

# HEALTH AND LIFE CHARACTERISTICS OF KÜÇÜK AYASOFYA POPULATION

## KÜÇÜK AYASOFYA TOPLUMUNUN SAĞLIK VE YAŞAM ÖZELLİKLERİ

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**Keywords:** Küçük Ayasofya Mosque, health, teeth, disease

**Anahtar Sözcükler:** Küçük Ayasofya Camii, sağlık, diş, hastalık

### ABSTRACT

*Skeletal remains are the conventional materials used in assessing the physical, genetic, and health characteristics of past cultures and to infer on their dietary history, lifestyle and demography. The purpose of this study is to examine the characteristic markers in the life of a Late Byzantine population who lived nearby the Sea of Marmara in Istanbul and to assess the nutrition and effects of urbanization in the area. Remains are from the five graves uncovered 1,5 m under the floor of the Küçük Ayasofya Mosque. In the study, age at death, sex, dental and skeleton population specific diseases were examined. The population consists of 20 individuals; 5 subadults, 9 adults and 6 unaged. There were a few cases of disease including periostitis, spondylolisthesis, spina bifida and a rare case of pink teeth of P2. There was a well developed arthritis in a male knee joint and vertebral osteophytes in some adults. The health is determined from teeth, trauma and infectious diseases of the skeletal remains. It is thought that there were various factors related to increased urbanization and intense labor causing nutritional stress and trauma.*

### ÖZET

*İskelet kalıntılarından, sıklıkla yeme alışkanlığının tarihçesini ve yaşam biçimini, demografilerden ise fiziki, genetik ve sağlıkla ilgili özellikleri belirlemek amacıyla yararlanılır. Bu çalışmanın amacı, İstanbul'da Marmara Denizi kıyısında yaşamış Geç Bizans topluluğunun fiziki karakterlerini araştırarak bölgedeki beslenme ve sürekli şehirleşmenin etkisini ortaya koymaktır. Çalışılan kalıntılar, Küçük Ayasofya Camii'nin 1,5 m altında bulunan beş mezardan elde edilmiştir. Ölüm yaşı, cinsiyet, diş ve topluma özgü spesifik hastalıklar araştırılmıştır. Topluluk, 5 çocuk, 9 yetişkin ve 6 yaşı bilinmeyen kişiden oluşmaktadır. Grupta, az sayıda periostitis, spondylolithesis, spina bifida ve nadir görülen olan pembe diş vakası saptanmıştır. Bir yetişkin erkekte ekstrem diz eklemi ve bazı yetişkinlerde de vertabrada osteofit gelişimi gözlenmiştir. Diş, travma ve enfeksiyonel hastalıklardan belirlenen topluluğun sağlığının hem uzun süren şehirleşme hem de ağır fiziki güç gerektiren işçiliklerde çalışılmasından ötürü beslenme sorunu yaşadığı ve travma geçirdiği düşünülmektedir.*

## INTRODUCTION

Bioarchaeology is defined as the application of scientific techniques to the assessment of ancient biological remains. Osteological analyses of skeletal and dental remains are frequently used to identify physical, genetic, and health characteristics of a population. Teeth are considered as one of the most reliable indicators of diet, since they are formed in embryonic life, being affected by diet, environment and genetics. Inferences are also made about dietary history, lifestyle and demography from the bones (Angel 1971; Özbek 1990; Güleç et al. 1998; Sevim et al. 2004). Bioarchaeology has now the means to procure data, measure and to infer on any past population providing to develop an insight on the subsistence patterns. Moreover, the developments in the methodology and in the scope of bioarchaeological research has now become a stimulus to other academic fields, triggering wide range of new research prospects, for example providing the interface between biological characteristics and economic success in ancient cultures (Erdal and Duyar 1998). The critical role of subsistence and diet in human biology and culture is best reflected in the adaptive shift from foraging to farming that took place during the last 10,000 years, eventually to become the global model, (Cohen and Armelagos 1984; Larsen 1995).

Human dentition and bones have been under control of genetics and environmental factors (Larsen 2002). Dental diseases, bone degeneration, infection and trauma are the most studied markers in skeletal remains to obtain data on cultural practices (Angel 1971; Brothwell 1981). The study of enamel defects is well illustrated with hypoplasia for ancient populations (Hodges 1987; Van Gerven et al. 1990; Cucina and İşcan 1997). Chronic infectious diseases, including periodontism, dental caries, periostitis and osteoarthritis has remained unchanged over thousands of years (Stewart 1953; Rudan et al. 2004). The protrusion of an intervertebral disc defined as Schmorl's node, is another often seen pathology in skeletal populations (Saluja et al. 1986), considered to be associated with biomechanical stress on the corpus of vertebrae (Lovell 1997; Üstündağ 2009). Some congenital anomalies are frequently studied on the vertebrae such as spondylolisthesis and sacral spina bifida caused by neural arch defect, not only in the past but also in contemporary human groups (Stewart 1953; Kumar and Tubbs 2011).

The purpose of this study is to investigate health and physical characteristics of a small Late Byzantine population who lived in a coastal area of the Sea of Marmara in Istanbul.

## MATERIALS AND METHODS

The Küçük Ayasofya Mosque (KAS) is located in Sultanahmet-Kadirga district of Istanbul, close to the Sea of Marmara, in the vicinity of the ruins of the Great Palace (Fig. 1) (Anonymous 2009). Originally built as a church in 527-536 A.D by the Byzantine emperor Justinian I and his wife Theodora, adjoining the northern wall of an existing basilica dedicated to the Saints Peter and Paul, inside the sea walls along the Sea of Marmara. The church was also in close proximity of the Hormisdas Palace, Justinian's residence prior to his enthronement. Both churches shared a courtyard to the west and they were surrounded by monastery buildings managed by the Monophysites. Historical resources show that the church was dedicated to the Saints Sergius and Bacchus ([archnet.org/library/sites/one-site.jsp?site\\_id=7343](http://archnet.org/library/sites/one-site.jsp?site_id=7343)). It was altered to a mosque in 1506 during the rule of Sultan Beyazid II (Fig. 1).

The material considered with this paper are human skeletal remains (Graves 1-6) found 1,5 m recovered below in the marble floor of Küçük Ayasofya Mosque during the restoration works carried out under the auspices of the Istanbul Archaeological Museums in 2011. The documents and final reports of the excavation are not available yet, but according to M. Gökçay<sup>1</sup>, the archaeologist in charge of the excavation, seemingly the bodies were buried haphazardly on top of each other without any particular directions or positions. Some skeletons have bulks of lime on their chests and one of the burials was in a wooden coffin filled with lime. Moreover, the graves were gouted with lime and the top of the grave was closed by stone. Gökçay has emphasized that such process took place when plague was in question. The graves might have been dated to the Late Byzantine period but it is not certain yet<sup>2</sup>. The remains were studied at the Istanbul University Institute of Forensic Sciences Anthropology Laboratory. The photographs illustrated in the article (also the Mosque) were taken by the authors with a digital camera.

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Graves G1 through G5 were analyzed; the bones from G6 were excluded from the study since the bones were heavily covered by lime and their study will necessitate radiographic technique. Hardened soil surrounding bones were removed with soft brushes in the laboratory and broken bones were mended with acetone based glue. The bone preservation was good. The minimum number of individuals was determined from the maximum number of any one bone with left and right sides recorded separately. Adult age was estimated according to established anthropological standards such are dental eruption in mandible (Brothwell 1981), suture closure of cranium (Meindl and Lovejoy 1985), epiphyseal union of long bones (McKern and Stewart 1957), and changes on the sternal end of rib (Işcan et al. 1984, 1985). For children dental eruption and diaphyseal length of long bones were used to approximate age at death (Moorrees 1957; Ubelaker 1978). Since skeletally based sex identification is often not reliable for children and juveniles, sex was not determined for the KAS children. In adults sexual dimorphism was observed in the orbit size, glabella, angle of greater sciatic notch and the circumference diameter of long bones (Martin and Saller 1957; Krogman and Işcan 1986).

Differential diagnosis of dental and skeletal pathology was made according to criteria in relevant publications (Ortner 2003). All pathology was examined in preserved bones of identified individuals in the population. Dental dimensions of mesiodistal (MD) and buccolingual (MD) were taken with a sliding digital caliper sensitive to 0,01 mm. The damaged teeth were not studied. Dental dimensions were averaged between left and right sides. Because of the fewer number of females in the sample, the differences could not be evaluated. An odontometric comparison was made with Galatas (11th-17th century) population of Greece (Işcan et al. 2007) and Adramyttion (5th-6th century A.D.) of Turkey (Atamtürk and Duyar 2008) both are located near the seaside.

## RESULTS

The present study is based on the analysis of the demographic, pathologic, and physical status of individuals recovered in five graves. It has been considered that dentition and bone structure are good indicators of many aspects of human characteristics such as the determination of sex and estimation of

age. The Küçük Ayasofya sample consists of 20 individuals (5 subadults and 15 adults) (Table 1). The sex was determined for all adults. Ages for all but 6 specimens could not be estimated. Of the children three were babies in 0-3 age category. The death ratio of children to adults had a high value of 25%. Age range for adults was 30-50 years and mean age was 38 years. There was no individual in the 18-30 year group. Of the 15 adults, 13 were males and two were females. Dentition was observed in 85 permanent and 14 deciduous teeth evaluated in terms of tooth present per sex, growth status and health (Table 2). The number of teeth was evenly distributed per dental category in children. The back teeth were better preserved in children. In males, similar situation, that is, more teeth in the back were observed. The measured dimensions were compared with the ones of the Galatas and the Adramyttions (Table 3).

The teeth size seemed smaller in many specimens in the KAS population. For example, MD dimensions of a maxillary P2 were smaller than those of the others. The frequency of dental pathological cases was observed for each tooth separately for children and adults (Table 4). The caries and abscesses were located on the buccal and occlusal surfaces. Three adult males had 4 caries and two abscesses (Fig. 2a). Calculus accumulation was observed in males and not in females. There was only one female edentulous mandible (Fig. 2c). Two children and 8 males had hypoplastic teeth with frequent horizontal lines. They were visible in all teeth especially canine through premolars (Fig. 2b). Calculus, carries, and abscesses were not observed in the children.

The rare case of pink teeth was observed in one individual only, the color being light pink. The tooth has no abnormality and was in situ in P2 in the left mandible (Fig. 2d). Only present pathological conditions were analyzed and are presented in the Table 5.

Almost all pathological lesions were present in males, only one female had osteophytosis in thoracic and lumbar vertebrae; accordingly, sex distribution in pathological cases could not be done. One male had severe osteoarthritis with enlarged patellar surfaces (Fig. 2g), articular condyles of the femur (Fig. 2j), and tibia of both sides, but did not have the similar conditions in other extremities. This defect spondylolisthesis, a variant of spondylolysis, repre-

sented by lumbar 4 and 5 where sliding and slip forward action between L4 and 5 as well as S1 (which is missing in the collection) in a male (Fig. 2f). But a few spondylitis cases summarized in a review work by Erkman and colleagues (Erkman et al. 2008). Two male individuals had moderate periostitic inflammation on fragmentary femur and tibiae as porous fiber (Fig. 2i). There were also several cases of degenerative arthritis most notably in the thoracic and lumbar vertebrae (Fig. 2e). Of all adults, 3 males and one female had well developed osteophytes but there were 2 males and a female with Schmorl's nodes. Two individual sacra have partial spina bifida involving sacrum 3 to 5 of a child and an adult male (Fig. 2h).

## DISCUSSION

The analysis of skeletal pathology and dental health yields important information about mortality, historical and geographic distribution of specific diseases, differences in diet and physiological stress as well as social structure of societies (Powell 1988; Larsen 2002). Evidently, the present study is based on the analysis of a restricted sample that had been recovered at Küçük Ayasofya in Istanbul of Late Byzantine period. We are conscious of the fact that the history of Istanbul is far more complex and multifarious being deeply rooted in prehistory, living through the glorious episodes of Roman, Byzantine and Ottoman Empires, at the same time attaining a central position to a number of religions including the Orthodox Church (Baynes et al. 1949). Even though the precise dating of our sampling is not available yet, they are of the Late Byzantine Period, of a short but a dynamic period within the long historic narrative of the city. The time of the Crusades had led to turmoil in the Byzantine Empire, the 4th Crusade devastating and destroying most of the city in 1204. Even though the city tried to recover and partially restored after being recaptured by the Byzantines during the 14th century, the people remained economically poor and population size dwindled down from about one million to less than a hundred thousand (Gregory 2010); subsistence activities such as fishing were carried out by small bands of people.

The analyses of the KAS sample could not have been done precisely. Six individuals had one or two fragmented bones which makes the age estimation

not possible. Usually age estimation is difficult and requires fairly complete skeletons (Krogman and İşcan 1986; İşcan 1989). The tooth size was found to be smaller in the KAS than the ones of the Galatas and Adramyttion communities. Garn and his colleagues (1979) noted that inadequacy in nutrition affected fetal dental size. They claimed that bad nutritional intake and health factors might lead early fetal death and these children may have had underdeveloped dentition. Therefore one can make inferences about early growth of teeth by assessing nutrition, size and anomalies.

The morphological characteristics of the KAS sample suggested that teeth are in good condition. Enamel hypoplasia is a dental defect showing arrested growth lines or pits in enamels. Skinner and Goodman recorded nutritional and health stresses during childhood (Skinner and Goodman 1992). Of the odontometric studies variation in dental dimensions was attributed to malnutrition and general stress arising from adaptation to war and hard labor. It has been known that stresses arising from wars and labor inadequacy needed for the social development may have haunted the population and labor caused biological stresses as illustrated by some researchers. Nicholson has indicated that pelvic inlet may react to nutritional stress by reducing its size and affecting successful birth (Nicholson 1945). Similar thought have also been raised by Angel involving this time incomplete growth of basilar suture on a time manner and reduction in the size of the cranial volume (Angel 1976). Almost all adult teeth of KAS people have frequently occurring lines yet the frequency in children is fewer. This situation may suggest that there is a differential exposure associated with age similar those stresses affecting the pelvic inlet as noted above during pre and post-war times. Comparison of the dental pathologies of KAS with other Byzantine populations is shown in the table (Table 6). Hypoplasia percentage (80%) was more in the KAS than all İznik (Erdal 1996), Kadıkalesi (Üstündağ 2008), Adramyttion (Atamtürk and Duyar 2008), Eski Cezaevi (Erdal 2003), Galatas (İşcan et al. 2007), Alanya Kalesi (Üstündağ and Demirel 2009), and Smyrna Agorası skeletal remains (Yaşar et al. 2008). Calculus rate was similar to Eskicezaevi and İznik communities. Abscesses and caries rates were higher than all compared populations. The frequency of carious lesions from a variety of archaeological sites shows a high association with the amount of carbo-

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hydrate consumption. High rates of dental caries are commonly seen in diets involving sticky food as in agricultural societies (Lucas 2004). According to M. Özbek 10% of all caries of the ancient Anatolian populations resulted from the carbohydrate consumption (Özbek 2007).

There are other conditions, in KAS people, frequency of which is rather low, including abscess, periodontal condition and antemortem tooth loss but sex differences were not observed. Generally periodontal disease involves an inflammatory response to irritants and undesirable hygiene. The most common irritant is calculus. (Held 1989). Variation in the consistency of food due to its toughness and preparation methods is a primary factor in antemortem tooth loss with dental attrition or caries a significant precipitating factor (Beckett and Lovell 1994; Bonfiglioli et al. 2003). Pink teeth were first described in the 17th century. Later investigations suggested that it is caused by an increased intrapulpal pressure (Kirkham et al. 1977). Many anthropologic and odontologic studies showed that it may occur before or after death and bodies found immersed in water or asphyxia (Borrman et al. 1994; Soriano et al. 2009). Its origin is yet unclear but the presence of such a case in the KAS sample may be explained by the fact that the population occupied in a coastal area where pink teeth were frequently seen.

Periostitis of long bones is an inflammatory disease commonly seen in tibiae associated with trauma and found frequently in ancient populations. The reaction to the trauma can be in the form of compact or porous fiber bone (Ortner 2003) When compared with the Alanya Kalesi (40,5%) and the İznik (25,6%) samples, the periostitis cases were less in KAS (13%). Osteoarthritis is caused by the breakdown and eventual loss of the cartilage of one or more synovial joints. The loss of the cartilage which may arise from stresses and heavy labor can cause

problems at the joint. Such conditions are frequently observed in the elderly individuals. However, it is also claimed that individuals with certain arthritic conditions might have genetic predisposition, age and sex differences (Brothwell 1981). Osteoarthritis seen in the KAS sample is a rather severe case affecting the bones of the knee joints bilaterally. Spina bifida is an asymptomatic and does not present medical problems as far as the sacral arch is concerned. Observed at S3, S4, and S5 should be considered within the limits of normal variation of the sacral hiatus (Kumar and Tubbs 2011). Although not severe, two individuals have partially developed partial spina bifida making the person subject to them external insults.

In conclusion, the KAS population lived along the Istanbul sea coast facing both Sea of Marmara and Bosphorus and seems as if they have lived in an urban area. Although the sample size is small and archaeological data has not been provided to the authors, pathologies may still give an idea about the life of people during the Late Byzantine Period in Istanbul. Dental pathology frequency was close to those compared. Skeletal diseases were mostly represented by one or two individuals except vertebral degenerations. The health was determined from teeth, trauma and bony infection. Considering the fact that Istanbul was under increasing urbanization creating trauma and requiring intense labor to recover and reduce nutritional stress.

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#### NOTES

<sup>1</sup> Metin Gökçay. Küçük Ayasofya Excavation. Personal communication. April 12 2008, Istanbul.

<sup>2</sup> Metin Gökçay. Küçük Ayasofya Excavation. Personal communication. September 13 2011, Istanbul.

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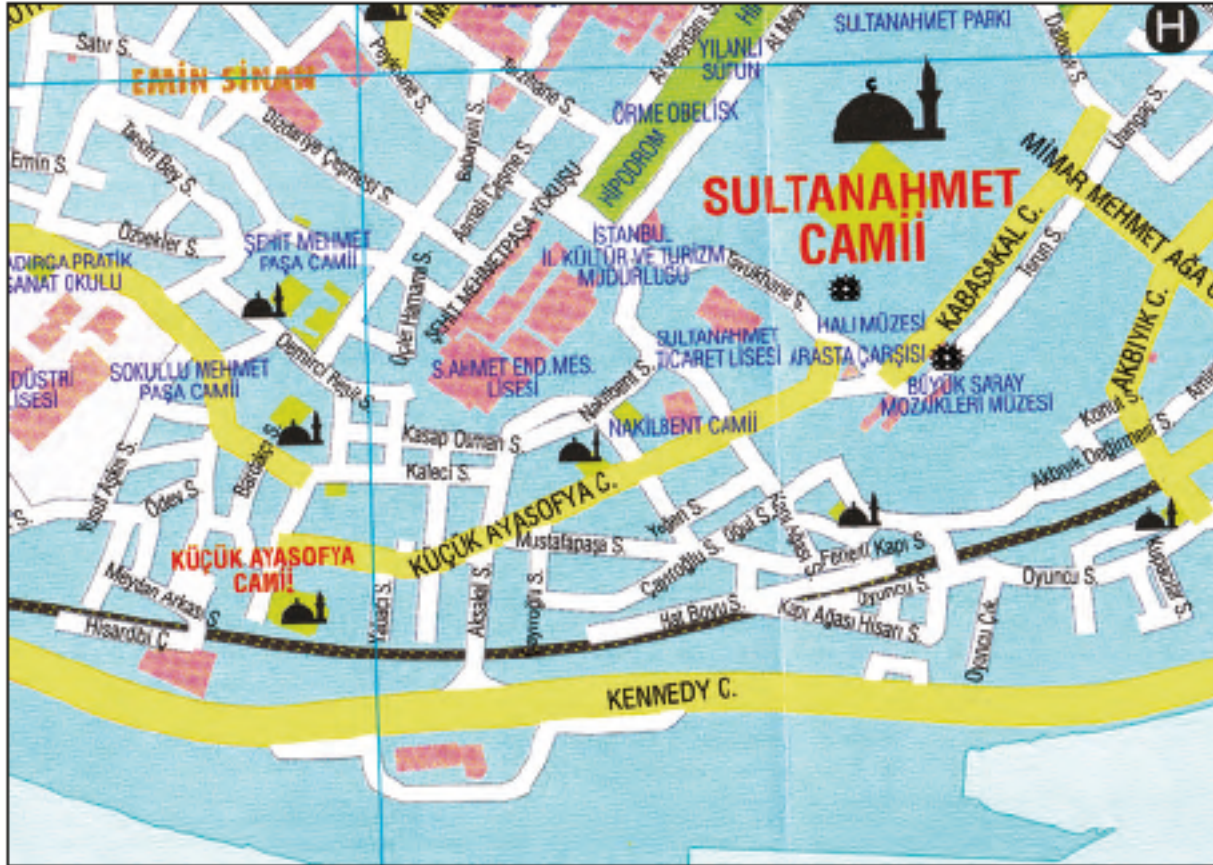


Fig. 1 - The location of the Küçük Ayasofya Mosque



Fig. 2a - Carries



Fig. 2b - Hypoplasia

HEALTH AND LIFE CHARACTERISTICS OF KÜÇÜK AYASOFYA POPULATION



Fig. 2c - Antemortem tooth lost



Fig. 2d - Pink tooth



Fig. 2e - Osteophytosis



Fig. 2f - Spondylolisthesis



Fig. 2g - Osteoarthritis in patella



Fig. 2h - Spina Bifida



Fig. 2i - Tibial periostitis



Fig. 2j - Osteoarthritis in femur

Age groups	Total		Males		Females		Total
	N	%	N	%	N	%	N
Babies(0-3)	3	15					
Children(4-11)	1	5					
Adolacent (12-17)	1	5					5
Adults (30-50)	9	45	8	53	1	5	9
Adults (not aged)	6	30	5	37	1	5	6
Total	20	100	13	90	2	10	20

Table 1. Distribution by age intervals and sex in the Küçük Ayasofya population.

Dentition	Children	Males	Females	Total
	N=2	N=8	N=2	N=12
I1	1	5	0	6
I2	2	9	0	11
C	1	14	0	15
P1	3	14	0	17
P2	2	13	0	15
M1	3	13	0	16
M2	3	12	0	15
M3	0	4	0	4
Total	15	84	0	99

Table 2. Frequency of dental remains in the Küçük Ayasofya population.

	Küçük Ayasofya				Galatas				Adramyttion			
	MD		BL		MD		BL		MD		BL	
	Maxilla											
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
I1	1	5,21	0		2	7,48	2	6,61	4	7,36	4	6,59
I2	2	6,20	1	6,27	2	6,35	2	5,78	4	6,66	4	6,09
C	2	6,98	2	7,40	7	7,03	7	7,72	3	6,98	3	8,12
P1	3	6,50	2	8,22	5	7,29	5	7,57	7	6,88	7	8,32
P2	2	6,49	1	8,83	6	7,37	6	7,86	3	6,91	4	8,23
M1	2	10,20	1	10,81	5	9,94	5	10,81	3	9,91	3	10,35
M2	2	9,76	1	10,29	5	10,22	5	10,93	4	9,71	4	10,07
M3	1	7,57	1	9,22	2	8,18	2	11,35	4	9,09	4	9,77
	Mandible											
I1	4	6,48	2	5,71	8	5,46	7	6,34	7	5,12	7	5,73
I2	4	6,58	2	6,30	7	6,51	7	6,48	5	5,43	7	5,86
C	3	6,05	3	6,40	9	6,84	10	7,91	6	6,49	6	7,13
P1	5	6,25	4	7,42	15	6,50	14	7,19	6	6,55	6	6,86
P2	5	6,67	4	7,62	10	6,66	10	8,12	7	6,61	7	7,46
M1	5	9,77	4	9,62	13	10,04	14	10,02	5	10,24	6	10,32
M2	5	9,60	4	9,19	14	10,13	14	9,72	5	9,96	6	10,04
M3	2	10,49	2	9,09	11	10,06	12	9,59	4	9,35	4	9,07

\*Galatas (İşcan et al. 2007: 29) Adramyttion (Atamtürk and Dayar 2008: 210)

Table 3. Descriptive statistics of odontometric characteristics of the Küçük Ayasofya with those of Galatas and Adramyttion populations.

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Dentition	Hypoplasia			Caries			Calculus			Abscess		
	C	M	F	C	M	F	C	M	F	C	M	F
	N=2	N=8	N=2	N=2	N=8	N=2	N=2	N=8	N=2	N=2	N=8	N=2
I1	0	0	0	0		0	0	2	0	0		
I2	0	0	0	0		0	0	3	0	0		
C	1	6	0	0		0	0	3	0	0	1	1
P1	1	2	0	0		0	0	3	0	0		
P2	1	4	0	0		0	0	2	0	0		
M1	1	0	0	0		0	0	4	0	0		
M2	1	1	0	0	1	0	0	2	0	0		
M3	0	0	0	0	3	0	0	0	0	0		
Total	5	13	0	0	4	0	0	19	0	0	1	1

\*C: Children, M: Adult males, F: Adult females

Table 4 Number (N) of dental pathological cases in the Küçük Ayasofya population.

Pathologies	Bone	Number of individuals	Present bones	Observed bones	Observed pathology
Osteoarthritis	Femur	15	19	2	1
	Tibia	15	14	2	1
	Patella	15	10	2	1
Osteophytosis	Thoracic vertebrae	15	20	6	4
	Lumbar vertebrae	15	10	9	4
Schmorl's Node	Thoracic vertebrae	15	10	5	3
	Lumbar vertebrae	15	20	5	4
	vertebrae	15	20	5	4
Spina bifida	Sacrum	15	4	1	1
	Lumbar				
Spondylolisthesis	vertebrae	15	10	1	1
Periostitis	Femur	15	19	1	1
	Tibia	15	14	2	2

Table 5. Number of skeletal lesions found in the Küçük Ayasofya population.

Population	Hypoplasia	Calculus	Carries	Abscess
	%	%	%	%
Küçük Ayasofya (Istanbul)	80	53	20	10
Adramyttion (Balıkesir)	60,2	29,6	10,1	1,4
Galatas (Poros/Greece)	7,35		1,22	2,86
Eskicezaevi (Istanbul)	75,4	57,2	9,6	5,1
Iznik (Iznik)	36,8	59,3	10,9	3,9
Kadıkalesi (Aydın)	35	55	65	
Alanya Kalesi (Antalya)	39,7	29,6	12,6	2,3
Symna Agorası (İzmir)	11,7	16,96	4,48	1,63

Table 6. Comparison of dental pathologies of the Küçük Ayasofya with Byzantine Period populations in Anatolia.