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# Health status in early modern Somali people from their skeletal remains

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**To cite this article:**

Hisashi Fujita. Health Status in Early Modern Somali People from their Skeletal Remains. *International Journal of Archaeology*. Vol. 2, No. 3, 2014, pp. 12-16. doi: 10.11648/j.ija.20140203.11

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**Abstract:** This study discusses the paleohealth of Somali men who lived between the end of the 19<sup>th</sup> century and the early 20<sup>th</sup> century and whose skeletal remains are stored at the University of Cambridge. These materials were divided into an early middle age group and a late middle age group based on the degree of cranial suture closure. Physical anthropological methods were used to examine their caries, periodontal disease antemortem tooth loss (AMTL), dental attrition level, alveolar bone loss, enamel hypoplasia, cribra orbitalia, and cranial porotic hyperostosis. There were limitations, such as the small number of individuals examined, all the individuals were men, and the postcranial skeletons were not examinable. This study observed the following findings regarding the paleohealth of Somalis from the end of the 19<sup>th</sup> century to the early 20<sup>th</sup> century: (1) the caries rate was low, (2) there was onset of periodontal disease and it progressed with aging, (3) the number of missing teeth was low, (4) the dental attrition level was lower than the level in Nigerians, and (5) there was minimal change in stress markers with aging, and only a small number of individuals exhibited severe stress markers. The results led to the speculation that the nutritional status was generally poor in Somali individuals examined in this study and that the mortality rates were high in newborns, infants, and young children, which resulted in deaths in individuals with severe stress markers before adulthood.

**Keywords:** Dental Diseases, Aging, Stress Markers, Somali, Human Skeletal Remains, Paleoepidemiology

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## 1. Introduction

Dental diseases and cranial stress markers in modern-day Somalis who were thought to have died in the first half of the 20<sup>th</sup> century were investigated. A literature search in the PubMed database showed that only a very small number of studies have evaluated dental disease and hygiene conditions in Somalis [1-4].

Paleopathological studies on ancient human skeletal remains are thought to have considerable significance to physical anthropology and modern medicine. Physical anthropologists who study ancient human skeletal remains typically evaluate only excavated human skeletal remains. However, there are many benefits for research if various types of information regarding modern people are incorporated into the analysis of ancient human skeletal remains.

This study aimed to elucidate the state of dental diseases and cranial stress markers in modern-day Somalis because very little has been elucidated to date. The paleohealth of people of that time is discussed from the perspective of

paleopathology and paleoepidemiology.

## 2. Materials and Methods

The samples analyzed in this study were nonexcavated human skeletal remains that were obtained from the suburbs of Berbera and stored at the University of Cambridge since 1941. Even at the laboratory of the University of Cambridge, no further information is available regarding these samples. A total of 63 individuals were housed in the laboratory. Only two of these individuals were women, and they were estimated to be of late middle age. Women were excluded from this study because the number of women was too small to be suitable for a scientific study. In the same fashion, individuals whose sex and age were unclear have also been excluded. The materials used in this study ultimately involve 56 individuals. The IDs of those individuals are as follows: Af.15-0-2, Af.15-0-3, Af.15-0-4, Af.15-0-5, Af.15-0-7, Af.15-0-8, Af.15-0-11, Af.15-0-12, Af.15-0-13, Af.15-0-14, Af.15-0-15, Af.15-0-16, Af.15-0-17, Af.15-0-18, Af.15-0-19, Af.15-0-20, Af.15-0-21, Af.15-0-22, Af.15-0-23, Af.15-0-24, Af.15-0-25, Af.15-0-27, Af.15-0-32, Af.15-0-33, Af.15-0-34,

Af.15-0-35, Af.15-0-36, Af.15-0-37, Af.15-0-38, Af.15-0-39, Af.15-0-41, Af.15-0-42, Af.15-0-43, Af.15-0-44, Af.15-0-45, Af.15-0-46, Af.15-0-47, Af.15-0-48, Af.15-0-49, Af.15-0-50, Af.15-0-51, Af.15-0-52, Af.15-0-53, Af.15-0-54, Af.15-0-56, Af.15-0-59, Af.15-0-60, Af.15-0-61, Af.15-0-62, Af.15-0-64, Af.15-0-65, Af.15-0-67, Af.15-0-68, Af.15-0-69, Af.15-0-70, Af.15-0-71.

The ages of the individuals were estimated using the degree of cranial suture closure as the main index [5], and the individuals were divided into two major age groups: early middle-aged and late middle-aged groups. Early middle age was established to be approximately 20 to 39 years old and late middle age was 40 to 49 years old. No individuals appeared to be elderly (50 years or older).

Cariou lesions were classified as C1, C2, C3, or C4 [6]. However, the carious levels were pooled because the number of samples was small. The classification of Fujita (2009) was used for caries sites [7]. Because of the small number of samples, caries was judged as either present or absent, and carious sites were divided into two groups, including coronal caries and root caries. Enamel hypoplasia was classified using the 3 grading levels of Yamamoto [8]. Dental calculus deposits were divided into 4 levels: none, slight, medium, and considerable deposits [9]. Alveolar bone loss was measured using the distance from the CEJ of the maxillary or mandibular first molar to the respective alveolar crest. Tooth

loss was established as antemortem tooth loss (AMTL) if the alveolar socket was closed or in the process of closing. Postmortem tooth loss was identified if the alveolar socket was completely open. The dental attrition level was classified using 8 grading levels based on the method of Fujita [10]. Cribriform orbitalia was classified using 4 grading levels: no cribriform orbitalia, porotic type, cribriform type, and trabecular type [11]. Porotic hyperostosis was reported as either present or absent because there is no standard grading scale for porotic hyperostosis.

A chi-square test was used to compare the AMTL rates, prevalence of dental caries, dental calculus deposit, enamel hypoplasias, and incidences of cribriform orbitalia and porotic hyperostosis by age. The Mann-Whitney U test was used to compare dental attrition by age, and Student's t-test was used to compare alveolar loss by age.

### 3. Results

Table 1 shows the results for the AMTL rate in the early middle age group and the late middle age group. Although these age groups did significantly differ regarding the number of missing teeth in some tooth types, the late middle age group generally had significantly higher AMTL rates, and the number of remaining teeth decreased with age.

**Table 1.** Antemortem tooth loss (AMTL) of Somali people in Early middle age and Late middle age.

	Tooth type					Total	Tooth type					Grand total
	Upper						Lower					
	I	C	P	M	Total	I	C	P	M	Total		
Early middle age												
Observed	168	84	170	252	674	130	65	130	195	520	1194	
Loss	9	3	1	8	21	0	0	3	7	10	31	
SD	0.23	0.19	0.08	0.18	0.17	—	—	0.15	0.19	0.14	0.16	
% AMTL	5.36	3.57	0.59	3.17	3.12	0	0	2.31	3.59	1.92	2.60	
Early middle age vs Late middle age	P=0.135	P=0.333	P<0.01	P<0.001	P<0.001	P<0.001	P<0.05	P=0.051	P<0.001	P<0.001	P<0.001	
	ns	ns	L>E	L>E	L>E	L>E	L>E	ns	L>E	L>E	L>E	
Late middle age												
Observed	52	26	52	78	208	44	22	43	65	174	382	
Loss	7	3	5	18	33	6	3	5	18	32	65	
SD	0.32	0.33	0.3	0.42	0.37	0.35	0.35	0.32	0.45	0.39	0.38	
% AMTL	13.46	11.54	9.62	23.08	15.87	13.64	13.64	11.63	27.69	18.39	17.02	

I: Incisors; C: Canines; P: Premolars; M: Molars in tooth type distribution.

ns: not significant

E: Early middle age; L: Late middle age

Table 2 shows the dental attrition level in the early middle age group and the late middle age group. The dental attrition level increased with aging, and the late middle age group exhibited a significantly higher level of attrition compared

with the early middle age group. However, attrition of incisors and canines did not differ significantly between these two groups.

**Table 2.** Degree of dental wear of Somali people in Early middle age and Late middle age.

	Tooth type					Total	Tooth type					Grand total
	Upper						Lower					
	I	C	P	M	Total	I	C	P	M	Total		
Early middle age												
Observed	12	8	52	121	193	30	15	46	98	189	382	
Wear score	22	20	96	248	386	99	43	88	206	436	822	
Average	1.83	2.50	1.85	2.05	2.00	3.30	2.87	1.91	2.10	2.31	2.15	
SD	0.83	1.07	0.36	0.78	0.71	0.99	1.00	0.36	0.96	0.99	0.88	

	Tooth type										
	Upper					Lower					Grand total
Early middle age vs Late middle age	P=0.079	P=0.501	P<0.05	P<0.001	P<0.001	P=0.292	P=0.092	P<0.05	P<0.001	P<0.001	P<0.001
Late middle age vs Late middle age	ns	ns	L>E	L>E	L>E	ns	ns	L>E	L>E	L>E	L>E
Observed	9	10	27	47	93	7	5	16	43	71	164
Wear score	22	26	65	128	241	26	19	35	122	202	443
Average	2.67	2.5	2.41	2.68	2.58	3.71	3.8	2.44	2.84	2.9	2.7
SD	1.32	1.08	1.19	1.22	1.19	0.49	1.1	0.81	1.4	1.26	1.23

I: Incisors; C: Canines; P: Premolars; M: Molars in tooth type distribution.  
 ns: not significant  
 E: Early middle age; L: Late middle age

Table 3 shows alveolar bone loss. Overall, alveolar bone loss was significantly more advanced in the late middle age group compared with the early middle age group.

Table 3. Alveolar resession of Somali people in Early middle age and Late middle age.

	Tooth type						
	Upper			Lower			Grand total
Early middle age	URM1	ULM1	Total	LRM1	LLM1	Total	
Observed	36	34	70	31	31	61	131
Average	3.13	3.24	3.19	2.16	2.27	2.23	2.74
SD	0.99	1.05	1.01	0.9	0.87	0.86	1.06
Early middle age vs Late middle age	P=0.165	P=0.104	P<0.05	P<0.05	P=0.218	P<0.01	P<0.05
Late middle age vs Late middle age	ns	ns	L>E	L>E	ns	L>E	L>E
Observed	11	9	20	8	7	15	35
Average	3.91	3.89	3.9	3.13	2.71	2.93	3.49
SD	1.64	1.05	1.37	1.25	0.76	1.03	1.31

ns: not significance  
 E: Early middle age; L: Late middle age

Table 4 shows the results for the caries rate. The caries rates were within 1% for both the early middle age group and the late middle age group, and the rates did not increase with aging.

Table 4. Prevalence of dental caries of Somali people in Early middle age and Late middle age.

Early middle age				Late middle age				P-value
Tooth type	Observed	Caries	% Caries	Tooth type	Observed	Caries	% Caries	
UI	168	0	0	UI	52	0	0	-
UC	84	0	0	UC	26	0	0	-
UP	170	0	0	UP	52	1	1.92	P=0.537
UM	252	6	2.38	UM	78	0	0	P=0.384
U-total	674	6	0.89	U-total	208	1	0.48	P=0.896
LI	130	0	0	LI	44	0	0	-
LC	65	0	0	LC	22	0	0	-
LP	130	0	0	LP	43	0	0	-
LM	195	4	2.05	LM	65	2	3.08	P=0.991
L-total	520	4	0.77	L-total	174	2	1.15	P=0.994
Grand Total	1194	10	0.84	Grand Total	382	3	0.79	P=0.820

Table 5 shows the carious sites. In the early middle age group, coronal caries accounted for 70% of the caries, but there was no root caries. In the late middle age group, all the carious lesions involved the root.

Table 5. Site of caries cavities.

Site	Early middle age	Late middle age
Coronal caries	7(70%)	0(0%)
Root caries	0(0%)	3(100%)
Unjudgeable	3(30%)	0(0%)

was no significant difference between the two age groups, and enamel hypoplasia was observed in 30-40% of the individuals.

Table 6. Enamel hypoplasias of Somali people in Early middle age and Late middle age.

Enamel hypoplasias	n	Observed (%)	P-value
Early middle age	42	14(33.33)	P=0.843
Late middle age	13	4(30.77)	

Table 7 shows observations of cribra orbitalia, and a mild porotic type was most frequently observed. There was no

Table 6 shows observations of enamel hypoplasias. There

difference in cribra orbitalia between the two age groups. The frequency of porotic hyperostosis in the parietal or occipital bone was 11.9% in the early middle age group and

7.69% in the late middle age group, and no statistically significant difference was observed between the age groups.

*Table 7. Cribra orbitalia of Somali people in Early middle age and Late middle age.*

	n	porotic (%)	cribrotic (%)	trabecular (%)	Total (%)	P-value
Early middle age	42	4 (9.52)	4 (9.52)	1 (2.38)	9 (21.43)	P=0.563
Late middle age	13	5 (38.46)	0 (0.00)	0 (0.00)	5 (38.46)	

## 4. Discussion

### 4.1. Periodontal Disease and Caries

Periodontal disease and dental caries, the two major oral diseases, are discussed below. As shown in Table 1, the AMTL rate was 2.60% in the early middle age group. This percentage was relatively very low, indicating the loss of a maximum of 1 tooth out of 32 teeth. In the late middle age group, the AMTL rate was 17.02%, which indicates the loss of approximately 5.4 teeth. Thus, the number of missing teeth clearly increased with aging. There was a significant increase in alveolar bone loss with aging as shown in Table 3, while there was no change in the caries rate with aging as shown in Table 4. These results indicate that tooth loss in Somalis was due to periodontal disease and not caries. Although it is difficult to speculate on the details of their diet, they are believed to have ingested a low intake of simple sugars and carbohydrates and other low-cariogenic food. The Somali skeletal remains showed the presence of periodontal disease from early middle age. The disease progressed with age and caused alveolar bone loss, which eventually resulted in bone that could not support the teeth and tooth loss. When an analysis was performed by tooth type, the region of the posterior teeth tended to change more with aging than the region of the anterior teeth. However, the region of the anterior teeth changed significantly with aging in the mandible but did not show any clear change in the maxilla. The reason for this observation is not presently known but should be investigated in future studies. In this study, the author observed an unexpectedly large number of remaining teeth in the late middle age individuals, similar to the Edo individuals in Japan [12].

In this study, the number of missing teeth was low in Somalis. As shown in Table 5, there was a high frequency of coronal caries in the early middle age individuals, but root caries accounted for 100% of carious lesions in the late middle age individuals. These results support the author's conclusions in previous studies [13]. Namely, the results indicate that the roots were progressively exposed as the periodontal disease progressed with age, and caries affected the exposed cementum roots, which are weaker than the enamel portions of the teeth.

### 4.2. Dental Attrition Level

As shown in Table 2, the anterior teeth showed no change in dental attrition with aging. However, the attrition level of the posterior teeth was significantly more severe in the late

middle age group compared with the early middle age group. Therefore, attrition of the posterior teeth progressed with aging. However, there was a relatively low level of attrition in the mandibular anterior teeth beginning in the early middle age [10]. The anterior teeth might have also been used for activities other than mastication. Our previous study examined teeth in Nigerians [13]. When the attrition level was compared between Nigerians and Somalis, Nigerians exhibited a higher attrition score compared with Somalis. The Nigerian individuals lived in the second half of the 19<sup>th</sup> century, while the Somali individuals lived from the end of the 19<sup>th</sup> century to the early 20<sup>th</sup> century. Thus, the difference in attrition level may have been caused by generational differences and dietary habits.

### 4.3. Enamel Hypoplasias

The frequency of enamel hypoplasias did not differ between the late middle age group and the early middle age group. The frequency of enamel hypoplasia was 33% in the early middle age group and 30% in the late middle age group. Enamel is formed from infancy to childhood [14]. Thus, a potential reason that no difference in the enamel hypoplasia frequency was observed is the lack of a relationship between enamel formation and changes with aging from the early to late middle age.

### 4.4. Cranial Stress Marker

In paleopathology, the nutritional status of an individual or a group is often assessed using criteria such as the presence of cranial porotic hyperostosis and cribra orbitalia, which is considered to be caused by iron-deficiency anemia [15]. As Table 7 indicated, the porotic type was the most frequent type of cribra orbitalia in the late middle age group. No individuals exhibited the severe cribrotic type or trabecular type cribra orbitalia. In the early middle age group, the percentage of individuals with the porotic type was similar to the percentage with the cribrotic type. One individual exhibited the trabecular type of cribra orbitalia. Unlike enamel hypoplasia, the formation of cribra orbitalia is not limited to individuals of a certain age. Furthermore, the individuals with moderate to severe cribrotic or trabecular cribra orbitalia likely died before they reached late middle age. The frequency of cranial porotic hyperostosis did not differ between the early middle age group and the late middle age group as shown in table 8. However, the frequency of cribra orbitalia was high in the early middle age group but low in the late middle age group. In general, cranial porotic hyperostosis is more often observed in

infancy and childhood, and serious findings are rarely observed in adolescents and adults [16]. The results likely reflect the difference in the age of onset between cribra orbitalia and cranial porotic hyperostosis.

**Table 8.** Porotic hyperostosis on crania of Somali people in Early middle age and Late middle age.

	n	porotic (%)	Total (%)	P-value
Early middle age	42	5	11.90 (%)	P=0.900
Late middle age	13	1	7.69 (%)	

#### 4.5. Limitations of this Study

Because of the relatively small number of specimens, only male specimens were analyzed in this study. Furthermore, it is impossible to determine dental diseases of Somali people who died a century ago and the rate of emergence for each stress marker using the results of this study. Various problems may also be encountered in the direct comparison of modern day peoples. We obtained data from ancient human bones that provided us clues to recognize dental diseases, stress markers, and potential environmental stressors of the Somalis of at least 70-80 years ago. Therefore, although this study exhibits some limitations, the results can provide a significant contribution to modern health science across the world if used with careful interpretation and application.

## Acknowledgement

I thank Dr. M. M. Lahr of the Director of Duckworth Laboratory, Leverhulme Centre for Human Evolutional Studies, the University of Cambridge, UK, for her kind permission to study the materials under her care.

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