. The adoption of chopsticks must have reduced the role of anterior teeth in initial food preparation. Therefore, both the maxillary and mandibular anterior teeth are expected to be worn in the absence of chopsticks. Limited wear severity on the maxillary anterior teeth of Yoshimohama suggests that they were not used intensively for food preparation.

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