

DENTAL CARIES AND ANTEMORTEM TOOTH LOSS IN LATE ANTIQUE CAUCASIAN IBERIA: A BIOARCHAEOLOGICAL STUDY OF DUSHETI MUNICIPALITY AND GREAT MTSKHETA

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ABSTRACT: This bioarchaeological study investigates the prevalence of dental caries and antemortem tooth loss (AMTL) in Late Antique populations of Dusheti municipality and Great Mtskheta in the Caucasus region of Georgia. Dental health data from 75 individuals and 666 examined teeth were analyzed to understand the relationships between dental pathologies, sex, age, and geographical location. Statistical analyses, including chi-square tests, were conducted to assess differences in caries and AMTL frequencies between sexes and regions. The results revealed significant disparities in dental health between Dusheti and Mtskheta, with higher AMTL prevalence observed in Dusheti. Furthermore, age and sex disparities in dental health were identified, with middle-aged adults exhibiting higher AMTL frequency and males demonstrating a higher prevalence of dental caries. These findings highlight the importance of considering historical, socio-economic, and geopolitical factors in understanding oral health outcomes in Late Antique populations. Further interdisciplinary research is recommended to enhance our understanding of oral health dynamics in ancient societies.

KEYWORDS: AMTL, Caries, Late Antiquity, Caucasian Iberia

Dental caries and antemortem tooth loss (AMTL) are key indicators in bioarchaeological research, providing important insights into the health, lifestyle, and dietary patterns of communities throughout Late Antiquity (1st–4th century AD). This study explores the complex relationship between oral disorders, specifically AMTL and car-

ies, to shed light on the intricate interplay of food, cultural developments, and health over this historical period.

During Late Antiquity, which was characterized by significant changes in nutrition, culture, and demographics (Armelagos, Cohen, 1984; Larsen, 1995, 2015), dental health emerges as an important lens through which to evaluate broader health dynamics. Studies in the New World have underlined significant sex disparities in oral health, with females demonstrating greater rates of caries and AMTL. These disparities become more prominent during agricultural changes, which may be impacted by changing sex-based food patterns (Lukacs, 1996) or increasing parity (Fields et al., 2009; Watson et al., 2010). Hormonal fluctuations, saliva pH, and osteoporosis have all been identified as factors influencing oral health during this time period (Lukacs, 2008; Watson et al., 2010).

AMTL refers to the cumulative loss of teeth over an individual's lifetime, often caused by dental caries or periodontal disease (Hillson, 2001; Shigli et al., 2009). Caries result from bacterial activity that converts carbohydrates into acids, leading to the dissolution of enamel and dentin (Hillson, 1996). Left untreated, this process can progress to pulp chamber infection, abscess formation, or tooth exfoliation (Kubehl & Temple, 2020). Another significant aspect is tooth wear, which refers to the wearing down of enamel, potentially exposing dentin and increasing susceptibility to infection and AMTL (Watson, 2008a, 2008b).

The clinical research on osteoporosis has established a substantial link between age-related bone loss and AMTL in living populations (Nicolopoulou-Karayianni et al., 2009; Savić Pavićin et al., 2017). Postcranial bone loss in osteoporotic patients is associated with alveolar bone loss, which eventually leads to tooth loss (Guiglia et al., 2013; Jonasson, Rythén, 2016). Research suggests that postmenopausal women with osteoporosis are more likely to experience tooth loss (Nicolopoulou-Karayianni et al., 2009; Savić Pavićin et al., 2017). This emphasizes the need for having a thorough understanding of how bone health affects dental outcomes.

In Georgia, no research has been conducted on dental caries and antemortem tooth loss (AMTL) during Late Antiquity. This study is the first to examine dental diseases in the Late Antiquity population of Georgia.

The main aim of the paper is to investigate the relationship between AMTL and sex/age, as well as the correlation between caries and sex/age. In addition, the present study aims to compare the Late Antique population of Dusheti municipality with that of Mtskheta regarding dental diseases. Were dental diseases prevalent common in females, and did they experience a different situation between the lowland and the foothills?

HISTORICAL CONTEXT

In 30 BC, Octavian's consolidation of power marked the end of the Roman Republic and concluded the Hellenistic age, inaugurating the Roman Empire and

ushering in Late Antiquity, particularly during the 1st–2nd centuries AD. This pivotal moment triggered a series of events that reverberated through the geopolitical landscape, and Caucasian Iberia found itself at the crossroads of the Roman Near East (Furtwangler, Gagoshidz et. al, 2008). The 1st century A.D. unfolded as a dynamic era shaped by invasions, alliances, and the ebb and flow of regional powers. The Kingdom of Iberia played a strategic role in navigating the complex spheres of influence between Rome and Parthia. This historical analysis delves into the intricate dynamics of this period, emphasizing the impact of the Sarmatian invasion, Rome's foreign policy, and Iberia's evolving role in the broader political context (Furtwangler, Gagoshidz et. al, 2008).

The early centuries of this epoch witnessed a significant surge in international economic relations. Iberia actively participated in the global trade network, and Mtskheta, as the capital of Kartli, played a central role in these economic interactions, positioned at the intersection of major roadways and emerging commerce routes. A compelling aspect of this era is the interplay between lowlands and mountains regions. Agricultural expansion from prehistoric times continued to shape the cultural dynamics. Recent archaeological findings from the Dzinvali expedition uncovered a densely populated settlement in Dzinvali, with evidence of urban characteristics dating primarily from the second to eighth centuries (Ramishvili, 2018). The geographical landscape of Iberia included vibrant and well-populated urban centers, as documented in *Strabo's Geography* (127). The majority of Iberians inhabited the plains, while a significant mountainous population, known for their martial inclination, coexisted with neighboring Scythians and Sarmatians, forming kinship ties despite simultaneously engaging in agricultural practices (*Strabo's Geography*, 128). The population of Iberia exhibited a hierarchical structure, divided into four categories – kings, who held the highest societal positions, judges administered justice, knights and horsemen, who embodied military prowess, and husbandmen, along with royal servants, represented agricultural pursuits and service to the monarchy (*Strabo's Geography*, p. 129–130). The graves from the 3rd to 4th centuries AD in the Dzinvali cemetery exhibit striking similarities to those in Armaziskhevi, Ertso plain, Urnisi, and other cemeteries. These collective burials are indicative of a specific cultural event characteristic of the region. In the 1st–2nd centuries, Iberian pitiakhshes emerged as state officials loyal to Rome, later demonstrating obedience to Sasanian Iran in the early Middle Ages, as evidenced by Varsken in the Kvemo Kartli *bidaxsh* (Bragvadze, 2021). Mtskheta, as the largest city in the Kartli kingdom, held a prominent position as its political epicenter. The city's substantial size, diverse population, and convergence of craft production, trade, and agriculture underscored its significance. Distinct districts like Tsitsamuri, Sapityakhsho, and Sarkine played vital roles in border control, winemaking, and the supply of weapons and metal products to the capital. Dusheti's hierarchical relationship with Mtskheta positioned the latter as the royal and pitiakhsh residence (Bragvadze, 2021).

MATERIALS AND METHODS

This study examines dental health in the Late Antiquity populations of Dusheti municipality and Great Mtskheta (fig.1), utilizing materials from the Institute of History and Ethnology's anthropology laboratory collected between the 1940s and 1970s. Due to limited specimen availability, the use of adhesive-coated teeth hindered specific dental attribute analysis, making it difficult to distinguish dental calculus, enamel hypoplasia, and tooth attrition. However, this preservation technique facilitated the distinction between antemortem tooth loss (AMTL) and caries.



Fig. 1. Map of Georgia with the locations of the Dusheti Municipality and “Great Mtskheta” sites

This study is based on dental remains from late antique sites (dating back to the first-fourth centuries AD) in Zhinvali, Aragvispiri, Nedzikhvi, Mlashe, and “Didi Mtskheta” (Samtavro, Armazi, Sagitara, Mogvtakari, Svetitskhoveli, Karniskhevi), including data from 75 individuals and 666 examined teeth. The study identifies distinct changes in AMTL and caries prevalence, providing valuable insights into oral health dynamics across multiple geographical contexts during the Late Antiquity. The materials consist of 48 males and 27 females (fig. 2).

Since the research material was compiled only from skulls, biological sex was determined using cranial features, and age was estimated based on the teeth. The biological sex of adult skeletons was assessed primarily using the cranium, with a focus on the morphology of the nuchal crest, mastoid process, glabella/supraorbital area, supraorbital margin, and mental eminence (Walker, 2008). The age-at-death was estimated based on the stage of cranial suture closure stages (Meindl, Lovejoy, 1985). Age estimates were determined using dental eruption and attrition criteria, as outlined by Buikstra and Ubelaker (1994), categorizing individuals into young adults (18–29 years), middle adults (30–49 years), or older adults (50+ years). Dental caries were identified through macroscopic observation, recording the location and number of caries on each tooth. The closure of dental sockets due to alveolar

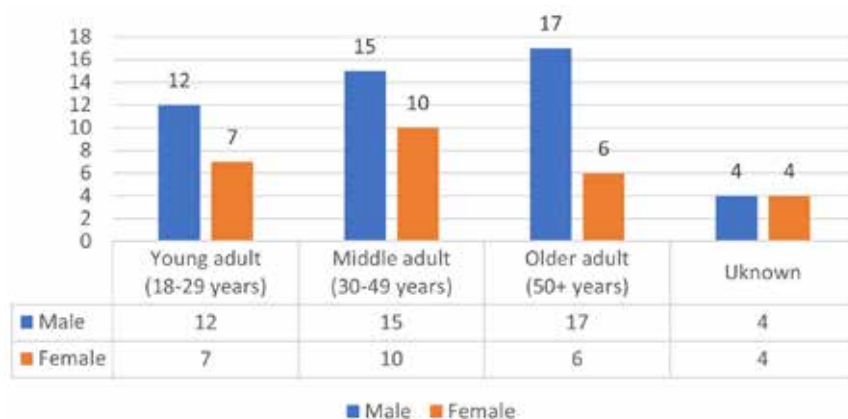


Fig. 2. Distribution of Dusheti and Mtskheta Region skeletal sample (n=75)

bone remodeling was considered as an indicator of antemortem tooth loss (AMTL), following the methodology outlined by Ubelaker (1994).

STATISTICAL ANALYSES

In this study, chi-square tests were employed to assess the differences in caries frequency and AMTL frequency between males and females across sample of 75 individuals and 666 examined teeth. Additionally, chi-square tests were utilized to investigate sex differences in both caries and AMTL prevalence.

The chi-square test is a statistical method commonly applied to determine whether there is a significant association between two categorical variables. This method allowed us to evaluate whether significant differences existed in the occurrence of dental caries and AMTL between males and females within the Late Antique populations of Dusheti municipality and Great Mtskheta.

RESULTS

Table 1 presents the observed teeth and frequency of caries and AMTL at Dusheti municipality and “Great Mtskheta”. Using this table, I made a chi-square test to determine whether caries and AMTL were more common in males in late antiquity than in females (see: tbl. 2). Despite the paucity of material, the relationship between caries incidence and sex is statistically significant at the conventional significance level ($p < 0.05$). There is evidence that there is a relationship between caries incidence and sex in the sample, with a higher prevalence of caries being observed in male than in female. Regarding AMTL, there is insufficient evidence to conclude that there is a relationship between AMTL frequency and sex in the sample.

Tbl. 1. Summary of dental pathologies

	Observed	caries N	Caries frequency %	AMTL N	AMTL frequency (%)
Male	412	17	4.10%	55	13.30%
Female	254	2	0.80%	28	11%
Total	666	19	2.90%	83	12.50%

Abbreviation: AMTL-antemortem tooth loss

Tbl. 2. Statistical Analysis of Sex Differences in AMTL and Caries Frequency

	χ^2	n (females, males)	df	p
AMTL frequency (%)	0.6095	25,47	1	.043496
Caries frequency (%)	6.0174.	25,47	1	.014165.

Age-related changes in AMTL were analyzed using the aged and sexed crania of the Dusheti and Mtskheta series. When the samples divided into younger, middle and older adults, the middle adult group had higher frequency of AMTL than the Younger group or older group ($p < 0.01$). But the chi-square test does not suggest a significant association between Caries frequency and Age category. The p-value is greater than the conventional significance level ($p > 0.05$), indicating that the observed association is not statistically significant. Therefore, there is insufficient evidence to conclude that Caries frequency varies significantly across different age categories (see: tbl. 3).

Tbl. 3. Statistical Analysis of Age Categories and Dental Health Parameters

	χ^2	Age category N (Young, Middle, Older, unknown)	df	p
AMTL frequency	35.7142.	8,32,23,11	3	<0.00001
Caries frequency	2.5562.	5,5,6,3	3	.465212.

POPULATION COMPARISON OF DENTAL CARIES AND AMTL

In this study, we conducted a comparative analysis of antemortem tooth loss (AMTL) and dental caries prevalence in the Dusheti and Mtskheta regions. Our findings revealed significant disparities in AMTL prevalence between the two regions. In Dusheti, the chi-square test indicated a substantial association between AMTL frequency and region, with a higher proportion of individuals experiencing antemortem tooth loss compared to those in Mtskheta. Conversely, our analysis of dental caries frequency did not reveal any significant differences between the regions (see: tbl. 4, 5).

Tbl. 4. Results of Chi-square Tests for AMTL Frequency Between Dusheti and Mtskheta

Region	χ^2	df	p
Dusheti, Mtskheta	5.8349.	1	0.015712

Tbl. 5. Results of Chi-square Tests for Caries Frequency Between Dusheti and Mtskheta

Region	χ^2	df	p
Dusheti, Mtskheta	0.8097.	1	0.36822

DISCUSSION

While isotopic analysis could have provided valuable insights into the dietary patterns of the Late Antique populations in Dusheti and Mtskheta, its absence in our study prompts us to rely on historical and archaeological context to understand potential factors influencing dental health disparities between these regions.

Late Antiquity in Caucasian Iberia was characterized by intricate geopolitical dynamics, with Rome, Parthia, and Sarmatian invasions shaping the socio-cultural landscape. Strabo's historical narratives of the mountain-dwelling Iberians, their martial nature, and alliances with neighboring powers offer significant context. These historical insights enrich our understanding of the socio-cultural milieu likely impacting oral health trends.

In the 1st century AD, Georgia was divided into Iberia and Colchis, with trade primarily conducted by the Romans, leading to shifts in familial structures, economic disparities, and social hierarchies. The rise of Persia and the decline of Rome weakened Georgia economically, impacting regions like Mtskheta, which had been politically and economically influential until the 4th century, leading to its eventual decline and isolation. Internal changes within Georgian tribes, such as the emergence of private land ownership and noble ranks, further shaped societal dynamics.

Mtskheta's significance during Late Antiquity is evident from its economic and political advancements, as indicated by Roman favoritism. However, from the 3rd century AD onwards, Georgia's trade with foreign powers declined due to the weakening of the Roman Empire and the ascension of Persia. Persian dominance and persistent conflicts also contributed to the decline in trade and agriculture, ultimately affecting the economy and quality of life in the region.

The observed dental pathologies in Dusheti and Mtskheta, particularly the higher prevalence of antemortem tooth loss (AMTL) in Dusheti compared to Mtskheta, may be attributed to these historical and socio-economic factors. Dusheti's geographical location and historical context likely subjected it to greater instability and conflict, leading to poorer overall health outcomes compared to Mtskheta. The decline in trade and agriculture due to Persian dominance may have further exacerbated health disparities, impacting the prevalence of dental caries and AMTL in these regions.

Moreover, our study reveals significant age and sex disparities in dental health. Middle-aged adults exhibited a higher frequency of AMTL compared to younger and older adults, highlighting potential vulnerabilities during this life stage. Furthermore, males demonstrated a higher prevalence of dental caries compared to females, suggesting potential gender-specific dietary or cultural factors influencing oral health outcomes.

In conclusion, while our study sheds light on dental health trends in Late Antique Caucasian Iberia, further interdisciplinary research incorporating isotopic analysis and broader historical context is necessary to fully elucidate the complex interplay of socio-economic, geopolitical, and environmental factors influencing oral health outcomes during this period.

Implications for Future Research: The study suggests that future research should include innovative dental examination methodologies, larger sample sizes, and geographical variety. These improvements can help us better understand the oral health dynamics of late antique societies.

CONCLUSION

In conclusion, our study provides valuable insights into the dental health dynamics of Late Antique populations in the Caucasus region, focusing on the Dusheti and Mtskheta areas in Georgia. Through a comprehensive analysis of dental pathologies, including caries and antemortem tooth loss (AMTL), we have uncovered significant disparities in oral health between these regions.

Our findings highlight the importance of considering historical, socio-economic, and geopolitical factors when interpreting bioarchaeological data. The higher prevalence of AMTL in Dusheti compared to Mtskheta suggests that geographical location and historical context played a significant role in shaping oral health outcomes. Factors such as instability, conflict, and changes in trade and agriculture likely contributed to poorer overall health outcomes in Dusheti.

Furthermore, our study reveals age and sex disparities in dental health, with middle-aged adults exhibiting a higher frequency of AMTL and males demonstrating a higher prevalence of dental caries. These findings underscore the need for a nuanced understanding of socio-cultural factors and gender-specific dietary practices in Late Antique societies.

While our study sheds light on dental health trends in Late Antique Caucasian Iberia, it also highlights the limitations of our research, such as the absence of isotopic analysis to elucidate dietary patterns. Future research should incorporate innovative methodologies, larger sample sizes, and geographical diversity to further advance our understanding of oral health dynamics in late antique populations.

In summary, our study contributes to the interdisciplinary field of bioarchaeology and historical epidemiology by elucidating the complex interplay of socio-economic, geopolitical, and environmental factors influencing oral health outcomes during Late Antiquity in the Caucasus region. By integrating archaeological evidence with

historical context, we can gain valuable insights into the health and lifestyle of past populations, ultimately enhancing our understanding of human health across different time periods and geographic regions.

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